Building resilience for social-ecological sustainability in Atlantic Europe

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Declaration

This is to certify that the work I am submitting is my own and has not been submitted for another degree, either at University College Cork or elsewhere. All external references and sources are clearly acknowledged and identified within the contents. I have read and understood the regulations of University College Cork concerning plagiarism.

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5th September 2016

Abstract

This thesis argues that complex adaptive social–ecological systems (SES) theory has important implications for the design of integrated ocean and coastal governance in the European Union (EU). Traditional systems of governance have struggled to deal with the global changes, complexity and uncertainties that challenge a transition towards sustainability in Europe's maritime macro-regions and sea basins. There is an apparent disconnect between governance strategies for sustainability in Europe's maritime macro-regions and a sound theoretical basis for them. My premise is that the design of governance architecture for maritime regional sustainability in Atlantic Europe should be informed by SES theory. Therefore, the aim of this research was to gain insight into a multilevel adaptive governance architecture that combines notions of sustainability and development in the context of the Atlantic Europe maritime macro-region. The central research question asked whether it is possible to achieve this insight by using a SES as a framework and analytical tool for relating governance architecture to maritime regional sustainability.

This research adopted social ecology and sustainability science as a foundation for understanding society–nature relations. Concepts from complex adaptive systems, SES and resilience theories were integrated into a conceptual framework that guided the investigation and analysis. A study was conducted to conceptualise the European Atlantic social–ecological system (EASES) as the unit of analysis. This was used to represent and understand the Atlantic Europe macro-region as a SES. The study examined the proposition that governance can be focused on building SES resilience to help achieve maritime regional sustainability. A workbook method was developed and used to elicit expert opinion regarding the conceptualisation of EASES. The study of EASES identified sources of resilience and resilience dynamics that require management in the context of multilevel adaptive governance. This research found that the Atlantic Europe macro-region is a key focal level for multilevel adaptive governance architecture. The majority of the findings are specific to Atlantic Europe and not generalisable to other situations or maritime macro-regions in Europe.

Maritime SES, particularly at macro-regional level, have received comparatively little attention from the research community. This thesis provides some theoretical justification for the EU's approach towards maritime policy and governance. It contributes a conceptual framework for understanding maritime macro-regional SES. It also contributes some general design guidelines for SES-based architecture for integrated maritime governance. This thesis concludes the following: To achieve maritime regional sustainability in Atlantic Europe, actors at every level in maritime governance need to understand and work with complex adaptive SES properties in order to build and manage resilience. Therefore, the design of multilevel adaptive governance architecture should be guided by complex adaptive systems thinking, a SES-based conceptualisation of the system-to-be-governed and a resilience framework for analysis.

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Glossary of acronyms and abbreviations

α	Reorganisation phase of the adaptive cycle
AAC	Atlantic Arc Commission
AC3A	Association of Chambers of Agriculture of the Atlantic Arc
ASDP	Atlantic Spatial Development Perspective
ASG	EU Atlantic Strategy Group
ATN	Atlantic Transnational Network
BSS	Baltic Sea Strategy
CAAC	Conference of Atlantic Arc Cities
CAQDAS	Computer assisted qualitative data analysis software
CAS	Complex adaptive system(s)
CFP	Common Fisheries Policy
CPMR	Conference of Peripheral Maritime Regions of Europe
DG ENV	Directorate-General for the Environment
DG MARE	Directorate-General for Maritime Affairs and Fisheries
DG REGIO	Directorate-General for Regional and Urban Policy
EASES	European Atlantic social–ecological system
EEA	European Environment Agency
EEZ	Exclusive Economic Zone(s)
EMFF	European Maritime and Fisheries Fund
ERDF	European Regional Development Fund
ESaTDOR	European Seas and Territorial Development, Opportunities and Risks
ESDP	European Spatial Development Perspective
ESPON	European Observation Network for Territorial Development and Cohesion
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
Fig.	Figure
GES	Good environmental status
GFCM	General Fisheries Commission for the Mediterranean
GIWA	Global International Waters Assessment

GST	General systems theory
HELCOM	Convention on the Protection of the Marine Environment of the Baltic Sea Area (a.k.a. Helsinki Convention)
ICES	International Council for the Exploration of the Sea
ICZM	Integrated coastal zone management
IHDP	International Human Dimension Programme on Global Environmental Change
IMO	International Maritime Organization
IMP	Integrated Maritime Policy for the European Union
Interreg	Interregional European Territorial Cooperation financing instrument of European regional development
ISOE	Institute for Social-Ecological Research
K	Conservation phase of the adaptive cycle
LME	Large marine ecosystem(s)
LOICZ	Land-Ocean Interactions in the Coastal Zone
MA	Millennium Ecosystem Assessment
MAES	Mapping and Assessment of Ecosystems and their Services
MEOW	Marine Ecoregions of the World
MEP	Member of the European Parliament
MPA	Marine protected area(s)
MSFD	Marine Strategy Framework Directive
MSP	Maritime spatial planning
MSY	Maximum sustainable yield
NEAFC	North East Atlantic Fisheries Commission
NEAT	North–East Atlantic regional sea
NGO	Non-governmental organisation(s)
NGT	Nominal group technique
NUTS	*Nomenclature des Unités Territoriales Statistiques*
Ω	Release phase of the adaptive cycle
OSPAR	Convention for the Protection of the marine Environment of the North-East Atlantic
PSSA	Particularly Sensitive Sea Area
r	Accumulation phase of the adaptive cycle
RAC	Regional Advisory Council(s)

RQ	Research question
S&T	Science and technology
SES	Social–ecological system(s)
SF	Structural Fund(s)
SPICOSA	Science and Policy Integration for Coastal Systems Assessment
UK	United Kingdom of Great Britain and Northern Ireland
UN	United Nations
UNCED	UN Conference on Environment and Development (‘Earth Summit’)
UNCLOS	United Nations Convention on the Law of the Sea
UNCSD	UN Conference on Sustainable Development (‘Rio+20’)
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
USA	United States of America
WCED	World Commission on Environment and Development
WFD	Water Framework Directive

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Beara, West Cork, September 2016

Chapter 1
Introduction

> 'The seas are Europe's lifeblood. Europe's maritime spaces and its coasts are central to its well-being and prosperity – they are Europe's trade routes, climate regulator, sources of food, energy and resources, and a favoured site for its citizens' residence and recreation' (European Commission 2007a: 2).

These are the opening words of the European Commission's Communication on An Integrated Maritime Policy for the European Union. They encapsulate the rationale behind the Commission's efforts to make Europe's maritime dimension a strategic priority for the European Union (EU). Here, maritime refers to human activities and policies concerning the oceans, seas and coastal regions. The European Commission's focus on developing a comprehensive policy on maritime affairs is a response to the rapidly changing, highly competitive and increasingly globalised world. Maritime affairs are now firmly established on the EU's political and economic agenda, which has been shaped by the recent global financial, economic and social crisis. In this context, EU policy is aimed at developing the potential of the European maritime economy in order to contribute to Europe's economic recovery and growth.

The EU's ambition to create sustainable economic growth and employment in the maritime economy must be reconciled with EU commitments to promote sustainable development and strengthen economic, social and territorial cohesion between Europe's regions and member states. In other words, the EU faces the challenge of balancing substantial maritime development of its territory with increased levels of ocean and coastal resource conservation and environmental protection. EU politicians, policy makers and stakeholders must therefore strive to achieve and maintain maritime regional sustainability for the well-being of present and future generations. The EU Integrated Maritime Policy (IMP) was introduced to address these commitments and goals by, among other things, changing the way in which sea-related policy is made and decisions are taken.

However, conventional institutions of knowledge production, policy formulation, planning and decision making have struggled to deal with these challenges.

A major challenge facing EU policy makers concerned with the maritime dimension is how to design and implement an effective multilevel system of maritime governance. That is, a system of governance capable of dealing with the unprecedented global changes (including climate change), complex cross-scale interactions and pervasive uncertainties that arise from human activities and their interactions with the environment. In this thesis, I argue that the theory of complex adaptive social–ecological systems has important implications for the design of integrated ocean and coastal governance in the EU. My basic premise is that a governance architecture based on social–ecological systems is necessary for European maritime governance to successfully meet the challenges of global change and sustainable development.

This chapter introduces the main themes of the thesis and provides an overview of the research. Section 1.1 presents the general background and rationale for the research. Section 1.2 sets out the research problem, propositions, research questions and study objectives, and considers the significance of the research. Section 1.3 summarises the research methodology and the conceptual framework for the study. Finally, section 1.4 presents an overview of the thesis structure.

1.1 Background

Throughout history, the human inhabitants of Europe's Atlantic periphery have relied on the seas and coasts to provide for their physical, social, cultural and economic well-being. Numerous coastal communities have evolved and endured in the face of storms, floods and other destructive natural events. For centuries, despite or perhaps because of such natural hazards, the context for this relationship has been the prevailing view that humankind has dominion over nature. The oceans and seas have long been viewed as inexhaustible reservoirs of both living and non-living natural resources; as unrestricted spaces for the transport of goods and people, and for naval and other sea-based activities; and as limitless sinks for the disposal of wastes. In many places, the coastline itself has a long history of being engineered to drain wetlands and 'reclaim' land from seabed or to provide structures to defend against inundation and erosion by the sea. Dominion over the seas and coasts continues to this day in the guise of command and control approaches (Holling and Meffe 1996) to coastal zone planning and management, fisheries management and other types of marine and coastal resource management. It is a subject that I am familiar with on a personal as well as intellectual level, having previously worked with marine environmental non-governmental organisations (NGO) for two decades.

Human activities and their impacts

Recognition that humans are a powerful force capable of manipulating nature, including to the detriment of human well-being, is not new. For example, Marsh (1864) argued that, since ancient times, imprudent human actions are a powerful force capable of producing environmental changes with harmful repercussions for both nature and human well-being. This is just one example to illustrate that society–nature relations have been recognised in the academic literature for many decades. Our relationship with nature is the principal object of my curiosity.

Only relatively recently has society, including science, begun to recognise that human activities taking place at sea, on land and in the atmosphere result in pressures on marine and coastal environments;[1] and that these activities and their impacts significantly affect biological diversity (biodiversity), ecological processes and structures and, consequently, the ability of ecosystems to support human social and economic development. Put simply, there are limits to how much fish and other natural resources can be extracted from the seas and coasts. Increasing demand and competition for coastal and marine space and access to resources diminishes human security. The concentration of urban systems, human populations and activities in coastal zones increases society's vulnerability to natural forces and anthropogenic influences, including climate change. Only

[1] For example, the Land-Ocean Interactions in the Coastal Zone (LOICZ, http://www.loicz.org) international research project, which commenced in 1993; and the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA, http://www.gpa.unep.org), adopted in 1995 by the United Nations Environment Programme (UNEP).

‘healthy’ marine and coastal ecosystems with adequately conserved biodiversity will continue to provide ecological services vital to human well-being and development.

The multiplicity of human activities and the changes they bring about in marine and coastal environments, associated ecosystems and interdependent social systems are generally well known, if not well understood (OSPAR 2000, 2010; Frid *et al.* 2003; EEA 2007a: Chapter 5). For example, the pressure that commercial fisheries exert on marine ecosystem structures, species composition and sensitive habitats through the removal of biomass, disturbance and modification are well known (FAO 2012). However, the corresponding social and economic consequences of unsustainable fishing activities (such as loss of employment and income when catches diminish, effort is restricted or when fishing grounds are closed leading to increased hardship in often already marginalised coastal communities and regions) are not (Prime Minister’s Strategy Unit 2004). Emerging issues are more uncertain and somewhat less familiar. These include issues such as the relationship between (European) lifestyles and the state of the marine environment, influence of climate change, consequences of new generations of synthetic chemicals, and effects of developing offshore renewable energy and other new uses of maritime space (Langmead *et al.* 2007). Likewise, the indirect and cumulative impacts, interactions among pressures and impacts, and synergistic effects arising from multiple and overlapping human activities (as well as from natural processes and events) have barely begun to be addressed (European Commission 2001a; Halpern *et al.* 2008).[2]

Complex problem clusters

There is a growing recognition that, rather than addressing single issues, solutions must be found to multiple interacting problems of unprecedented complexity that challenge the sustainability of the maritime dimension and stand in the way of sustainable development. Schmandt (2006: 2352) refers to ‘complex problem

[2] Synergistic effects arise when interactions produce a total effect greater than the sum of the individual effects, so that the character of the final impact is different to the character of both the individual impacts and the cumulative impact. Cumulative impacts are the combined result of incremental changes and additive effects involving several individual impacts. Indirect impacts (sometimes referred to as secondary impacts) are not a direct result of the human activity, but occur away from the original effect or as a result of a complex pathway.

clusters' that arise from multiple, cumulative and interactive natural and social stresses caused by demographic and economic growth, which impact (directly or indirectly) on natural systems. Therefore, it is important to understand complex problem clusters in their context.

In general, research efforts explicitly focused on questions of sustainability are problem driven and have the goal of creating and applying knowledge in support of decision making for sustainable development. The role of sustainability science is to untangle the complexity of dynamic interactions between humans and the rest of nature, thereby providing a knowledge base; and to do so while recognising that knowledge about individual components of social and ecological systems provides insufficient understanding about the behaviour of whole systems (Clark and Dickson 2003). Indeed, efforts to provide useful knowledge for solving highly complex sustainability problems often require fundamental advances in our conceptualisation and understanding of integrated social and ecological systems (Clark 2007; Fischer *et al.* 2015).

Ecological systems and social systems

For the purpose of this thesis, I adopt Christopherson's (1997) definition of ecosystem as 'a natural unit consisting of all plants, animals and micro-organisms (biotic factors) in an area functioning together with all of the non-living physical (abiotic) factors'. It is commonly assumed that this definition places humans, or at least socially-constructed aspects of humans, outside the ecosystem. I use the term 'ecological system' to encompass all the different types of ecosystems (interacting biotic and abiotic factors) that occur at a certain place or, more specifically, within the geographical unit of analysis used in this research.

Ecosystems and the human physical world (i.e. human beings and the concrete products of human society, such as technology) exist in the physical reality of Popper's (1978) World 1. Society, social systems and other intangible products of the human mind exist in the socially constructed reality of Popper's World 3. I use the term 'social system' to refer to a grouping of people (World 1) and their fundamental interrelationships, interactions and constructions (World 3). The concept of social system encompasses interpersonal relationships, communication, identity, group membership, values, norms, institutions and social organisation. It also includes the roles that individuals, communities and other actors play in society, which includes cultural, economic, political and technological aspects.

Social–ecological systems

The ability of interacting and interdependent social and ecological systems to both sustain and be sustained while continuing to co-evolve is of fundamental significance to maritime affairs at all levels. Solutions to the interwoven ecological, social and economic problems that challenge sustainability depend on our ability to understand the interplay between persistence and change, disturbance and reorganisation, and sustaining and development in complex adaptive systems (CAS) in general (Levin 1998) and social–ecological systems (SES) in particular (Berkes and Folke 1998a; Folke 2006). SES are complex integrated systems of individual people, human society, the built economy and the rest of nature (Costanza 1996, 2003, 2011; Costanza *et al.* 2007a, 2012a, 2014).[3] They are a type of CAS (the theory of complex adaptive SES is described in Chapter 2). The term 'social–ecological system' and other terms involving 'social–ecological' are used to emphasise the integrative humans-in-nature perspective, which stresses that the conceptual and analytical distinction between social and ecological systems is artificial and arbitrary (Berkes and Folke 1998a: 4). Social and ecological systems are deeply and dynamically interconnected through interactions and reciprocal feedbacks across scales; in effect, they are equally important, interdependent subsystems that function as a coupled co-evolutionary system (Gunderson and Holling 2002; Berkes 2011a: 12). This thesis focuses on the sustainability of maritime (ocean and coastal) SES.

Sustainable development and sustainability

The terms 'sustainable development' and 'sustainability' have different meanings in different contexts. Nowadays, both terms are part of the international lexicon and often used interchangeably. However, they are not synonymous.

[3] Social–ecological systems are alternatively referred to as socio-ecological systems (Gallopín *et al.* 1989; Young *et al.* 2006a), ecological–economic systems (Costanza 1996; Costanza *et al.* 1993a), coupled human–environment systems (Turner *et al.* 2003a; Schröter *et al.* 2005a) and coupled human and natural systems (Liu *et al.* 2007a; McConnell *et al.* 2011).

In 1987 the World Commission on Environment and Development (WCED) brought the concept of sustainable development to global attention with the publication of its report to the United Nations (UN) titled *Our Common Future* (WCED 1987a). The WCED is also known as the Brundtland Commission after Gro Harlem Brundtland, the then Prime Minister of Norway, who established and chaired it. The Brundtland Commission is widely credited with popularising the notion of sustainable development as an 'overriding and global political concept' (WCED 1987b: 5). Nevertheless, both the Commission and the concept originated in the 1972 UN Conference on the Human Environment in Stockholm, Sweden. This was the first major international conference to discuss sustainability on a global level (Kates *et al.* 2005; UNGSP 2010). It was also the first to proclaim a common outlook and common principles based on integrating environmental factors with social and economic development (UN 1973). Subsequently, the first prominent conception of sustainable development appeared in 1980 in the World Conservation Strategy (IUCN/UNEP/WWF 1980). The strategy emphasised the interdependence between development to satisfy human needs and improve well-being, and the conservation of living resources. It argued for a global approach towards achieving sustainable modes of development and sustainable use of species and ecosystems. The strategy also proposed ways of integrating conservation into the development process for the essential benefit of people.

Thus, the Brundtland Commission was able to draw on precursory conceptual frameworks regarding sustainable development when it began its undertaking to 'elaborate upon this concept, to analyse what it should mean and to draw conclusions as to how our behaviour must change so that development can be sustainable' (WCED 1987b: 5). The Brundtland Commission's formulation of the concept of sustainable development is particularly conspicuous and, therefore, provides a widely accepted starting point for discussions concerning sustainability (Adger and Jordan 2009a). In the words of Brundtland upon presenting *Our Common Future* to the Governing Council of UNEP:

> "We define sustainable development in simple terms as paths of progress which meet the needs and aspirations of the present generation without

compromising the ability of future generations to meet their needs" (WCED 1987c: 4).

Clearly, there is a relationship between sustainable development and sustainability. What, then, is sustainability? The concept of sustainability emerged primarily from ecology and scientific perspectives on the fundamental character of the interactions between social and ecological systems. Although definitions of sustainability vary (Table 1.1), most assume the need to balance environmental/ecological, social and economic factors simultaneously while promoting the judicious use of resources and the reduction of waste (e.g. Keiner 2004; Manderson 2006; see also White 2013). There is, however, almost universal agreement regarding the necessity to harness science and technology, and integrate other, diverse forms of knowledge (van Kerkhoff and Lebel 2006) in promoting a global social transition towards sustainability; a transition that enhances human well-being and prosperity while simultaneously protecting the Earth's life-support systems and substantially reducing hunger and poverty (WCED 1987a; Lubchenco 1998: 495; NRC 1999a; Kates *et al.* 2001; ICSU 2002; Raskin *et al.* 2002; Kates and Parris 2003; Parris and Kates 2003; Clark *et al.* 2004; Robinson 2004; Martens and Rotmans 2005; Schmandt 2006).

Table 1.1 Selection of definitions of sustainability in the environment and development, ecological economics and sustainability science literatures.

Author(s)	**Definition**
Solow 1993: 181	[Sustainability] is an obligation to conduct ourselves so that we leave to the future the option or the capacity to be as well off as we are.
Allen and Hoekstra 1993: 107	[Sustainability] is a process of evolution that is incorporating humans and their institutions into a larger ecological system.
Serageldin 1996: 188	Sustainability is to leave future generations as many opportunities as, if not more than, we have had ourselves.
NRC 1999a: 21	Ours is a normative vision of sustainability, which in our view is defined by the joint objectives of meeting human needs while preserving life support

	systems and reducing hunger and poverty.
Costanza *et al.* 2001: 5	Sustainability broadly refers to the persistence of the integrity and structure of any system over time; the concept is thus of central interest to both ecologists and policy analysts who study resource use.
McMichael *et al.* 2003: 1919	For human populations, sustainability means transforming our ways of living to maximize the chances that environmental and social conditions will indefinitely support human security, wellbeing, and health.
Robinson 2004: 381	[Sustainability is an] approach or process of community-based thinking that indicates we need to integrate environmental, social and economic issues in a long-term perspective, while remaining open to fundamental differences about the way that is to be accomplished and even the ultimate purposes involved.
Manderson 2006: 96	[Sustainability is] the changing ability of one or many systems to sustain the changing requirements of one or many systems, over time.
Bosselmann 2008: 53	The principle of sustainability itself is best defined as the duty to protect and restore the integrity of the Earth's ecological systems.
Levin 2012: 432	[Sustainability] includes the stability of financial markets and economic systems, of reliable sources of energy, as well as of biological and cultural diversity. At the core, though, it must mean the preservation of the services that we derive from ecosystems, and this raises a suite of scientific challenges.

Sustainability can be viewed as both an outcome and a process (Adger and Jordan 2009a: 5-6). Sustainability is an outcome in the sense of what of universal value to society is to be sustained: the overall quality of human well-being and the ecosystems on which humanity ultimately depends. Sustainability is also a process of change in the way society is organised to achieve the desired outcome: a change in how society–environment interactions are shaped and directed to sustain social and economic development and the ecological basis in the long term. The process dimension of sustainability is intimately linked with the notion of governing and, therefore, governance.

Governing and governance

A successful transition towards the normative goals of sustainable development and sustainability requires a collective ability and willingness to govern human–environment interactions and society–nature relations. That is, to coordinate, control or steer the dynamics of SES. Governance is a large topic in its own right and a detailed discussion is beyond the scope of this thesis. However, it is important to have a general idea of what governance is.

The concept of governance is used in many academic fields, including political science, public administration, political geography, sociology, human ecology, institutional economics and ecological economics (Kok and Veldkamp 2011). The popularity, conceptual vagueness and loose application of the term 'governance' have produced a plethora of definitions and hindered multidisciplinary consensus regarding the concept's core meanings and attributes (van Kersbergen and van Waarden 2004). Nevertheless, a number of important points concerning governance have emerged over the last two decades. These are succinctly summarised by Adger and Jordan (2009a: 10-11) as (1) governance is not the same as either governing or government; and (2) governance is not bound to a particular period of time or geographical place.

According to Kooiman (1993a), the term 'governing' refers to the activities of social, political and administrative actors 'that can be seen as purposeful efforts to guide, steer, control or manage (sectors or facets of) societies' (p. 2). In contrast, 'governance' describes the patterns (i.e. outcome and higher-level framework for day-to-day governing efforts) that emerge from such governing activities. In modern societies, governance is a mix of governing activities by, and interactions between, diverse social-political actors at different organisational levels, in different modes; a combination of efforts to guide and direct society in response to persistent and changing governing demands set against ever growing social diversity, dynamics and complexity (Kooiman 2003: 3).

The notion of government implies a formal governing process, a hierarchical decision-making structure, and a monocentric approach in which political power and authority is centred on the institutions and actions of the state. However, the concept of governance has the capacity 'to cover the whole range of institutions and relationships involved in the process of governing' (Pierre and Peters 2000: 1). Governance intersects with and extends beyond the state and traditional government. Governance is characterised by (1) a shift towards participation in governing activity at different levels by previously uninvolved non-state actors; (2) new and changing models of interaction and growing interdependencies between political, economic and other social actors concerning a collective set of challenges and responsibilities; (3) dispersion of centralised government authority; (4) less formal and more inclusive institutions; and (5) the creation of co-governing arrangements, that is, interactive social-political structures, networks, processes that stimulate communication between actors, and non-hierarchical forms of decision making (Kooiman 1993b, 2003; Pierre and Peters 2000; Kohler-Koch and Rittberger 2006; Adger and Jordan 2009a; Termeer *et al.* 2010). Simply put, governance signifies a change in the meaning of government (Rhodes 1996).

There are no universally accepted principles of environmental governance.[4] However, the basic principles of 'good' environmental governance for sustainable development were endorsed in the Rio Declaration signed at the 1992 UN Conference on Environment and Development or 'Earth Summit' (UNCED). Subsequently, these were reaffirmed in the Johannesburg Declaration adopted at the 2002 World Summit on Sustainable Development and in *The Future We Want* declaration of the 2012 UN Conference on Sustainable Development or 'Rio+20' (UNCSD) (UNGA 2012). The general principles are perhaps best summarised by the UNEP sub-programme on environmental governance, which refers to four key goals or overarching principles for strengthening environmental governance at all levels: sound science for decision-making, international cooperation, national development planning, and international policy setting and technical assistance (UNEP 2009: 2).

It is generally accepted that principles of 'good' environmental governance take into account:

[4] According to UNEP (2009), environmental governance comprises 'the rules, practices, policies and institutions that shape how humans interact with the environment' (p. 2).

- *Levels*. Embedding environmental sustainability in all levels of decision making and policy action, from global to local.
- *Access*. Promoting public access to information; to participation in transparent, inclusive, equitable and accountable decision-making; and to justice and redress.
- *Cooperation*. Effective environmental governance depends on cooperation and partnerships among a diversity of actors and stakeholders (from governments to NGOs, the private sector and civil society) at different levels.
- *Ecosystem basis*. Adopting and implementing an 'ecosystem approach' strategy for the knowledge-based integrated assessment and management of land, water and living resources that promotes conservation and sustainable use in an equitable way.[5]

The principles of environmental governance are, of course, dynamic. New governance principles emerge from new modes of environmental governance and interactions among global, regional and local policy processes (Ramcilovik-Suominen and Shannon 2009).

I do not intend to provide a concrete definition of governance that constrains this research. Instead, I will briefly present my understanding of what governance 'ought' to be: multilevel and adaptive.

Multilevel adaptive governance

A transition towards sustainability requires institutions and governance architecture based on more sophisticated notions than the state actor as sole decision-making authority. Instead, new forms of governance are needed that are based on actor networks and institutions that interact across scales and levels. The specific issue of governance architecture is examined in Chapter 4. Here it is worth highlighting two fundamental principles of governance in the European context. The first is multilevel governance. The second is adaptive governance.

[5] See https://www.cbd.int/ecosystem/ [accessed 27/4/2016].

In the EU, the concept of multilevel governance concerns arrangements and processes in which power, decision-making authority and policy-making influence are not monopolised by the national governments of member states. Decision-making competencies are instead shared (through continuous negotiation) between multiple interconnected levels of governmental and non-governmental institutions and actors: the subnational (local and regional), national, transnational (macro-regional) and supranational levels (Hooghe and Marks 2001, 2003; Bache and Flinders 2004; Piattoni 2010). In terms of EU cohesion policy and maritime policy, a multilevel governance approach calls for (1) the horizontal coordination and integration of national policies and strategies between member states; and (2) vertical coordination and integration with subnational and (potentially) transnational or macro-regional territorial levels of political authority and social and economic perspectives. Multilevel governance is a basic EU approach to cooperation.

Adaptive governance is a suite of approaches that aim to respond to and shape SES dynamics (Olsson *et al.* 2004a, 2006; Folke *et al.* 2005). It addresses the emergence and evolution of flexible institutions (rules and arrangements) and social networks that are capable of addressing complex sustainability problems through a system of ongoing self-organisation and self-governing (Dietz *et al.* 2003). Adaptive governance includes various forms of adaptive management such as adaptive co-management, ecosystem management, integrated coastal zone management, and natural resource management.[6]

Adaptive governance proceeds through a framework that engages stakeholders in an iterative, participative and reflexive process of experimentation, learning by doing, readjustment and planning. The aim of such a system is to facilitate society's adaptability (adaptive capacity) and increase social learning capacity for adaptation (Lebel *et al.* 2006). Adaptive governance is a process that provides and revises a long-term vision and direction for sustainability; a process that identifies competing goals and priorities, power relationships and conflicts. It is a means for

[6] Pahl-Wostl *et al.* (2010) define adaptive management as 'a systematic process for improving management policies and practices by systemic learning from the outcomes of implemented management strategies and by taking into account changes in external factors in a pro-active manner' (p. 573).

resolving trade-offs between decision-making units under conditions of prevailing complexity, uncertainty and change. Adaptive governance is aimed at integrating science, policy and decision making in systems that manage for change rather than against change (Gunderson and Light 2006).

The arrangements and processes of adaptive governance rely on social relations, networks and collaboration among actors according to different formal and informal rule systems and incentives (i.e. institutions). Individuals and groups are connected and coordinated in different institutional settings, at different organisational levels and across spatial and temporal scales. Adaptive governance is subject to diverse experiences and perspectives, values and priorities. Actors and institutions are also subject to power relationships. The devolution of rights and responsibilities, and the sharing of knowledge and power among non-state actors are uneven; significant differentials exist in the autonomy, empowerment and accountability between various public and private non-state actors (Lebel *et al.* 2006; Biermann 2007). In sum, adaptive governance systems are polycentric, multilevel, participatory and collaborative.

A key design challenge regarding multilevel adaptive governance is to match the various institutional arrangements not only to the structure and dynamics of the focal level SES of interest, but also to the interconnected and interdependent levels above and below in the hierarchy of nested systems (Holling 2001; Ostrom 2009). Even so, there is no design blueprint for a single type of governance system. As Andersson and Ostrom (2008) state: 'No perfect governance arrangement exists. All governance institutions are imperfect responses to the challenge of collective-action problems' (p. 73). Nevertheless, architecture for sustainability governance is required and this is discussed in Chapter 4.

Resilience

The concept of resilience is applied to SES. It provides a lens through which to study and understand society–nature relations and the sustainability and sustainable development of SES (Folke 2006). A resilience perspective is also an approach for understanding how multilevel adaptive governance can help society deal with complex problem clusters and cope with global change while continuing to develop (Duit *et al.* 2010).

The concept of resilience is discussed in Chapter 3. Put simply, resilience is the capacity of a CAS (e.g. an ecosystem or landscape, human community or society, market or mixed economy, sociotechnical system or integrated SES) to deal with change and continue to develop in a world facing many challenges and uncertainties (Folke and Gunderson 2006: 1; Huitric *et al.* 2009: 32). Social–ecological resilience is actually a multifaceted and loosely organised cluster of concepts: abstract ideas or mental symbols that represent different aspects of a SES's ability to persist, adapt and when necessary transform in continually changing conditions. Resilience provides a useful organising framework for the analysis of dynamics (e.g. the interplay between development, disturbance and renewal) of SES (Folke 2006; Walker and Salt 2006; Folke *et al.* 2010).

Resilience and related concepts concerning persistence and change in CAS have important implications for EU maritime governance and Europe's relationship with the oceans and seas, especially with regard to the following issues:

- Sustainability of SES in geographically coherent maritime regions of Europe.
- Development and implementation of integrated maritime governance and sea basin strategies for enhanced macro-regional level cooperation towards sustainable, balanced and harmonious development (EU 2012: Article 3) of Europe's maritime sectors and coastal regions.
- Achievement of the EU's political objectives regarding sustainable economic growth and employment in Europe's maritime economy.

1.2 Research problem and questions

The EU's IMP framework (European Commission 2007a) was introduced to address sustainable development and sustainability of marine areas and coastal regions through, among other things, changing the way in which sea-related policy is made and decisions are taken. The IMP promotes an integrated approach to maritime governance at all levels of decision making, including the transnational macro-regional or sea basin level (European Commission 2008a). However,

> *traditional systems of governance have struggled to deal with the unprecedented global changes, complexity of interactions and pervasive uncertainties that challenge a transition towards marine and coastal sustainability in Europe's maritime macro-regions.*

This is the central problem addressed in this thesis.

I use the term 'traditional systems of governance' as an umbrella term to refer to established ('old') instruments, methods, forms, modes and systems of governance in which a state or central authority (e.g. supranational, national, regional or local government or governmental organisation) exercises legislative, administrative or judicial power predominantly through hierarchical structures and processes: hierarchical coordination, institutional steering, rule enforcement and control arrangements, including top-down regulation, in the public, private and market spheres or sectors. Kooiman (1993) sums this up as 'one-way steering and control' (p. 35). Traditional governance is often associated with politically-dominated state institutions, public administration and sectoral regulation. Traditional or old modes of governance tend to rely on organisational and territorial division of the state, with limited governmental autonomy of regional and local levels.

Dunsire (1993) argues that traditional systems of governance are no longer adequate for dealing with the increasing complexity, dynamics and diversity of contemporary society. Therefore, Kooiman (1993b) considers 'new' modes of interactive social-political governance essential to respond effectively to the decision-making challenges created by increased complexity, dynamics and diversity. (Space precludes any discussion of new modes of governance; for further information, the reader is referred to Héritier and Rhodes 2011, particularly the definition of new modes of governance on page 164.) The rationale expressed by Dunsire and Kooiman applies to governance of the EU and its member states in general and to maritime governance in particular. (For an in-depth analysis of the continued failure in governance and policy making regarding the maritime shipping and ports sector, see Roe 2013).

To achieve maritime regional sustainability, actors at every level in maritime governance need to understand the dynamics of SES and work with rather than against fundamental characteristics of CAS. This means dealing with characteristics such as open boundaries, self-organisation, emergence of structure and behaviour (patterns and processes), nonlinear interactions and feedbacks across scales, unpredictability and alternative development trajectories (Levin 1992, 1998). Like Wilson (2006) as regards ocean fisheries, and Curtin and Prellezo (2010) regarding marine ecosystem-based management, I believe that many of the difficulties facing maritime governance in general result from a failure to understand and deal with such CAS characteristics. This is for the following reasons:

> *Marine and coastal systems are complex.* Interactive governance theory argues that fisheries and coastal systems are inherently complex, dynamic and diverse (Chuenpagdee and Jentoft 2009: 112). Complexity necessitates addressing changing relationships and cross-scale interactions between interconnected, interdependent social and ecological subsystems composed of heterogeneous components. Furthermore, interactions take place between the social and ecological 'systems-to-be-governed' (or the objects of governance) and the governing systems (Chuenpagdee 2011: 200). This confronts maritime governance with 'wicked' problems: problems that are difficult to define and differentiate from other problems, difficult to address, have no technical or apparent solution, and which tend to persist, posing a continual challenge (Rittel and Weber 1973; Chuenpagdee and Jentoft 2009).
>
> *Systems of marine and coastal governance are complex.* To be effective, governance systems must somehow reflect the complexity, dynamics, diversity and scale of the marine and coastal social and ecological systems-to-be-governed, as well as respond natural and anthropogenic changes

(Kooiman and Bavinck 2005, 2013; Jentoft and Chuenpagdee 2016: 23; see also Chuenpagdee 2011; Jentoft and Chuenpagdee 2015).

Ecosystems are difficult to manage. According to Chuenpagdee (2011), ocean and coastal ecosystems are likely among the most challenging ecosystems to manage. 'The difficulty stems from the complexity of marine populations, the dynamics of linked social-ecological systems, and the scale issues related to jurisdictional boundaries and organizations' (Chuenpagdee 2011: 197). Interactions within marine ecosystems 'create certain levels of complexity and dynamics that are difficult to comprehend and to steer' (Chuenpagdee 2011: 200). Hammer (2016: 75) points out that natural resource management of marine ecosystems is challenged by a lack of knowledge, inadequate governance institutions and traditional management approaches that are not tailored to cope with the processes and dynamics of complex marine SES such as the regional seas in Europe.

Fisheries are complex SES. The complexity of fisheries systems and their governance in terms of decision and policy making are well recognised (e.g. Symes 2012: 5-6). As Mahon *et al.* (2008) state, 'The conventional approach to fisheries systems has been to treat them as predictable and controllable, when in fact as complex systems they are neither and have to be approached differently' (p. 106).

The inherent unpredictability of the natural resource base (fish populations and ecosystems) is a major source of uncertainty. 'This is due to their internal complexity, their openness to external effects, as well as to the difficulty in obtaining accurate information about them' (Mahon *et al.* 2008: 106). Conventional fisheries management treats fishery systems as controllable, provided enough information is available and regulatory measures are implemented.

> 'Improving fisheries management has focused on acquiring more information, constructing more complex models, and refining control systems. This approach has not been able to deal adequately with the

> complex, dynamic nature of fisheries systems and it has become apparent that something rather more radical is needed instead of, or in addition to, the conventional approach' (Mahon *et al.* 2008: 104).

Take, for example, the well-documented failure of the EU Common Fisheries Policy (CFP) to achieve sustainable fisheries management (Daw and Gray 2005; Khalilian *et al.* 2010; Österblom *et al.* 2011). In terms of governance, the CFP epitomises the failure of traditional natural resource 'command-and-control' management approaches (Holling and Meffe 1996). Decision making by EU fisheries ministers continues to ignore scientific advice and the requirements of the reformed CFP, which came into force in January 2014 (Pew 2016a, 2016b).

The interdependence of social and ecological systems in world fisheries is, as Ommer and Perry (2011: 403) conclude, usually unrecognised in the literatures on fisheries governance. Nevertheless, the interconnectedness of humans-in-nature 'poses challenges for the successful management of what are, in fact, complex adaptive systems that operate at a range of scales and involve human agency' (Ommer and Perry 2011: 403). Mahon *et al.* (2008) argue that recognition that fisheries systems exhibit the characteristics of CAS 'should lead to a radically different approach to management of fisheries systems that places much emphasis on enabling self-organization, learning, and adaptation' (p. 106). They suggest that governing fisheries as CAS has potential to address natural resource management problems and improve the management of fisheries systems. This perspective is supported by Berkes (2011a), who states that addressing complexity in marine SES means paying attention to drivers 'and dealing with a number of characteristics of complex adaptive systems ignored by conventional resource management' (p. 18).

Hammer (2016: 79) considers understanding marine ecosystems and integrated SES as CAS key to sustainable (adaptive) governance of marine ecosystems in Europe. Key aspects of ecosystem management would include:

> 'a broader system-wide perspective, integrating ecological and human systems and boundaries, emphasis on the functioning of ecological

> systems, acknowledgement of uncertainties and risks in complex systems, integration across various spatial and temporal scales, and adaptive, flexible management processes and decision-making' (Hammer 2016: 81).

Therefore, achieving effective maritime governance (including marine and coastal ecosystem-based management) requires a paradigm shift towards CAS thinking. This is in keeping with the findings of Duit *et al.* (2010) regarding governance challenges posed by global change in general, and of Perry *et al.* (2010a: 336) regarding interdependent marine SES stressed by global changes, Ommer *et al.* (2012: 320) regarding fisheries management and Mee *et al.* (2014) regarding a common European maritime policy landscape[7] in particular.

There is a knowledge gap between what is known about governance for sustainability in Europe's maritime macro-regions in general and the Atlantic Europe macro-region in particular, and what is known about CAS theory regarding SES. In other words, there is an apparent disconnect between the EU's emerging maritime macro-regional sustainable development strategies, including the Atlantic Strategy, and a sound theoretical basis for them.

In this thesis, I argue that the design of integrated ocean and coastal governance in the EU should be informed by theory of complex adaptive SES (see Chapter 2). Furthermore, I argue that SES-based governance architecture is necessary if the EU is to successfully meet the challenges of achieving sustainability and sustainable development in the maritime dimension (see Chapter 4). I use the concept of resilience (see Chapter 3) to represent the capacity of a SES to tolerate and deal with change in ways that sustain system integrity, adaptive capacity and options for future development of people, society and the rest of nature. My interest is in the transnational macro-regional level of governance, with a geographical focus on Atlantic Europe. Therefore, the main aim of this research is

[7] This comprises the IMP, Marine Strategy Framework Directive (EU 2008), CFP, Maritime Spatial Planning Directive (EU 2014a), Water Framework Directive (EU 2000), Habitats Directive (EU 1992) and Birds Directive (EU 2010).

to gain insight into multilevel adaptive governance architecture that combines notions of sustainability and sustainable development in the context of European maritime macro-regions and sea basins in general and Atlantic Europe in particular.

The central research question asks

whether it is possible to achieve this insight by using a social–ecological system as a conceptual framework and analytical tool to relate governance to sustainability and development?

To address this question, a study was designed and conducted to conceptualise the European Atlantic social–ecological system (EASES). This conceptualisation (described in Chapter 6) was used as the unit of analysis for understanding the Atlantic Europe maritime macro-region as a SES. EASES provides a basis for relating governance architecture to maritime regional sustainability in Atlantic Europe (see Chapter 7).

Assumptions and propositions

Instead of formulating and empirically testing predictive hypotheses as part of formal theory construction (cf. Johnson 2008, chapter 4), this research developed propositions as points of departure during different stages of the research process. I interpret the term 'proposition' loosely to mean a tentative assertion or reasonably confident statement regarding the assumed or expected properties or relationships of the things being studied, and/or the conditions under which they assumed or expected. Propositions can be true or false. They are interpretive rather than predictive, and are intentionally provisional and exploratory. They provide an explicit starting point from which to develop concepts and understanding (Walker *et al.* 2006). The process of iteratively refining or restating the propositions allows the research process to be updated and adjusted as new knowledge is acquired, existing knowledge is revised, and understanding evolves.

The study of EASES examined the basic proposition that *governance can be focused on building social–ecological system resilience to help achieve sustainability in the Atlantic Europe maritime macro-region.*

Deconstruction of this proposition led to a set of normative assumptions that underlie this research:

Assumption 1: Maritime regional sustainability in Atlantic Europe is both possible and desirable.

Assumption 2: SES-based governance is needed to achieve maritime regional sustainability.

Assumption 3: Governance should focus on building SES resilience.

Assumption 4: It is possible to design a SES-based framework for integrated maritime governance.

Assumption 5: It is possible to identify and describe key attributes of SES, including resilience, at the macro-regional level.

These assumptions led to an initial set of propositions, which provided a point of departure for the study:

Proposition 1: Europe's seas and coastal regions comprise a number of identifiable maritime SES, including at macro-regional level.

Proposition 2: In terms of a complex systems hierarchy and social–ecological dynamics, the macro-regional level of organisation is a key focal level regarding developing and implementing a multilevel governance framework for achieving maritime regional sustainability and sustainable development.

Proposition 3: The related SES properties of resilience, adaptability and transformability determine the possible sustainable development trajectories and future identities of maritime SES.

> *Proposition 4*: A maritime SES that encompasses Europe's Atlantic seaboard and adjacent ocean space is conceivable: the European Atlantic social–ecological system (EASES) is commensurate with the Atlantic Europe macro-region (the 'Atlantic Arc' or 'Atlantic Area' in EU parlance).

> *Proposition 5*: EASES has an identity in relation to various geographic, biogeographic, socioeconomic, political and institutional scales.

> *Proposition 6*: EASES is an appropriate unit of analysis with which to explore the concepts of SES resilience and governance architecture in relation to maritime regional sustainability.

Research questions

Research questions were formulated to guide the research process in general and the study of EASES in particular. Questions 1 to 5 were formulated on the basis of an initial review of the literature, and in the context of the central research question, geographical focus and propositions outlined above. Research question 6 was added during the course of the study to provide additional clarity. The questions are as follows:

> *Research question 1*: How can the concepts of maritime regional sustainability, sustainable development, SES resilience and multilevel adaptive governance be united in a single conceptual framework?

> *Research question 2*: How can a maritime macro-regional SES (i.e. EASES) be conceptualised and used as the unit of analysis for understanding potential governance architecture for maritime regional sustainability in Atlantic Europe?

> *Research question 3*: What key factors determine the resilience, adaptability and transformability in EASES?

Research question 4: What patterns and processes of persistence and change can be discovered in EASES that allow for a better understanding of how a successful social transition towards sustainability can be shaped?

Research question 5: How can resilience in EASES be managed to reduce vulnerability to multiple hazards, increase capacity to tolerate and deal with change, and so achieve maritime regional sustainability?

Research question 6: What are the necessary design elements for a SES-based architecture for integrated maritime governance for maritime regional sustainability in Atlantic Europe?

In addition to these research questions, a number of questions and sub-questions were asked as part of the study of EASES (see Chapter 6).

Study objectives

To address the research questions posed and introduce structure to the research process, the study of EASES was designed around a set of specific objectives. The process of achieving these objectives contributed to a progressively better understanding of the central research problem and possible solutions. The primary objectives of the study were as follows:

Study objective 1: To develop a SES conceptual framework and theoretical foundation to guide the analysis and understanding of maritime macro-regions in general and the Atlantic Europe macro-region in particular.

Study objective 2: To qualitatively investigate resilience in the Atlantic Europe macro-region using a well-defined unit of analysis (i.e. EASES).

Study objective 3: To produce a synthesis that links the concepts of maritime regional sustainability, SES resilience and multilevel adaptive governance in the context of sustainable development in the Atlantic Europe macro-region.

Study objective 4: To formulate a set of design guidelines regarding the development of SES-based governance architecture for the sustainability and sustainable development of maritime macro-regions in Europe.

Study objective 5: To produce knowledge useful to policy actors concerned with achieving sustainable regional development and multilevel governance in Atlantic Europe.

Significance of the research

The research undertaken for this thesis goes some way to filling the knowledge gap identified above. It adds to the existing body of knowledge in the field of social–ecological research for sustainability and, more specifically, sustainability of the maritime dimension in the European context. The research demonstrates that CAS theory and a SES approach can be used for the analysis of a maritime macro-region (in this case, the Atlantic Europe macro-region represented by EASES).

Some of the findings have broader applicability, at an abstract level, to other maritime macro-regions in Europe. But the majority of the findings are not generalisable to other situations or macro-regions because they are highly context specific. In this sense, the research has produced knowledge that is potentially useful to governance actors at all levels that have an interest in maritime regional sustainability and sustainable regional economic and social development in Atlantic Europe.

So far, comparatively little attention has been paid by the research community to integrated marine and coastal SES as opposed to individual marine or coastal SES. This is particularly so at the macro-regional level. Thus, the research not only contributes to the body of academic knowledge, but also contributes to an improved understanding of potential SES-based governance architecture. In the real world, the EU is already far advanced in implementing the IMP and developing a multilevel system of European maritime governance. But the EU has forged ahead in the absence of a strong theoretical foundation for what is taking place. This research provides some theoretical justification for the EU's approach towards maritime policy and governance. At the same time, the research also indicates that a SES approach has yet to be adopted by actors engaged in maritime governance. Consequently, this thesis contributes some general design guidelines for use in developing SES-based multilevel governance architecture for achieving maritime regional sustainability in Atlantic Europe and potentially other European macro-regions.

1.3 Methodology and conceptual framework

Guided by the research questions (see section 1.2), a study was conducted to conceptualise EASES: the unit of analysis used to represent the Atlantic Europe maritime macro-region (described in Chapter 6). The study required a framework to serve as a nexus between the research methodology and the things[8] being studied. This section provides an overview of the research approach, conceptual framework, research design and method.

Research approach

This thesis adopts a SES approach to sustainability research. It is an approach based on social ecology and sustainability science; a way of theorising about and investigating society–nature relations based on the paradigm of CAS thinking. Social ecology is 'the science that studies societal relations to nature' (ISOE 2015). Sustainability science is 'an emerging field of research dealing with the interactions between natural and social systems, and with how those interactions affect the challenge of sustainability' (PNAS 2015). Taken together, social ecology and sustainability science provide a basic philosophical and theoretical framework for this work: a logical structure for the integration of complementary components of different theories relevant to SES research.

The basic premise of this approach is that contemporary society–nature relations and interactions are strongly influenced by the rapidly changing relationship

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[8] Note on terminology: I use the term 'things' rather than 'phenomena' in order to encompass both empirical and non-empirical entities and evidence. 'Things' may refer to ideas, symbols, concepts, objects, data, knowledge, people, relationships, interactions, patterns, processes, systems, actions, events and so forth.

between humanity and the rest of nature (Castree 2001; Glaeser 2002; Costanza *et al.* 2007a; Glaser *et al.* 2008, 2012a; Steffen *et al.* 2011a, 2011b; Bruckmeier 2013). Social–ecological research is normatively concerned with (1) advancing understanding of the dynamic relationships between humans, society and the rest of nature; and (2) producing knowledge useful for solving complex social problems and informing decision making regarding sustainability. In other words, it deals with complex, continually changing social–ecological realities, which can be very different and often contradictory due to the plurality of perspectives involved.

Investigating complex society–nature relations and interactions inevitably involves a variety of complementary and competing forms of knowledge, encompassing a multitude of facts and concepts. Therefore, some form of overall organisation is needed to help integrate knowledge as well as accommodate and reconcile different theoretical and analytical perspectives. Furthermore, social–ecological research seeks a better understanding of how social and ecological systems interact across different scales. Consequently, there is a need for greater integration of knowledge and insights, not only between the natural and social sciences, but also between disciplines across the sciences, humanities and practice. Bammer (2005) refers to the need for diverse and hybrid epistemologies. However, greater integration of social and ecological knowledge is impeded by the lack of a coherent, truly integrated and interdisciplinary (or transdisciplinary) framework to guide the conceptualisation of research concerning SES (Glaeser et al 2009: 183-188).

Conceptual framework

Research is always guided, whether implicitly or explicitly, by some form of conceptual framework. For this thesis I define a conceptual framework as

> *a plausible representation of the dynamic system of concepts and other components of theory that together are used to structure a way of thinking about the things being studied.*

In terms of functionality, this research required a conceptual framework that (1) can accommodate concepts derived from different disciplines and perspectives; (2) allows relevant concepts and their (assumed) relationships to be identified, gathered and organised in a coherent way; and (3) provides a general, abstract explanation of key concepts and relationships, which in turn serves as the theoretical basis and justification for the conceptualisation of EASES (described in Chapter 6).

The conceptual framework developed during the research is not intended to be fully comprehensive or universally applicable. A balance is struck between general and specific applicability. The framework links the more abstract theoretical level to the more concrete and specific analytical level. It provides a coherent structure for relating, organising and synthesising a diversity of assumptions, concepts, models and other components of theory used to explain the things being studied. The conceptual framework consists of two parts. The first describes the theory of CAS in general and SES in particular (Chapter 2). The second part describes social–ecological resilience theory (Chapter 3). Together, these are used for the conceptualisation and analysis of EASES (described in Chapter 6).

During the research, the conceptual framework evolved through several iterations and was modified and refined to reflect new information and understanding. This new knowledge was derived from a combination of an ongoing literature review and feedback from an expert panel during the EASES study.

Research design

The research design is located in the interpretivist, social constructivist paradigm of enquiry. This refers to my (the researcher's) philosophical orientation and basic assumptions regarding the nature of reality (ontology), the nature of knowledge and the relationship between the knower and the knowable (epistemology), and the approach and procedure (systematic enquiry) for acquiring knowledge (methodology) (Guba 1990: 18). As a researcher, my worldview recognises that there are multiple socially constructed realities that are constantly changing, interacting and potentially in conflict with each other (a relativist ontology). On the one hand, knowledge is constructed in the mind of the individual learner. On the other hand, knowledge is co-constructed in the interaction between the researcher and the participants during the research process (a subjectivist epistemology). Instead of objectivity, emphasis is placed on credibility, transferability, dependability and confirmability (Denzin and Lincoln 2005a). Mertens (2010) states:

> 'The assumption is made that data, interpretations, and outcomes are rooted in contexts and persons apart from the researchers and are not figments of their imagination. Data can be tracked to their sources, and the logic used to assemble interpretations can be made explicit in the narrative' (p. 19).

Furthermore, it is important to acknowledge that the research is influenced by the system of values between the researcher and other participants in the research. In terms of methodological approach and procedure, it is assumed that the research process is embedded in a normative context that has social, political, historical, ecological and other dimensions. Therefore, a strategy of qualitative methods is best suited to studying complex issues, problems and systems involving human–environment interactions and society–nature relations.

The research on which this thesis is based consists of a qualitative single case study of a conceptual social–ecological system: EASES. This is both an analytical construct representing the Atlantic Europe maritime macro-region and the unit of analysis for studying the macro-region as a complex adaptive SES. The study was designed to elicit opinion regarding EASES from a panel of geographically dispersed experts; in particular, opinions regarding the conceptualisation of EASES and the characteristics that determine resilience in EASES. For practical reasons, the researcher (myself) interacted with panellists without physically meeting. For methodological reasons, panellists remained anonymous to each other during the study (and their responses remain anonymised afterwards).

The EASES study took place between November 2009 and December 2010. The study involved a two-round consultation with an invited panel of experts.

Nineteen panellists participated in round one and seven of them went on to participate in round two. A workbook method was developed and used in each round to ask questions and gather information from panellists. An overview of the study and description of the workbook method is presented in Chapter 5.

1.4 Structure of the thesis

This thesis is divided into eight chapters that address five main themes: (1) complex adaptive SES theory, (2) the multifaceted concept of SES resilience and (3) SES-based governance architecture, which are needed for shaping (4) a transition towards sustainability using insight based on analysis of (5) a maritime SES conceptualised to represent the Atlantic Europe macro-region. The structure of the thesis is shown in Figure 1.1.

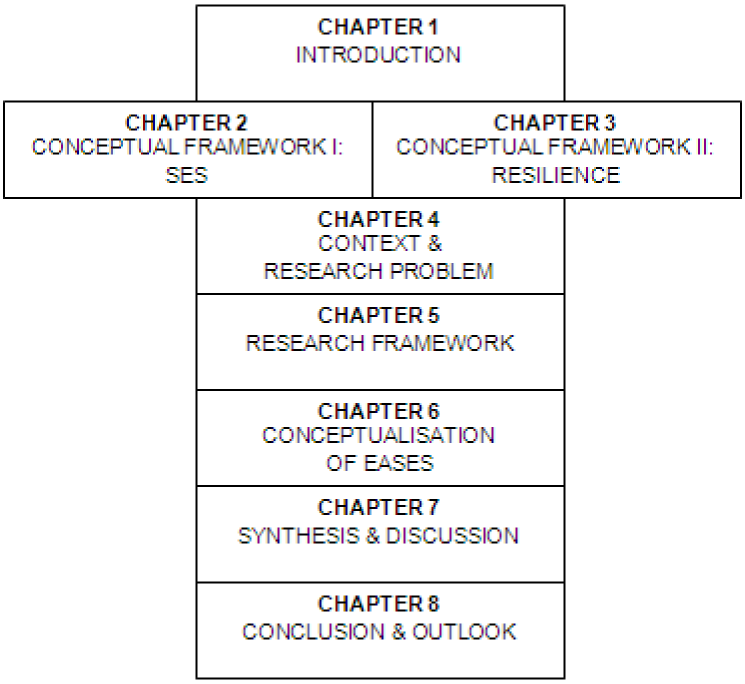

Figure 1.1 Structure of the thesis.

Following this introductory chapter, Chapter 2 describes the first part of the conceptual framework that guided the study of EASES: a way of thinking about society–nature relations based on complex adaptive SES theory. It considers a complex systems approach and describes key characteristics of complex adaptive

SES and their dynamics. The chapter provides a foundation for the conceptualisation of EASES, which is described in Chapter 6.

Chapter 3 describes the second part of the conceptual framework: resilience theory, which is a particular element of complex adaptive SES theory. The chapter considers the different ways in which resilience is defined and presents the conceptualisation of SES resilience used in this research. It also examines the interrelated concepts of adaptability and transformability. The chapter presents a framework for resilience analysis of EASES, which is described in Chapter 7.

Chapter 4 contextualises the research problem and presents a justification for the study of EASES. It describes the general background in terms of the sustainability context and governance for sustainability. The chapter considers key elements of architecture for sustainability governance. It looks at the European maritime dimension in general, including the approach to maritime governance. The chapter also describes the EU maritime macro-regional approach.

Chapter 5 describes the research framework for addressing the research problem and questions identified in this chapter. It charts the researcher's (my) philosophical stance and methodological perspective, which underlie the research approach, design and methodology used to address the research questions. The chapter justifies the unit of analysis (EASES) and explains the qualitative research strategy adopted for the study of EASES. It also describes the methods used in the research.

Chapter 6 describes the conceptualisation of EASES as the unit of analysis for understanding maritime macro-regions in general and the Atlantic Europe macro-region in particular. It describes the study results and analysis regarding key characteristics: boundaries and boundary conditions; system structures, processes and functions; structural hierarchical relationships and cross-scale interactions between EASES and other levels; human activities, disturbances and other drivers of change that affect the sustainability of EASES.

Chapter 7 draws together insights from across the previous chapters and links concepts to answer the research questions and arrive at a number of conclusions. The chapter presents some general design guidelines for SES-based governance architecture.

Finally, Chapter 8 summarises the main themes and issues, reflects on the methodology and other aspects of the research, and presents recommendations for future research.

Chapter 2
Complex adaptive social–ecological systems theory

This chapter describes the theory of complex adaptive social–ecological systems (SES). It presents a way of thinking about society–nature relations based on complex adaptive systems (CAS) theory. The chapter provides a foundation for the conceptualisation of the European Atlantic social–ecological system (EASES), which is described in Chapter 6.

2.1 Introduction

Any system of integrated maritime (ocean and coastal) governance must deal with the implications for society–nature relations arising from rapidly changing systemic dynamics and complexity. This includes dealing with macro-scale processes such as globalisation, Europeanisation and climate change. Such a system must also deal with lack of information, incomplete knowledge and high levels of scientific uncertainty. These challenges to decision making may benefit from a cultural paradigm shift (Kuhn 1996 [1962]) in the predominant pattern of thinking. That is, a shift away from the mechanistic (reductionist, linear and hierarchical) and deterministic views of reality that accompany modern 'normal' science; a shift beyond the intermediary pattern of general systems theory (von Bertalanffy 1968), which attempts to understand the whole system by fragmenting it and analysing the parts (limited holism and reductionism); a shift towards a new pattern of thinking based on complexity or CAS theory and the premise of systemic wholeness (ecological holism) and situated in a postmodern, post-normal 'science of sustainability' philosophy (Ravetz 2006, 2011; Wulun 2007; Beumer and Martens 2010; Rajeswar 2010). The emergent paradigm (worldview or system of thought) is variously referred to as complexity theory, complex (adaptive) systems approach, social–ecological (systems) approach or resilience thinking.[9]

[9] Note on terminology: Many researchers commonly use the terms 'systems approach' and 'systems thinking' interchangeably. To all intents and purposes, these terms are synonymous (see Gasparski 1991: 19). In general, I do not make a distinction between the two terms (or between similar terms, e.g. 'resilience approach' and 'resilience thinking'). However, I prefer the term 'systems approach' over 'systems thinking'. This is because, in the literal sense of 'approach', it

The critical intellectual shift towards a postmodern social–ecological paradigm is already underway in many areas (Matthews and Boltz 2012: 3). Evidence of this deep cultural change can be seen in the increasingly widespread adoption of more holistic, ecological, integrative and systems-based approaches to sustainability, predicated on the notion of a co-created or participative reality (Sterling 2004: 50). These types of approaches find expression in fields such as sustainability science, ecological economics and human ecology; and in practices including ecosystem-based management of fisheries and oceans, adaptive management, co-management, integrated water management, integrated coastal zone management and maritime spatial planning.

It is incumbent upon all governance actors to recognise and deal with fundamental properties of ecosystems, human societies, economies and integrated SES: all examples of CAS. Such properties include (based on Levin 1992, 1998):

- The ability of systems to self-organise and reorganise following disturbance.
- The emergence of complexity and other higher-level collective effects.
- Nonlinear cross-level and cross-scale interactions and feedbacks.
- Nested hierarchical structure.
- Open and indeterminate ('fuzzy') boundaries.
- Time lags, path dependency and legacy effects.
- Multiple equilibria and alternative stable states (system regimes).
- Multiple thresholds and cascading effects.
- Slow transitions between states as well as abrupt and surprising regime shifts.
- Intrinsic variability, unpredictability and persistent uncertainty.
- Alternative development trajectories and multiple possible outcomes.

For the reasons given in Chapter 1 (section 1.2), I believe that the failure to understand and deal with these fundamental properties of CAS underlies many of the difficulties encountered during the implementation of sustainable development

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can be assumed that advancing towards and dealing with an issue (research problem, research objective, etc.) is a deliberate process; it is based on careful thinking and decision making using systems ideas.

principles in policy and practice, including in the form of the EU's Integrated Maritime Policy and related policy instruments such as the Marine Strategy Framework Directive and Maritime Spatial Planning Directive. In terms of governance architecture, there is a need to address these shortcomings by achieving a paradigm shift towards approaches grounded in systems thinking. Principally as a result of work undertaken in various international science–policy interface frameworks,[10] it is now widely recognised that complex systems approaches are both conceptually sound and essential to integrating knowledge for achieving sustainability (Leemans *et al.* 2009).

The remainder of this chapter describes a way of thinking about society–nature relations based on the 'evolving paradigm of complex adaptive systems thinking' (Trochim and Cabrera 2005: 12). Section 2.2 considers the concept of system, what a systems approach is and the development of systems thinking. Section 2.3 describes the key characteristics of CAS, while the main concepts underlying their dynamics are described in section 2.4. The theory of the adaptive cycle and panarchy of adaptive cycles is explained in section 2.5. SES theory is presented in section 2.6. Finally, a summary is provided in section 2.7.

2.2 From system to complex systems approach

Concept of system

The concept of SES is central to this thesis, which uses a systems approach. But what does 'system' mean? Is the term more than a metaphor for a 'compound of things' (Becker 2012: 46)? In the literature, there are numerous definitions of what a system is or represents. Opinions differ on how the term 'system' ought to be understood; whether systems really exist to be discovered, or whether they are constructed to give meaning to the world, or else some combination of the two.

[10] For example, the Intergovernmental Panel on Climate Change (IPCC)/United Nations Framework Convention on Climate Change (UNFCCC) framework; or the International Council for the Exploration of the Sea (ICES) and Scientific, Technical and Economic Committee for Fisheries (STECF)/European Commission framework concerning EU fisheries management.

The classical definition of system by Hall and Fagen (1956: 18): 'A system is a set of objects together with relationships between the objects and between their attributes.'

According to Becker (2012: 48), to become more than just a metaphorical expression, the definition of system requires two additional constraints: (1) the definition of spatial or functional boundaries at different levels; and (2) the identification of patterns between the sets of relationships, expressed as topological structures (e.g. networks, causal chains and feedback loops).

Of course, many definitions of system go beyond the basic Hall and Fagen definition to describe a system by key attributes such as open, dynamic, complex and adaptive. For example, the following descriptive definition of system appears in the SPICOSA (Science and Policy Integration for Coastal Systems Assessment) project[11] guide to system design (Tett *et al.* 2011a: 11, emphases in original):

> 'A system:
> - consists of parts and relationships or interactions amongst these parts;
> - often contains feedback loops which create *emergent* properties additional to those of the individual parts and relationships;
> - has *boundaries* in space and time, which define system extent and scale;
> - has an internal *state*, which responds to internal dynamics and transboundary processes;
> - can contain a *hierarchy* of sub-systems; emergent properties of one level appear as relationships at the next higher level.'

The notion of wholeness is implicit in the SPICOSA definition. Other systems definitions explicitly identify the whole. For example, in *Re-Creating the Corporation*, Ackoff (1999: 5-8) proposes a definition that attempts to capture areas of general agreement between numerous other definitions of system in the

[11] A four-year integrated project (2007-2011) for the sustainable management of coastal zone systems, funded by the EU's Sixth Framework Programme (FP6); http://www.spicosa.eu/

literature. ‘A system is a whole that cannot be divided into independent parts without loss of its essential properties or functions’ (Ackoff 1999: 8).

Systems approach

Systems theory, systems science and the systems approach are all essentially methods of shifting from reductionist to holistic patterns of thinking, while acknowledging the unity of reality and the relationships between reality’s components and properties (Strijbos 2010: 453). The origins of this shift towards a holistic paradigm are widely attributed to the pioneering work of theoretical biologist Ludwig von Bertalanffy (1950, 1968, 1972) who formulated the idea of general systems theory (GST).

The systems theory paradigm that emerged in the mid-20th century has since become an important framework for the analysis of persistent and complex problems. Terms such as ‘systems theory’ or ‘systems thinking’ are very general, referring to ‘a universal language to address complex patterns of interaction between different components’ (Loorbach 2007: 54).

Regardless of definitional differences and (implicit) tensions between analytical/ reductionist and synthetic/holistic aspects, the fundamental systems ideas (i.e. components and relationships, parts and wholes, emergent properties, and hierarchy and boundaries) have not changed significantly over the years.

In summary, the systems approach is a process with three complementary aspects. First, it is a fundamental way of perceiving the world (worldview). Second, it is an organised way of thinking that enables individuals and groups to understand and organise information about real-world phenomena. Third, it is a rational way of acting and dealing with the complexity and dynamics of real-world problems.

Complex systems approach

Where social and ecological processes and interactions have become so complex, and the resulting problems and their solutions so complicated, there is a tendency for scientists, policy makers and other stakeholders to embrace the science of complex systems (also known as complex systems theory, complex adaptive systems theory, complexity theory or complexity science). Indeed, complex systems approaches are increasingly used to bridge the natural and social sciences and integrate the perspectives of different disciplines and sectors. Moreover, a complex systems approach can help with developing three social capabilities considered essential for a successful transition towards sustainability: preparedness to change, capacity to change and options for change (Huitric *et al.* 2009: 40).

The hallmarks of theoretical approaches to complex systems are their focus on (1) the ways that order (pattern, arrangement, organisation, structure, form and so forth) emerges spontaneously rather than being imposed by design; and (2) the fundamental role of interconnections among components. The concepts of emergence and interconnectedness are essential to understanding how complex systems change over time and under what conditions. These and related concepts have been developed in recent decades to describe and explain the properties of complex systems in a wide variety of fields.

Complex systems are of course ubiquitous in society, nature, science and technology. (For an overview of complex systems see Bar-Yam 1997; Bossomaier and Green 2007 [2000]; Northrop 2011.) Among them, there are complex systems of very different kinds that exhibit the qualities of coherence and persistence in the face of changing conditions. This is because, despite their differences, they each possess the ability to adapt. In other words, they all have the capacity to respond to changes in their environment and make adjustments (small changes), and learn from experience, in order to fit the new conditions. This subset of complex systems is collectively referred to as the complex adaptive systems or CAS (Holland 1995: 4). Having already listed the key properties of CAS in the introduction above, I elaborate on these in the following two sections. Section 2.3 addresses the basic concepts of CAS theory. Section 2.4 deals with the dynamics of CAS.

2.3 Basic concepts of CAS theory

CAS theory provides a basis for understanding the complexity and dynamics of persistence and change in SES; it is central to the analysis. As previously mentioned, a system is a set of components and their relationships that function as a whole, and whose boundaries distinguish the system from its environment (i.e. anything external to the system). A complex system is one that consists of many different components, where self-organising local interactions (without any central control) among components give rise to emergent properties such as collective behaviours and multiple levels of organisation. These emergent properties influence the system's identity and how the whole system functions, interacts and forms relationships with its environment. CAS are special kinds of complex systems that can adapt (change their behaviour to improve their chances of survival or success) through learning or evolutionary processes (Mitchell 2009: 13). Examples of CAS include ecosystems, human societies, cities, the economy, financial markets, fisheries, corporations, individual people and the immune system (Holland 1992b, 2012; Levin 1999; Markose 2005; Mahon *et al.* 2008; Grove 2009). CAS are characterised by several key features, described in the following paragraphs.

Agents and interconnectedness

The key components of CAS are those entities that adapt or learn as they interact and, in doing so, bestow complexity to the system. These are often called 'agents' or, if they involve people, 'actors' because they play a role in or have some influence on the system (Walker and Salt 2006: 163). Groups of individual agents (e.g. cells in an organ, fauna and flora in an ecosystem, people and other social actors in society, fish and fishermen in fisheries, traders in a market and nations in the EU) interact with each other by sending and receiving large numbers of signals simultaneously. In other words, they are interconnected.[12] Taken together as a set, agents and their interconnections constitute a dynamic network (Webb and Bodin 2008). The agents' actions and reactions are usually conditional, that is, dependent on signals they receive either from other agents or from their

[12] Note on terminology: The term 'interconnected' or 'interconnection' is used to imply a close relationship between two or more agents.

environment (Holland 2006). In complex systems theory, each agent typically follows relatively simple rules with no central control or leader; it is their collective actions that give rise to complex and changing patterns of behaviour (Mitchell 2009).

Understanding CAS involves understanding the interconnectedness and interdependence between all system components; not only between agents, but also between the processes of action, reaction and interaction that link agents. In SES, social–ecological processes are the interconnections among components (Chapin *et al.* 2009b: 10). These may be primarily ecological (e.g. processes that maintain marine ecosystem integrity and community complexity), socioeconomic (e.g. processes by which coastal communities respond to changing environmental policy) or a mix of ecological and social processes (e.g. marine capture fisheries, aquaculture and offshore renewable energy development). Aquaculture illustrates global interconnectedness and interdependence. For example, shrimp produced in aquaculture operations in tropical regions such as Thailand and Vietnam are traded on global markets and consumed principally by markets in the USA, Japan and EU (Lebel *et al.* 2002). The commercial feed to produce these shrimp comes from coastal and marine ecosystems across the planet, such as meal from fish caught in the North Sea (Folke *et al.* 2009: 112).

Openness and fuzzy boundaries

CAS are open systems.[13] They continually interact with their external environment through transfer and exchange of information, energy, materials, people or other organisms across permeable boundaries. For example, marine and coastal ecosystems and natural resource systems such as fisheries have permeable boundaries. These boundaries are selectively open to water, plankton, fish, predators, fishing vessels, disease organisms and pollutants. A seaport is another example of an open system. Apart from the flow and exchange of materials, goods and information across its boundaries, linking coastal and ocean environments, a seaport is open to its policy environment regarding transport, economic growth and territorial development (Cetin and Cerit 2010; Justice *et al.* 2016). The

[13] Closed systems are isolated from their environment.

boundaries between a CAS and its environment are often complex, indeterminate ('fuzzy'), multiscale and spatially and temporally variable (Cumming and Collier 2005). Such boundaries are often difficult to identify, 'making operational closure dependent on context (and observer)' (Martin and Sunley 2007: 578).

Nonlinearity

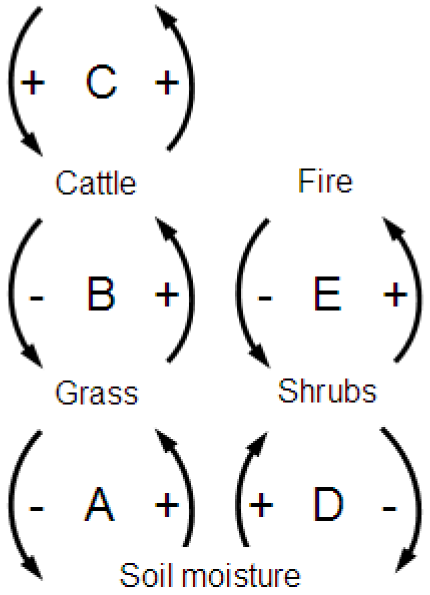
In CAS, the underlying relationships and processes of interaction, both among components within the system and between the system and its external environment, are inherently nonlinear. CAS dynamics are not linearly dependent on the state variables that constitute the system, but are instead generated when one variable is affected disproportionately by another variable. In other words, the magnitude of the effects are not proportional to the magnitude of the causes; a very small disturbance may initiate dramatically large-scale and not necessarily predictable effects across multiple spatial–temporal scales. This can lead to phenomena such as thresholds, alternative stable states, cycles and chaotic dynamics (Scheffer 2009).

Here are two examples of nonlinearity. In the first, Anderies *et al.* (2013), using an Earth system model, present an analysis that illustrates the existence of dynamic, nonlinear thresholds or tipping points ('planetary boundaries') in global carbon cycle dynamics. A key finding is that nonlinear feedbacks cause thresholds to move. For example, the feedbacks between the different carbon stocks of the deeper and upper layers of the ocean have implications for the long-term capacity of the ocean to absorb carbon and keep up with the rising rate of human emissions. In the second example, Carpenter *et al.* (2011) investigated the nonlinear dynamics of drastic ecosystem changes or 'regime shifts' to unwanted states. They did this by experimentally triggering a food web transition by gradually adding piscivorous top predators to a lake dominated by planktivorous fishes to destabilise and reorganise its food web. The experiment induced a trophic cascade leading to dominance of the food web by piscivores: a nonlinear ecological regime shift. (For further examples of nonlinearity in CAS dynamics, see Scheffer *et al.* 2001; Scheffer and Carpenter 2003; Scheffer and van Nes 2004; Liu *et al.* 2007a: 1514.)

Feedbacks

The stability and internal dynamics of CAS are governed by two important types of nonlinear interactions: stabilising feedbacks and amplifying feedbacks. These are represented in Figure 2.1, taken from Chapin *et al.* 2009b.[14] A feedback loop is a 'set of cause–effect relationships that form a closed loop, so that a change in any particular element eventually feeds back to affect the element itself' (Hastings and Gross 2012: 781). More simply, feedback refers to situations in which an effect influences its cause (Cumming 2011: 18). According to Chapin *et al.* (2009b: 10), stabilising feedbacks (also known as damping, balancing or negative feedbacks) inhibit or reduce fluctuations in process rates and, therefore, tend to stabilise the state of a system. Stabilising feedbacks occur when two interacting components cause each other to change in opposite directions. Amplifying feedbacks (also known as reinforcing or positive feedbacks) augment changes in process rates and, therefore, tend to destabilise the state of a system. They occur when two interacting components cause each other to change in the same direction (i.e. both components increase or both decrease). System stability and dynamics depend on the balance of both types of feedbacks as well as the types and frequencies of disturbances.

[14] For further examples of feedbacks in SES, see the *Ecology and Society* special feature on Exploring Feedbacks in Coupled Human and Natural Systems (CHANS) http://www.ecologyandsociety.org/issues/view.php/feature/85.



Process		Nature of feedback
Resource uptake	A or D	Stabilising
Competition	A + D	Stabilising
Herbivory	B	Stabilising
Resource exploitation	C	Amplifying
Disturbance cycle	E	Stabilising

Figure 2.1 Examples of linked amplifying and stabilising feedbacks in a pastoral social–ecological system. Arrows show whether one species, resource or condition has a positive or a negative effect on another. The feedback between two species is stabilising when the arrows have opposite signs (e.g. grass has a positive effect on cattle, but cattle have a negative effect on grass). The feedback is amplifying when both components affect one another in the same direction (e.g. more cattle providing more livelihoods, which motivates people to raise more cattle, represented by feedback loop C). (Adapted from Chapin *et al.* 2009b: 10, Fig. 1.4.)

Path dependence

CAS exhibit the phenomenon of path dependence. During a system's development or evolution, its current state and trajectory depend on non-reversible events, disturbances, adaptations or decisions that occurred in its past. This is the idea that 'history matters' (David 2007). Likewise, the range of development opportunities and possible future states of a system are influenced (enabled or constrained) by similar such conditions and occurrences during the present. In other words, multiple outcomes (future states and patterns of behaviour) are possible depending on (1) the historical legacies (lasting effects) and system memory of past events and conditions and the system's responses to them; and (2) the influences of current conditions and human agency. Path dependence is a consequence of the system's underlying nonlinear dynamics; the rules that guide localised interactions, including feedbacks, among individual components change as the system evolves and develops (Levin 1998: 433).

David (2005) argues that economic processes, particularly long-term processes of economic development, are path dependent: they 'cannot shake off the effects of past events' (p. 151). Similarly, Martin and Sunley (2006) and Martin (2010) argue that the evolution of the regional economic landscape (of industries and institutions) is often a path-dependent process. Martin and Simmie (2008) argue that path dependence is important for understanding the different historical economic development trajectories followed by different cities. Within urban economies, structural development of new technologies or industrial sectors 'rests on continual interactions between local economic history and the absorptive and innovative capacities of local firms, organisations and institutions' (p. 192).

Self-organisation

CAS are fundamentally capable of internal self-organisation: a process of reorganisation and pattern formation arising from nonlinear interactions among system components, often in response to external factors (exogenous forces and conditions outside the system). Self-organisation occurs without any direction from a central or global controller, or imposition by external forces (Levin 1998: 432). For example, most activities in social insect colonies 'are regulated not by a central controller but in a decentralized manner via interactions among individuals and between individuals and their environment' (Bonabeau 1998: 437). Various kinds of self-organised patterns (e.g. network configurations, hierarchical and modular structures, or forms of behaviour) reflect the tendency of CAS to evolve towards order and increased complexity instead of disorder and less complexity (Kauffman 1993, 1995). Self-organisation plays a crucial role in the adaptive cycle of system development and renewal (see section 2.5) and in the generation of emergent properties.

With regard to ecosystems, the process of ecological succession provides an example of self-organisation in which persistent community assemblages develop in response to fluxes of solar energy, water and nutrients (Parrott and Lange 2013: 21). Regarding society, the 'invisible hand' metaphor – attributed in general to Adam Smith (1776) – for capitalist markets self-regulating if left on their own, is an example of self-organisation in a complex socioeconomic system. In this view, according to Olsson *et al.* (2011), the market or outcome of self-organisation is 'the result of a decentralized and nonintentional process where the role of government is to guarantee freedom, property rights, and security in a process that should work even if participants are unaware and have no knowledge of it' (p. 4). In another example, the Stockholm metropolitan area has witnessed a growth in stewardship and conservation groups concerned with management of the National Urban Park (Barthel *et al.* 2005). These locally developed institutions represent local self-organisation around ecosystem management (Colding 2013).

Emergence and emergent properties

Higher order, if not whole system, properties (e.g. state, structure, capacity and behaviour) cannot be explained or managed by considering components in isolation. This is reflected by Fiksel (2006: 17) who states that integrated assessment of sustainable systems cannot be accomplished by simply linking together a collection of domain-specific models; to assess higher-order interactions among interdependent systems requires new tools to capture the emergent behaviours and dynamic relationships that characterise CAS. Put simply, complexity emerges and CAS are more than the sum of their components.

The spontaneous emergence of higher-order or higher-level properties is a key characteristic of many CAS (e.g. Holland 2002 regarding economic planning). The concept of emergence refers to processes in which larger (macroscopic) scale patterns, structures, behaviours, functions and other significant emergent properties tend to arise from a combination of three key determinants acting at lower levels and smaller (microscopic) scales. These are: (1) local interactions, according to simple rules, among individual components; (2) their responses to changing conditions in the external environment; and (3) autonomous selection processes (Levin 1992, 1998). Thus, emergence and self-organisation, though different, are closely related processes in CAS.

Genuinely emergent system properties often cannot be adequately explained or predicted solely by studying the properties of individual components of the system.[15] The corollary is that emergent properties must be studied at the aggregated levels at which they occur; whether at whole system level or at nested hierarchical levels within the system. In other words, CAS cannot be analysed entirely in terms of their micro-scale properties and interactions (reductionism); they must be analysed in terms of macro-scale patterns and dynamics in the context of the whole system (holism).

The concept of emergence is important because it explains how complex systems spontaneously acquire increasingly higher degrees of organisational complexity; it also explains how they begin to exhibit genuinely novel properties (e.g. new as opposed to modified patterns) that in some sense transcend the properties of their components (Kim 1999: 3; Ratter 2012).

Ecosystems provide an example of CAS in which macroscopic system properties ('patterns') such as trophic structure emerge from interactions among components at lower levels, and may feed back to influence the subsequent development of those interactions (Levin 1998: 431). In another example, Parrott and Meyer (2012) use a whale-watching SES in the St. Lawrence Estuary in Quebec, Canada to explain emergence in a complex land- and seascape in which human and biophysical components are intricately linked. Figure 2.2 (Parrott and Meyer 2012) shows a conceptual diagram of a complex SES representing a regional landscape composed of locally interacting, heterogeneous components whose

[15] Silberstein and McGeever (1999) distinguish between 'ontologically emergent' properties that are neither reducible to nor determined by more basic properties, and 'epistemologically emergent' properties that are 'merely an artefact of a particular model or formalism generated by macroscopic analysis, functional description or some other kind of 'higher-level' description or explanation' (p. 182).

combined behaviours give rise to emergent patterns, processes and institutions on the landscape.[16]

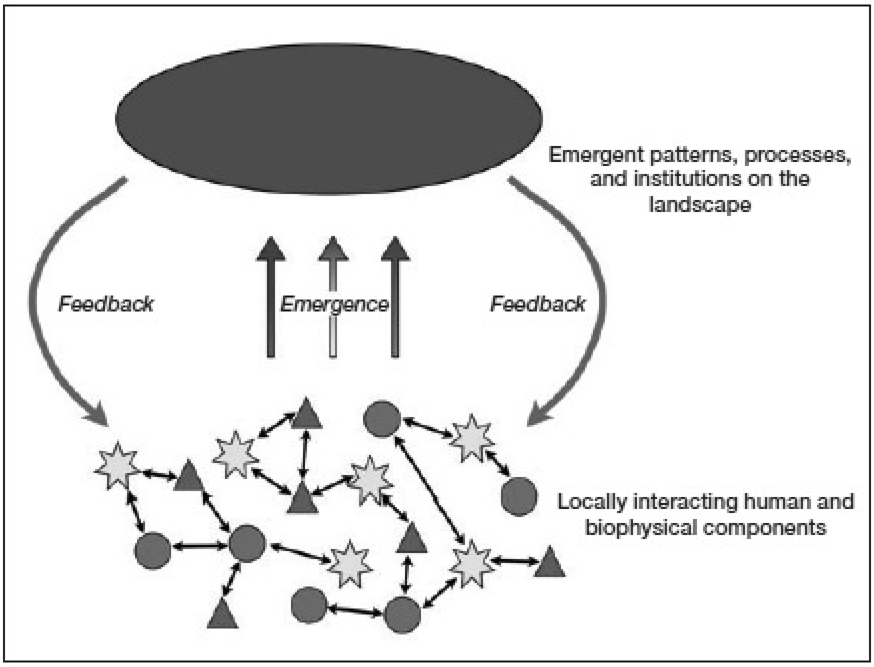


Figure 2.2 Conceptual diagram of a complex social–ecological system representing a regional landscape. (Source: Parrott and Meyer 2012: 384, Fig. 2.)

Scale and hierarchy

The occurrence of nonlinear dynamics and pattern formation over a range of scales and levels (see Box 2.1) is another characteristic of CAS. On the one hand, phenomena ranging from individual agents and self-interest to subsystems and cooperative behaviour are integrated across scales of space, time and organisational complexity to form whole systems (Levin 2010b). On the other hand, these same phenomena, including whole systems, are distributed across scales in a discontinuous pattern. In other words, CAS may be arranged in discrete regimes at different levels of organisation separated by thresholds or discontinuities (Garmestani *et al.* 2009). Each regime is defined by a particular set of self-organised agents, processes and properties that are tightly interconnected

[16] Parrott *et al.* (2012) use bottom-up modelling to simulate the dynamics of individual boats and whales to understand emergent system properties and inform conservation and management decision makers on how to mitigate the impacts of maritime traffic on whales in the St. Lawrence Estuary.

and function over a discrete range (level or layer) of spatial, temporal and other scales. Thus, through the processes of self-organisation and emergence, CAS typically organise into multidimensional structural arrangements or configurations. These are usually described in terms of vertical 'hierarchical' and horizontal 'distributed' relationships. In most cases, however, this is an artificial division.[17]

Cities (i.e. urban CAS) are manifestations of human adaptation to the natural environment (Garmestani *et al.* 2008a: 138). Garmestani *et al.* (2008b) provide an example of discontinuous scaling in which city size distributions within the south-eastern region of the USA are the expression of hierarchical processes acting upon urban systems. Cities fall into discrete size classes with growth dynamics that differ at different scales; discontinuities appear as gaps in regional rank-size distributions of city size. Although cities grew or shrank over time, the overall distribution pattern remained discontinuous. This suggests that city size classes reflect the scales of opportunity available in a given system and the processes that structure city size operate at discrete levels of spatial and temporal scales resulting in a dynamic hierarchy (Garmestani *et al.* 2007; Sundstrom *et al.* 2014: 6930). In another example, industrial sectors have been found to consist of manufacturing firms that are clustered in size classes (Garmestani *et al.* 2006). In ecological systems, an example of scaling and hierarchy is the discontinuous body mass distributions of species that correspond to discrete spatial and temporal ranges of resource distribution and availability, and ecosystem structures and processes (Holling 2001; Garmestani *et al.* 2013; Sundstrom *et al.* 2014).

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[17] The term 'hierarchy' implies arrangement or ranking according to relative importance, status or power (cf. Oxford Dictionary 2015). Hierarchy is frequently represented as a pyramid-like arrangement of entities connected in linear chains with progressively less entities at higher levels. Hierarchy carries with it (negative) connotations of top-down direction and control in which higher-level entities with power direct the behaviour of 'sub' entities at lower levels: so-called 'command and control' (see Holling and Meffe 1996). Hierarchy also connotes fixed functional roles and a lack of agency and social (vertical) mobility.

Box 2.1 Concepts of 'scale' and 'level'

As Vervoort *et al.* (2012: 1) observe, concepts associated with scale are used in many contradictory ways in different research literatures. The imprecise and inconsistent use of the terms 'scale' and 'level' can lead to misunderstandings and confusion (Bissonette 2013: 79). Sayre (2005: 285) warns against conflating scale and level, while King (1997) admonishes: 'It is inappropriate to use the terms *scale* and *level* interchangeably as if they were synonymous. They are not' (p. 200, emphases in original). Therefore, it is important to clarify the terminology.

Gibson *et al.* (2000: 219) use 'scale' to refer to spatial, temporal, quantitative or analytical dimensions used to measure and study objects and processes. In other words, scale is a measurable – in the sense of being significant – dimension such as spatial extent (total area), temporal extent (time period) or jurisdiction (institutional reach). The term 'levels' refers to the units of analysis located at different positions on a scale (Gibson *et al.* 2000: 218; Cash *et al.* 2006: 2). That is, an individual level is a particular location or region along a measurable dimension. In terms of hierarchy, levels are perceived relative to each other within the observed range. A scale may have discrete levels, each consisting of multiple properties and processes of interest. In many cases, properties and processes can occur over either a continuous or discontinuous range of levels as well as between scales, for example, cross-scale interactions (Cumming and Norberg 2008). The term 'multiscale' refers to the presence of more than one scale, and 'multilevel' to the presence of more than one level, but without implying that there are important cross-scale or cross-level interactions (Cash *et al.* 2006: 4).

Cross-scale linkages

In complex multiscale, multilevel systems, changes in structure and dynamics at one level of hierarchical organisation on one scale are influenced by changes in structure and dynamics at other levels and scales. Consequently, nonlinear cross-linkages and interactions are essential for the study of many real-world CAS.[18]

According to Cash *et al.* (2006), important linkages and interactions in CAS may occur within and across scales. They can occur between different levels on a scale ('cross-level') and between either analogous or different levels on different scales ('cross-scale'). The different combinations of linkages and interactions are graphically represented in Figure 2.3. In general, these cross-level and cross-scale linkages and interactions are changeable: they may change in strength and direction over time in response to internal and external influences. Possibly after some considerable time lag, such changes may in turn modify the internal and external influences through feedbacks. The complexity of such cross-level and cross-scale dynamics (hereafter 'cross-scale dynamics') means that a system's behaviour, potential trajectory and future state are generally unpredictable.

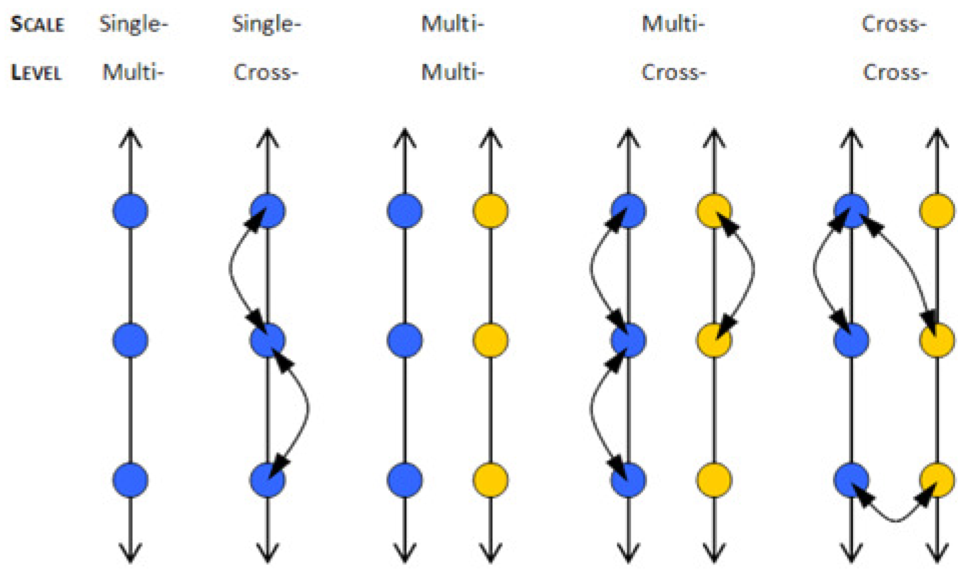

Figure 2.3 Typology of linkages and interactions within and between scales (based on Cash *et al.* 2006).

[18] 'Cross-scale linkages' are defined by Chapin *et al.* (2009b) as 'processes and networks that connect the dynamics of a system to events that occur at other times or places' (p. 344). For Cumming *et al.* (2010), cross-scale and cross-level linkages refer to 'the ways in which parts of the system at different levels (and/or scales) constrain, explain or influence one another' (p. 416). Dirnböck *et al.* (2008) define 'cross-scale interactions' as those in which 'processes and phenomena at one scale or level influence processes and phenomena at other scales or levels' (p. 8).

The Millennium Ecosystem Assessment (MA) was designed to meet the needs of decision makers regarding scientific information on the consequences of ecosystem change for human well-being (Carpenter *et al.* 2006: 257). Though aware of scale-related issues from its inception, the MA conceptual framework (MA 2005: vii, Fig. B) shows the scales (local, regional, global) stacked up behind each other like duplicates, but with no explicit cross-scale interactions (Scholes *et al.* 2013: 17). Subsequently, Carpenter *et al.* (2006) published an update of the MA conceptual framework (reproduced in Figure 2.4). This three-dimensional model illustrates the reality of cross-scale dynamics through a series of specific cross-scale interactions, rather than the orderly pile of duplicates depicted in the original MA conceptual diagram (Scholes *et al.* 2013: 17).

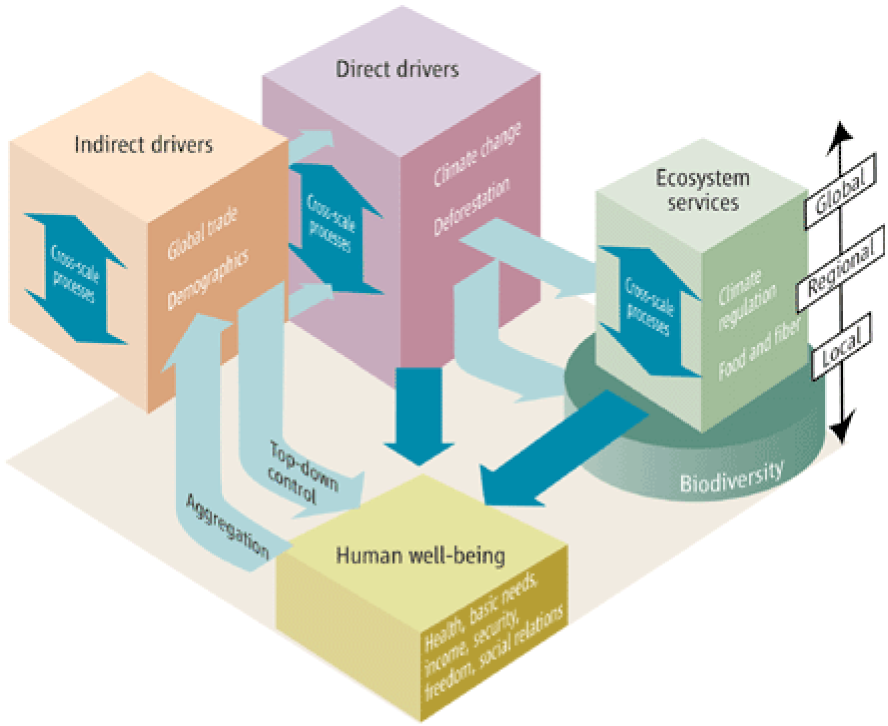

Figure 2.4 The MA conceptual framework, modified to illustrate connections among local, regional and global scales for a few processes. Light blue arrows indicate actions that are amenable to policy interventions. (Reproduced from Carpenter *et al.* 2006: 257.)

As an example of cross-scale dynamics, Carpenter *et al.* (2006: 257) give the loss of buffering coastal ecosystems that exposed extensive regions to catastrophic damage in the 2004 Asian tsunami and the 2005 Gulf of Mexico hurricanes. In these cases, local processes spread to become regionally important. In another example, tropical deforestation to make way for agriculture involves cross-scale interactions in driving local change, including loss of ecosystem services, and large-scale feedbacks to the climate system (Swanson and Chapin 2009: 168). Makri (2005: 43-44) considers the ecological and human dynamics of disease vulnerability that operate at local levels in urban setting, but are connected to larger-scale processes that involve environmental and social change at regional and global levels: processes such as deforestation, biodiversity loss, water projects, migration or climate change. Further examples of cross-scale interactions include the impacts of international policies on the collapse of local fisheries, the effects of a global market on local management practices, or the effects of regional drought on global food prices (Scholes *et al.* 2013: 19).

Adaptation

The main principle behind CAS theory is that all such systems are adaptive. That is, they all have ‘the ability or tendency to adapt to different situations’ (Collins Dictionary 2015) and are ‘characterized by or given to adaptation’ (Oxford Dictionary 2015). Before proceeding, some clarification of terminology is appropriate. The ability to adapt refers to the capacity of system components (agents and processes) and their properties (structures, behaviours and functions) to individually or collectively make small, incremental changes (adjustments) in response to, or anticipation of, changes (either internal or external to the system) and the resulting new conditions. The term ‘adaptation’ is used to refer to both the process of making adjustments and an outcome or product of that process. Typically, it is assumed that adaptations are advantageous in terms of improving a system’s and, therefore, its agents’ chances of successful persistence. (The term ‘maladaptive’ and its derivatives refer to the inability or failure to adjust adequately or appropriately to changing circumstances.)

CAS continually adapt and develop through experimentation, learning and evolutionary processes associated with self-organisation and emergence: complex cross-scale dynamics in which some components persist, some disappear and others appear (emerge). These changes occur in the system in order to maintain a balance between the state variables that constitute the system. The many degrees of freedom associated with CAS components allow for a large number of options at each branching or selection point[19] during the adaptation process (Kumar 2007: 1349). Depending on chance events ('accidents of history'), multiple outcomes and alternative developmental pathways are possible (Levin 1998, 1999). Thus, CAS are endowed with characteristic variability and unpredictability.

Let us consider one example of adaptation to climate change[20] involving marine fisheries systems comprising marine ecosystems, fish resources, fishermen, fisheries-dependent communities, fishing industry, fisheries management and fisheries governance. (Space precludes further examples of adaptation, for which the reader is referred to IPCC 2014.) Marine fisheries systems are a type of CAS (Wilson 2006; Levin and Lubchenco 2008: 28; Mahon *et al.* 2008: 104). More specifically, fisheries are dynamic SES that are constantly adapting to various forms of change (Perry *et al.* 2010a, 2010b; Berkes 2011a; Ommer and Perry 2011; Perry *et al.* 2011; Ommer *et al.* 2012). This includes adaptation to climate variability such as the North Atlantic Oscillation, long-term climate change, and non-climate pressures and shocks such as lost markets or new regulations (Daw *et al.* 2009: 138). The future impacts of anthropogenic climate change pose multiple additional risks to fisheries systems (Barange and Perry 2009; Cochrane *et al.* 2009; Daw *et al.* 2009).

[19] At points during system evolution and adaptation, agents (components with agency) are able to respond to changing circumstances by selecting among a set of possible strategies.

[20] According to Daw *et al.* (2009: 137), adaptation to climate change is defined in the climate change literature as an adjustment in ecological, social or economic systems, in response to observed or expected changes in climatic stimuli and their effects and impacts in order to alleviate adverse impacts of change, or take advantage of new opportunities. Adaptation is an active set of strategies and actions taken by people in response to, or in anticipation of, change in order to enhance or maintain their well-being. Therefore, adaptation can involve both building adaptive capacity to increase the ability of individuals, groups or organisations to predict and adapt to changes, as well as implementing adaptation decisions (i.e. transforming adaptive capacity into action). Both dimensions of adaptation can be implemented in preparation for, or in response to impacts generated by a changing climate. Hence adaptation is a continuous stream of activities, actions, decisions and attitudes that informs decisions about all aspects of life and that reflects existing social norms and processes.

Examples of adaptation to climate change in fisheries systems are dominated by diversification or flexible livelihoods and migration in response to climate-mediated fluctuations in yield (Daw *et al.* 2009: 138). Table 2.1 presents examples of adaptation to climate impacts on fisheries; the choice of specific adjustments would depend on the context and the social, economic and ecological costs and benefits (De Young *et al.* 2012: 112).

Table 2.1 Examples of adaptation to specific climate impacts on fisheries.

Impact on fisheries	**Potential adaptation measures**
Reduced fisheries productivity and yields	Access higher value markets Increase effort or fishing power*
Increased variability of yield	Diversify livelihood portfolio Insurance schemes Precautionary management for resilient ecosystems Implementation of integrated and adaptive management
Change in distribution of fisheries	Private research and development and investments in technologies to predict migration routes and availability of commercial fish stocks* Migration*
Reduced profitability	Reduce costs to increase efficiency Diversify livelihoods Exit the fishery for other livelihoods/investments
Increased vulnerability of coastal, riparian and floodplain communities and infrastructure to flooding, sea level and surges	Hard defences* Managed retreat/accommodation Rehabilitation and disaster response Integrated coastal management Infrastructure provision (e.g. protecting harbours and landing sites) Early warning systems and education Post-disaster recovery Assisted migration
Increased risks associated with fishing (e.g. safety at sea)	Private insurance of capital equipment Adjustments in insurance markets Insurance underwriting Weather warning system Investment in improved vessel stability/safety Compensation for impacts
Trade and market shocks	Diversification of markets and products Information services for anticipation of

	price and market shocks
Displacement of population leading to influx of new fishers	Support for existing local management institutions
Various	Publicly available research and development
Note: * Adaptations to declining/variable yields that directly risk exacerbating overexploitation of fisheries by increasing fishing pressure or impacting habitats. Source: De Young *et al.* 2012: 113, Table 1; based on Daw *et al.* 2009: 139, Table 6.	

Current problems with fisheries management call for strong and reliable institutions governing resource use (Daw *et al.* 2009: 143). However, top down or rigid command-and-control approaches do not offer the flexibility to ensure resilient and adaptive fisheries systems and communities under climate change (Lane 2010: 201). Adaptive (co-)management[21] approaches to natural resource management, including marine fisheries, are designed to address uncertainty through learning and subsequent adaptation of management based upon that learning. Learning takes place through experimentation, monitoring and evaluation in real world settings, where knowledge is incomplete and when, despite inherent uncertainty, managers and policy makers must act. The process is iterative and serves to reduce uncertainty, build knowledge and improve management over time in a goal-oriented and structured process (Allen and Garmestani 2015: 2-4; Fabricius and Currie 2015: 147-149; see also Lane 2010).

Co-evolution

In terms of CAS theory, co-evolution refers to the simultaneous development of adaptations in two or more heterogeneous entities (populations, species, system components, systems or other categories) interacting so closely that each is a strong selective force on the other (Raven and Johnson 1986, cited in Cairns 2007: 103; Rammel *et al.* 2007: 1-2). Co-evolution is a process in which adaptations in one entity complement adaptations in another entity. This leads to irreversible patterns of change (Kemp *et al.* 2007: 80). Over the long term, these entities

[21] Adaptive co-management refers to an ongoing process of collaboration that (1) takes into account a diversity of knowledge systems (including, for example, informal, local and traditional knowledge, and formal scientific knowledge); and (2) allows a diversity of stakeholders (for example, resource users, local stewardship associations, government agencies and NGOs) to share rights, responsibilities and power across multiple levels within a governance system 'where they can explore their objectives, find common ground, learn from their institutions and practices, and adapt and modify them for subsequent cycles' (Fabricius and Currie 2015: 148).

follow a co-evolutionary development path marked by mutualistic evolutionary changes that favour the reproduction/renewal and survival/persistence of each entity (Norgaard 1984; Cairns 2007; Gual and Norgaard 2010). A fundamental principle of SES theory is that a special co-evolutionary relationship exists between humans and the rest of nature. This, of course, is a generalisation. Patterns of co-evolutionary dynamics are often very complex and hard to unravel. For instance, the co-evolution of a system with its environment may depend on co-evolutionary interactions at both component and system levels. Co-evolutionary processes can be mutually cooperative, competitive parasitic, predatory or dominating (Kallis and Norgaard 2010: 691).

The concept of co-evolution is well established in evolutionary biology and ecology. Biological co-evolution refers to reciprocal evolutionary change between two or more interacting species (Thompson 2009: 125). Examples include the close ecological relationships between butterflies and their food plants that shape the evolution of both (Ehrlich and Raven 1964) or between hosts and parasites (Anderson and May 1982), and predator–prey relationships (Holding *et al.* 2016). Biological co-evolution is a highly dynamic process that over time continually reshapes interactions among species within local communities as well as across ecosystems and large geographic ranges (Thompson 2005, 2009). In recent years, the use of the concept has broadened across diverse fields to include similar dynamics between complex components or systems that co-evolve (Weisz and Clark 2011).[22]

Kallis and Norgaard (2010: 691-692) consider five types of co-evolutionary mechanisms relevant to the field of ecological economics. First, biological co-evolution, which is outlined above. Second, social co-evolution, which refers to the reciprocal evolution of two or more human social systems. For example, co-evolution of technologies and institutions, populations of producers and consumers, or organisations and their environments. Third, gene–culture co-

[22] Co-evolution is different from mere co-dynamic change of social and ecological variables or feedbacks and impact responses between broadly defined social and ecological systems; the difference in co-evolution is that at least one (social or ecological) system is evolving, that is, changing through Darwinian principles of variation, inheritance and selection (Norgaard 1994: 40; Kallis 2007: 5-6; Hodgson 2010; Kallis and Norgaard 2010: 690).

evolution, which refers to interactions between the cultural and biological evolution of the human species. Examples include the co-evolution of sign language with deafness, or lactose-tolerance with dairy farming. The fourth mechanism is bio-social co-evolution, which refers to reciprocal influences between social evolution and non-human biological evolution. Examples include co-evolution between pest populations and regulatory policies for the pesticide industry, or fishing practices and fish populations.

Kallis and Norgaard's fifth mechanism is socio-ecological co-evolution. This refers to cases where evolution in the social system affects the biophysical environment, which in turn affects evolution in the social system (Norgaard 1994). For example, the co-evolution of water resources supply and demand in Athens, Greece: new water supply generates higher demands that in turn favour water supply expansion over other alternatives, resulting in a growing city water footprint that degrades the environment and communities in the surrounding countryside (Kallis 2010). In other words, changes in the developing social system influence the biophysical system while amplifying (positive) feedbacks from the altered biophysical system affect the development of the social system.[23]

Socio-ecological co-evolution has been recognised as a key conceptual framework for understanding change in complex adaptive SES (Kallis and Norgaard 2010). Co-evolutionary interactions between human (social, cultural, economic, technological, etc.) systems and ecological systems provide a framework for linking society–nature relationships and adaptive evolutionary change with sustainability and the normative objectives of sustainable development (Norgaard 1994; Cairns 2007; Kallis 2007; Rammel *et al.* 2007). As Norgaard (1994) points out:

> '[…] social and environmental systems coevolve such that environmental systems reflect the characteristics of social systems—their knowledge, values, social organization, and technologies—while

[23] Kallis and Norgaard (2010: 692) consider this situation analogous to niche construction: the process whereby organisms, through their activities and choices, modify their own and each other's niches (Laland and Boogert 2010). That is, socio-ecological co-evolution involves a social niche construction.

> social systems reflect the characteristics of environmental systems—their mix of species, rates of productivity, spatial and temporal variation, and resilience. The coevolutionary description of development explains why, and to some extent how, everything is related to everything else' (pp. 36-37).

SES are co-evolving systems. Stagl (2007: 55) defines three main levels of co-evolutionary processes that are particularly relevant in the context of sustainable development of SES: (1) co-evolution of the environment and governance (macro level); (2) co-evolution of technology and governance (meso level); and (3) co-evolution of human behaviour and culture (micro level). Interactions occur between the different levels. Likewise, Geels (2006) adopts a multilevel perspective and distinguishes three levels of co-evolutionary processes (at niche, regime and landscape levels) in socio-technical systems to explain the co-evolution of technology (evolution from propeller to turbojet aircraft) and the developing aviation socioeconomic system. Overall, as Weisz and Clark (2011) observe, the notion of society–nature co-evolution presents a conceptual framework for keeping nature and human society/culture under one conceptual umbrella; this has implications for identifying potential social–ecological pathways for a transition towards sustainability.

Resilience

The capacity to absorb stresses and shocks without losing integrity or the ability to continue functioning is inherent in many CAS. The concept of resilience is used to understand the properties of CAS that enable them to persist in the face of disturbance and change. Persistence is related to the interplay between disturbance and how systems respond to the resulting changes (Folke 2006; Fleischman *et al.* 2010; Folke *et al.* 2010; Miller *et al.* 2010). Resilience and related concepts concerning the interplay between persistence and change in complex adaptive SES are central to this thesis. Given their importance, they are described in detail separately in Chapter 3.

2.4 Dynamics of complex adaptive systems

CAS are inherently dynamic. Agents and processes continually interact with each other and their environment. Self-organisation, cross-scale interactions and nonlinear feedbacks create and maintain hierarchical structure and emergent properties. Adaptation allows CAS to continue to evolve and develop in response to changing conditions. The following paragraphs describe the main concepts underlying CAS dynamics.

Patterns and processes of change

Patterns, processes, structures, behaviours, functions and other properties of CAS change across spatial, temporal and organisational scales in response to different driving forces or drivers. These drivers of change include sustained pressures and discrete events. They may originate endogenously in the dynamics at different levels of hierarchical organisation within the system or exogenously in the dynamics of the external environment. Sets of drivers may interact with each other across multiple scales, causing diverse effects or processes of change – how systems adapt, transform, develop or evolve from one stage to another – in complex multiscale multilevel systems. Qualitatively, the resulting patterns of change at different system levels and scales variously consist of three main types of change:

> *Incremental or adaptive change*. Gradual, near-continual and fairly predictable; a series of small steps. Characteristic of adaptation processes and long-period phases of system development (e.g. renewal, growth, maturity and decline) while the system remains within the same regime.

> *Abrupt or transformative change*. Episodic, discontinuous, pattern-breaking and often surprising; a step change. Characteristic of relatively rapid phases of system transition (e.g. from growth or maturity to collapse then renewal) and transformations involving a radical shift to a fundamentally new regime; that is, involving the alteration of endogenous control processes and feedbacks and the ranges over which they operate.

> *Alternating or chaotic change*. Episodic, oscillatory, fluctuating, apparently disordered and highly uncertain; a turbulent change. Often preceding, accompanying or superimposed on abrupt change and transitional phases (e.g. between growth and decline or collapse). Characteristic of self-organising system states that evolve towards criticality (the 'edge of chaos'), regime shifts across a critical threshold (catastrophic bifurcation or tipping point) between alternative regimes, and some early-warning signals of impending critical transitions (Scheffer *et al.* 2009).

These are general patterns. Depending on conditions, each may either arise spontaneously or be imposed. In terms of directionality, each may possess a different potential for reversibility: reversible, possibly reversible given the right conditions or management, reversible with hysteresis[24] along a different pathway, or irreversible (Walker and Meyers 2004). Of course, there are other significant types of system change. For example, stochastic or randomly determined change, periodic or cyclical change, cumulative change, cascading change and regime shift. These are considered distinctive processes in their own right.

Regimes, attractors and stability landscapes

The concept of a system regime (equivalent to stability domain or basin of attraction; see Folke *et al.* 2010) gives expression to the dynamically stable configuration and nonlinear behaviour of CAS during long periods of incremental or adaptive change (i.e. during system evolution and development).

From a CAS perspective, a regime is not a singular or static 'stable' state existing at or very close to equilibrium conditions.[25] Instead, a regime is a set of coexisting

[24] According to the Resilience Alliance: 'Hysteresis refers to how a system responds, or more specifically, the return path taken following some disturbance or change due to cumulative effects. When the system follows a different path upon return to its former state, this is called a hysteresis effect.' Source: http://www.resalliance.org/glossary [accessed 23/11/2015].

[25] The notion of equilibrium refers to the steady state condition of a dynamic system where the processes of interaction among all the state variables are such that all the forces are in balance, and no variables are changing (Walker and Salt 2006: 164). At equilibrium there is no net change in basic system structure or function over a particular time period (Chapin *et al.* 2009b: 351). An equilibrium state may be stable, unstable or transient. An equilibrium is 'stable' if the system returns to it following a small disturbance, and 'unstable' if the system moves away from the

states (particular conditions at a specific time) that the system 'visits' concurrently and repeatedly. Put another way, a regime is a dynamic configuration of system components and their relationships, which persists as the system progressively self-organises and self-stabilises along an evolutionary development trajectory relative to a particular equilibrium or attractor (see below). Therefore, a regime comprises the set of all possible states that a system can persist in and still behave in the same general way. Despite significant variability, the system retains essentially the same basic characteristics (function, structure, feedbacks and identity) over long time periods (Walker *et al.* 2002, 2004, 2006). The system is said to remain in the same regime.

Crucially, this set of all possible states (i.e. regime) may encompass both near to equilibrium behaviour (constancy or low variability) and far from equilibrium behaviour (changeability and high variability). Far from equilibrium behaviour takes place close to, but remains within, the boundaries of stability. Far from equilibrium conditions or critical states near boundaries (critical points or thresholds) and transition phenomena are often described in terms of the concept of self-organised criticality at the edge of chaos (Bak *et al.* 1988; Bak 1996; Kauffman 1993; see also Pruessner 2012). Bak *et al.* (1988) proposed that a CAS evolves by self-organising towards a critical state of dynamic equilibrium, referred to as 'self-organised criticality'. This self-organised critical state, which exists at the border between order and disorder ('the edge of chaos'), is a dynamic balance between stability and instability. That is, it is maintained by a balance of stabilising (negative) and amplifying (positive) feedbacks. When a system is in a far from equilibrium critical state, it demonstrates a readiness to adapt to changes in its environment and retains its basic integrity and functions.

Use of the term 'regime' helps us move away from flawed assumptions and potentially misleading notions that CAS do, or should, exist in an optimal ('well-balanced') steady ('stable') state at a single equilibrium; as might be supposed, for example, under a top-down command and control approach to management of people and resources (Holling and Meffe 1996). The corollary is the assumption

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equilibrium after such a disturbance (Scheffer 2009: 354). A 'transient' equilibrium exits between two stable and/or unstable equilibria and is, in effect, a threshold (Holling 1973: 11-12).

that CAS are disturbed into a suboptimal (‘unbalanced’) and unsteady (‘unstable’) state by being displaced linearly away from, and before returning linearly to, a single equilibrium. Such notions are central to engineering resilience rather than ecological resilience (Holling 1996) or the broader sense of social–ecological resilience.

Basins of attraction

The regime of a dynamic system is often described using the concept of a stability domain or basin of attraction (Lewontin 1969, cited in Holling 1973: 20). The basin metaphor encompasses several notions. First, the area or volume of the basin represents the phase space or state space, which is the multidimensional continuum that could potentially be occupied by the regime. State space is defined by all possible (theoretical) combinations of the values of large numbers of interacting biotic (living) and abiotic (nonliving) variables that constitute a system (Walker and Salt 2006: 164). Nevertheless, it is more usual to model state space as an abstract defined by either two or three key variables (Gallopín 2006: 297).[26]

Second, the dynamics of a system are reflected by its movement through this state space (Walker *et al.* 2006: 3). At any point in time, the ‘state of a system’, that is, its configuration and pattern of behaviour is defined by the current values of its variables, particularly its state variables: the set of variables that help characterise the system state at that time.[27] As the state of a system changes, the succession of states through time (temporal evolution) defines a path or trajectory of the system. The trajectory unfolds from some initial state to the current state, to some future state and (possibly, but not necessarily) to a final state. Each system state is represented by a point or region in the state space (Gallopín 2006: 297). Each successive location of a system in state space is a function of the previous location (path dependence) plus subsequent movement (Cumming 2011: 18). The ‘ball in a basin’ metaphor (see Figure 2.5) is commonly used to visualise a snapshot of the

[26] Walker *et al.* (2006: 5) put forward the ‘rule of hand’ proposition that critical changes in social–ecological systems are determined by a small set of typically three to five key variables. ‘More complex models are not necessary to explain the key interesting patterns and, in fact, are likely to mask them. This is both because generally humans can only understand low-dimensional systems and because, empirically, it appears that only a few variables are ever dominant in observed system dynamics’ (p. 5).

[27] Note on terminology: I treat ‘state of a system’ and ‘system state’ as synonymous.

location of the state of a system (represented by the ball) relative to the cup-shaped basin of attraction and sometimes the wider stability landscape (Walker *et al.* 2004: 3-5).

Third, a dynamic system will tend to remain on a trajectory (or set of trajectories) towards an equilibrium state or attractor. In resilience-related work, the attractor is usually envisaged as the bottom of the basin of attraction. However, in some models the attractor may be depicted as the peak of a mound, for example, in the 'fitness landscape' model used in evolutionary theory (Malloy *et al.* 2010: 67). To avoid confusion, I will stick with the basin (cup or valley) metaphor.

The basin is the domain of state space under the influence of a single attractor (Gallopín 2006: 298). An attractor is a point or region of state space with a combination of values of different variables that makes it the 'preferred' equilibrium state of a particular system dynamic or set of dynamics. The attractor corresponds to the theoretical final state of the system (Scheffer 2009). In the absence of critical disturbances, and given long enough time, the system's configuration and behavioural regime will tend to converge (or evolve, develop, settle, decay, gravitate) towards the final state. In this sense, an attractor is the long-term destination of system trajectories (Allen 2001: 29). The basin of attraction represents the full set of different initial states that could theoretically give rise to different trajectories tending towards the same attractor.

Fourth, the concept of basins of attraction is central to the notion of resilience (Gallopín 2006: 297). In this sense, resilience is the capacity of a system to persist in the same basin of attraction (stability domain or regime) by absorbing disturbances and reorganising so as to retain essentially the same controls on structure and function.

The relative stability of a system's configuration (its components and their relationships) and character of its behaviour depend on where the system's dynamics take place: near to equilibrium, far from equilibrium and closer to the basin boundary, or somewhere in between. If undisturbed, successive states of a system tend to converge towards equilibrium; the system trajectory tends towards the attractor of the current basin (regime). In reality, even when it is near to equilibrium, moderate and somewhat random pressures and disturbances (including the decisions and actions of human actors) continually buffet the state of a system. To use the 'ball in a basin' metaphor, they jostle the ball, keeping it away from the attractor. As pressures and disturbances increase or resilience is diminished, or both, the system trajectory leads further away from the attractor towards the basin boundary or threshold. The closer the system is to the threshold, the greater its precariousness (Walker *et al.* 2004: 3-7).

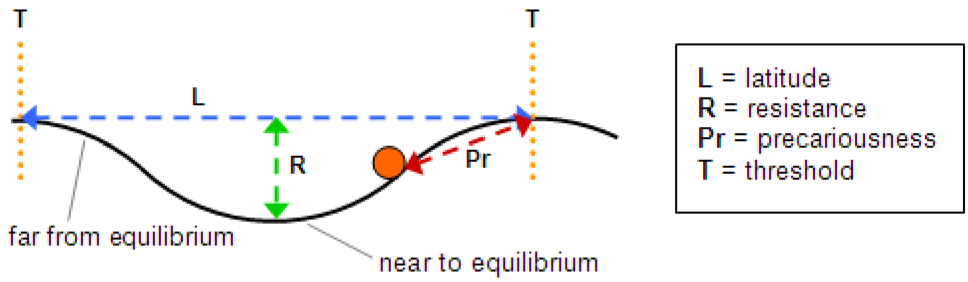

Figure 2.5 Basin of attraction (regime) in two dimensions showing the position of the system (ball) in state space; key aspects of resilience (latitude, resistance and precariousness); and positions of thresholds (boundaries) between basins. (Adapted from Walker *et al.* 2004: 5, Fig. 2).

The relative dimensions (topography) of the basin reflect key attributes of resilience (Figure 2.5). Less resilient (more vulnerable) regimes are characterised by a shallow, narrow basin; more resilient regimes by a deep, wide basin (Figure 2.6). The basin width or latitude represents the maximum amount of change the system can undergo before losing its ability to regenerate, reorganise and renew. A wide basin indicates that the system configuration can encompass ('visit') a greater number and variety of different states without approaching precariousness or breaching the basin boundary (i.e. crossing a threshold), which makes recovery difficult or practically impossible. The basin depth or resistance represents the ease or else difficulty of changing the system. A deep basin indicates that greater pressures and disturbances are required to move the system on to a trajectory away from the attractor.

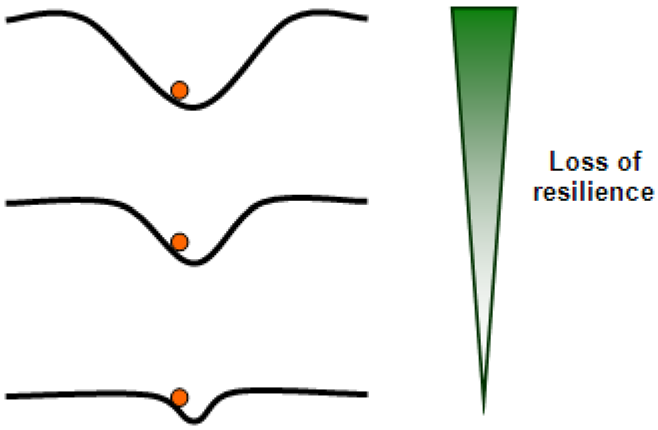

Figure 2.6 Basin of attraction showing loss of resilience through structural changes in state space: from a deep wide basin to a shallow narrow basin. (Adapted from Gallopín 2007: 29).

In summary, a CAS evolves through state space towards an attractor: a dynamically stable equilibrium state. The system is inclined to remain within the domain of influence (basin) of one attractor. More precisely, it is inclined to remain until circumstances destabilise the system, moving it first towards far from equilibrium conditions, then even further towards a critical state. That is, towards a state of self-organised criticality in the vicinity an unstable equilibrium or threshold, which may be a tipping point between the current attractor and one or more alternative attractors and their respective domains of influence (alternative regimes).

Stability landscapes and multiple stable states

Very simple dynamic systems with few state variables might have only one attractor. In contrast, many CAS (including social systems, ecosystems and SES) usually have very large numbers of state variables and more than one attractor. Theory and empirical evidence concerning both the persistence and transience of states in ecosystems, and to a lesser extent SES, point to the existence of multiple stable states and far from equilibrium behaviour as the norm, not the exception (Holling 1973; May 1977; Knowlton 1992, 2004; Gunderson 2000; Nyström *et al.* 2000; Scheffer *et al.* 2001; Beisner *et al.* 2003; Scheffer and Carpenter 2003; Folke *et al.* 2004; Mayer and Rietkerk 2004; Scheffer and van Nes 2004; Cole and

Flenley 2007; Scheffer 2009: 11-36; Hirota *et al.* 2011). Multiple stable states are also referred to as 'alternate stable states' (e.g. Knowlton 2004), 'alternative stable states' (e.g. Scheffer and Carpenter 2003) or 'alternative dynamic regimes' (e.g. Mayer and Rietkerk 2004).

The notion of multiple stable states with distinct basins of attraction (regimes) is a highly simplified image of reality in ecosystems (Folke *et al.* 2010: 2), social systems and SES. Nevertheless, it is now widely accepted that such systems may exhibit: (1) alternative regimes organised around unique attractors (i.e. multiple basins of attraction) separated by thresholds in state space; (2) multiple possible states that may encompass both near to equilibrium and far from equilibrium dynamics; and (3) the potential to undergo a critical transition (regime shift or transformation) across a threshold from one regime into a qualitatively different regime.

A two or three-dimensional 'stability landscape' is a commonly used metaphor for the structure of a system with multiple stable states (e.g. Peterson *et al.* 1998: 11; Scheffer *et al.* 2001: 593; Holling *et al.* 2002: 11; Walker *et al.* 2004: 4).[28] The stability landscape shows all the basins of attraction that the system could theoretically occupy in state space. The ridges separating the basins represent thresholds between qualitatively different (alternative) regimes. The topology of the stability landscape is dynamic.

The stability landscape reflects the unperceived evolution of slow state variables, which are often implicitly and incorrectly assumed to be constant (Gallopín 2006: 299). Over time, the complex arrays of co-evolving social and ecological variables that constitute the stability landscape progressively change their values in response to internal and external influences. The resulting structural changes in the stability landscape may variously involve the appearance, expansion, division (bifurcation), contraction or disappearance of attractors and their associated basins (Walker 2005: 82; Cole and Flenley 2007: 109). This can lead to a different number of basins (alternative regimes), a reduced or enhanced resilience capacity

[28] NB. Not all dynamic systems can be adequately described by a stability landscape (Walker *et al.* 2004: 7).

(as basins change latitude and resistance), altered positions of thresholds (ridges), and altered precariousness (less or more acute ridge tops).

Concerning the stability landscape of a system that exhibits multiple stable states, Gallopín (2006: 299) distinguishes three levels of stability. The first is local stability or engineering resilience (Holling 1996), which refers to system behaviour in the vicinity of an attractor (near to equilibrium) within a basin of attraction. Essentially, this is the time taken by the state of a system to return to steady state behaviour (constancy) following disturbance. The second level refers to changes in the state of a system between the different basins of attraction within the stability landscape of the system. This is ecological resilience or the capacity of the system when disturbed to either remain in the same basin by maintaining the values of key state variables within a certain range, or else shift across a threshold into an alternative basin. The third level is structural stability/instability (robustness/vulnerability), which refers to changes in the stability landscape itself. This is essentially the capacity of a system to either preserve or fail to preserve the topology of its trajectories (i.e. the qualitative features of its stability landscape) when disturbance affects its dynamics.

Thresholds

The concept of threshold is important in understanding the dynamics of CAS that have the potential for multiple stable states. There are different ways to interpret a threshold of change. First, a threshold is a breakpoint or bifurcation at which one relatively stable system basin of attraction gives way to another under certain conditions (Walker and Meyers 2004: 3). In this sense, a threshold is the least stable equilibrium or disequilibrium separating two basins. Second, a threshold is a critical point or level along a state variable that defines and influences structure and/or behaviour of a system. Third, a threshold is a region or zone of transition, rather than a discrete point or sharp break, in which threshold effects exist (Huggett 2005: 302; Eigenbrod et al 2009: 12). According to Huggett (2005): ‘Zone-type thresholds imply a gradual shift or transition from one state to another rather than an abrupt change at a specific point as suggested in point-type thresholds’ (p. 303). In other words, thresholds can be points at which abrupt change takes place or zones that involve more gradual nonlinear change (Kato and

Ahern 2011: 278). At such a point or zone, a system is very sensitive to changing conditions (Scheffer 2009: 357). Fourth, a threshold is a discontinuity (scale break) in the distribution of structures and frequencies within a hierarchy of systems. In this sense, a threshold is apparent as a gap between, for example, different size classes, discontinuous structures or discrete levels of organisation (Holling 1992; Allen *et al.* 2005; Garmestani *et al.* 2006, 2009).

The position of a threshold on a state variable can change over time. Even if its exact position is not knowable, it might be possible to identify factors that (1) move the threshold relative to the current regime (basin) or vice versa; and/or (2) make the threshold either more or less difficult to reach. Furthermore, when CAS such as SES are considered, it is likely that multiple thresholds interact across scales, leading to multiple possible threshold effects (including cascading effects) and outcomes of transitions (Kinzig *et al.* 2006). Despite the uncertainties regarding threshold positions and interactions, thresholds are an important aspect of a SES-based approach to policy, governance and management. Chapin *et al.* (2009c: 336) state: 'There is no region so resilient that policy makers and resource managers can ignore potential threshold changes'. Gaining a better understanding of thresholds in coastal systems, for example, will help managers understand the potential and direction of change in critical states of the coast, and therefore plan more effective coastal management strategies (McFadden 2008: 303).

Regime shifts

With changes in the stability landscape, the state of a system (or a particular subsystem) may at times approach near to equilibrium conditions. At other times, the system may be closer to far from equilibrium conditions and approaching a critical threshold state (tipping point or catastrophic bifurcation). At a critical threshold, either a minor disturbance or further incremental change in conditions may be sufficient to cause the system to exceed the threshold. This may trigger an abrupt critical transition in which an amplifying (positive) feedback propels the system dynamics towards an entirely new attractor in a qualitatively different regime (Scheffer and Carpenter 2003; Walker and Meyers 2004; van Nes and Scheffer 2007; Scheffer 2009; Scheffer *et al.* 2009; Dakos *et al.* 2011: E153-E154; Hilt *et al.* 2011; Petraitis 2013; Conversi *et al.* 2015). Whether the state of a system moves relative to thresholds in the stability landscape or the thresholds move relative to the system state, the result is the same: without sufficient potential for reversibility, the trajectory changes and the system is captured by a different attractor in a new basin. A new regime now applies; the system will tend to stay there until either a disturbance of sufficient force or else system drift (Dekker 2011: xii) drives it across a threshold (or multiple, potentially interacting thresholds (Kinzig *et al.* 2006)) into an alternative regime.

In Figure 2.7, the orange ball represents the state of a system. Its dynamics cause it to move towards the attractor (bottom of the basin). As system attributes and/or state space (represented by the shape of the basin) change, resilience is lost, and disturbance or drift may trigger an abrupt, rapid and drastic regime shift towards a new attractor.

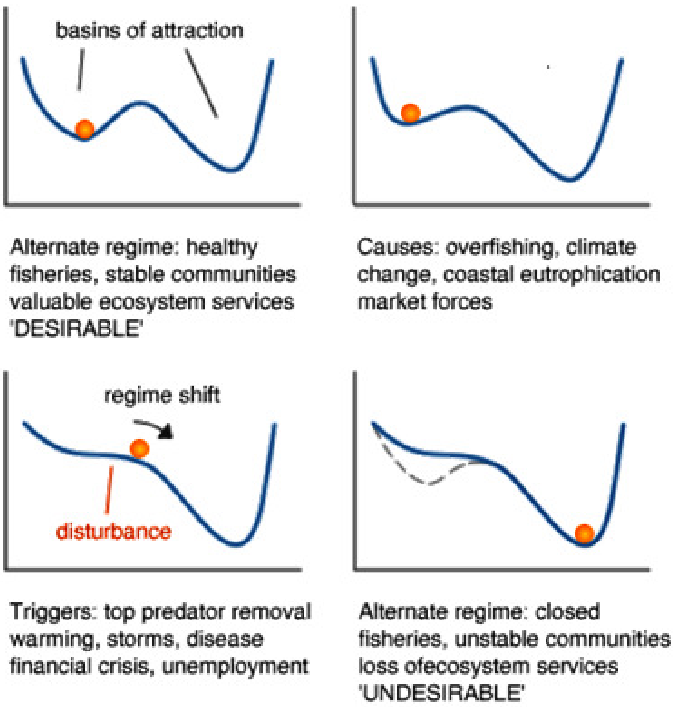

Figure 2.7 Alternative regimes (basins of attraction) plus possible causes and triggers behind loss of resilience and consequent regime shift in an ecosystem or SES. (Adapted from Deutsch *et al.* 2003: 213, Fig. 3; Folke *et al.* 2004: 12, Fig. 2).

The critical transition phase or regime shift marks a sudden change in system behaviour as the threshold is exceeded. In some cases, this brings about a surprisingly rapid, drastic, large-scale and long-lasting change in the responding state variables. In other cases, the transition in the state variables is more gradual (Walker and Meyers 2004: 2). During the regime shift, the system experiences transient dynamics, in other words, chaotic behaviour that is distinctly different from its eventual long-term dynamic behaviour (Hastings 2004).

As the system emerges from the regime shift, it is not the same as before. Altered or new internal structures and processes, including stabilising feedbacks that control function, have emerged. The configuration (components and their relationships) is qualitatively different; the pattern of behaviour is altered; significant reorganisation has taken place; and novelty may have been introduced. Therefore, notions of system wholeness and identity require a different understanding. Although various critical system functions may have been significantly altered, any actual loss of function associated with the new regime will depend on whether and how the overall functional diversity[29] of the system is affected. For example, redundancy within and among functional groups may help compensate against loss of critical function.

2.5 Adaptive cycle theory

It is evident that many organisms, species, ecosystems, societies, economies, sociotechnical systems, SES and other types of CAS have a tendency to persist over time. This tendency involves an apparent paradox. On the one hand, persistence depends on a system's ability to maintain integrity (i.e. retain its fundamental structure, function and identity) by absorbing, resisting and recovering from disturbances. On the other hand, persistence also depends on the system's ability to continually learn, adapt, change and evolve in response to changing conditions and, when necessary, transform. Persistence, of course, depends on the interplay between both abilities.

[29] Functional diversity refers to the diversity of system functions fulfilled by different species and actors, i.e. the variety of different functional groups that contribute to system performance (Walker *et al.* 2006: 6).

Consider a generalised CAS exhibiting persistence. The overall long-term pattern of macro-scale change is one of gradual adaptive or evolutionary change punctuated by episodes of rapid transformative or revolutionary change. From ecological studies (Holling 1986, 1992; Gunderson *et al.* 1995; Peterson 2000; Carpenter and Gunderson 2001; Gunderson and Holling 2002; Holling and Gunderson 2002) and increasingly economic (Grafton *et al.* 2004; Pendall *et al.* 2010; Simmie and Martin 2010; Phelan *et al.* 2011) and social (Homer-Dixon 2006; Moore *et al.* 2012) studies, it has been postulated that as a system evolves along a trajectory its state progresses through various phases of organisation and function in a cyclical pattern represented by the four-phase adaptive cycle (Walker and Salt 2006: 163).

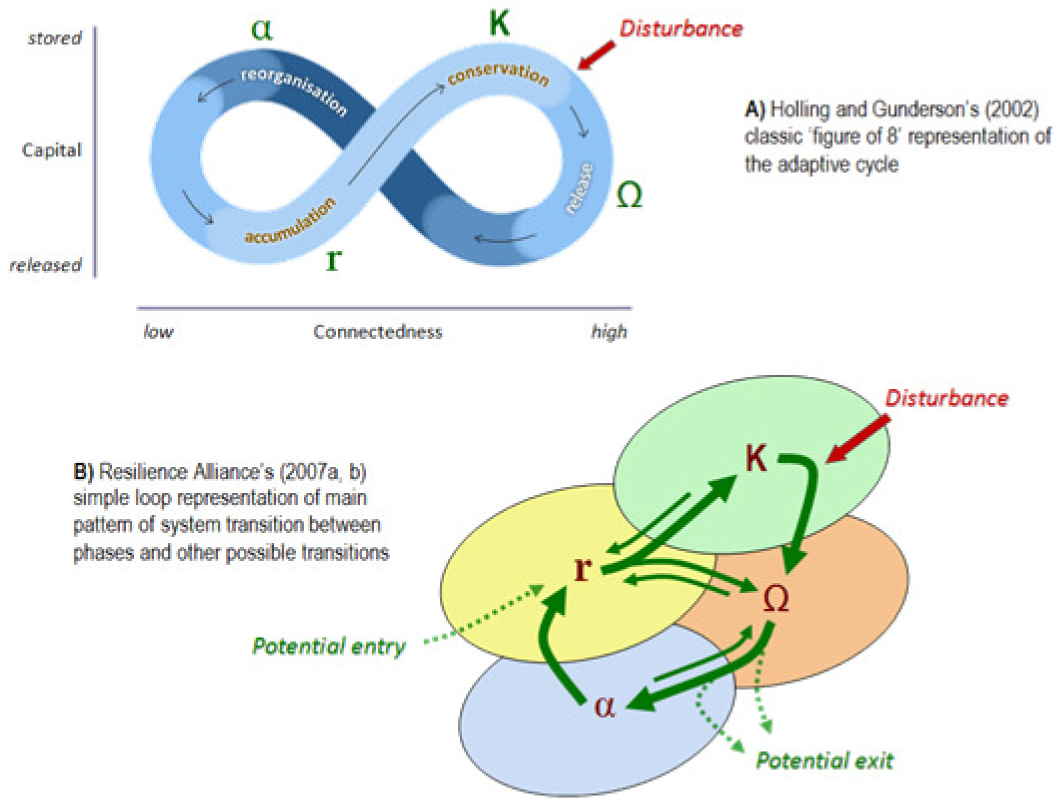

Figure 2.8 Two versions of the adaptive cycle model of system change showing the four characteristic phases of development and renewal driven by discontinuous events and processes.

Adaptive cycle of change

Holling's adaptive cycle is a conceptual model that describes a generalised pattern of evolutionary–revolutionary change in many ecological, economic, sociopolitical, institutional and SES (Holling 1986, 2001; Gunderson and Holling 2002). The adaptive cycle links four distinct phases of change (accumulation, conservation, release and reorganisation) in a recurring sequence. Figure 2.8 shows two versions of the model: A) classic 'figure of 8' (adapted from Holling and Gunderson 2002) and B) loop representation (Resilience Alliance 2007a, 2010).

The concept provides a framework for relating system structure, dynamics and resilience at a particular scale or level within a dynamic hierarchy or panarchy. As a metaphor for system persistence and change, the adaptive cycle is useful for describing: (1) the interplay between periods of adaptive and transformative change; (2) recurring relationship between development and renewal, driven by discontinuous events and processes; and (3) transitions between the different periods, as well as the triggers associated with occasional critical transitions. An ideal adaptive cycle consists of the following sequence of phases and transitions (Holling 1986, 2001, 2004; Gunderson and Holling 2002; Folke 2006; Walker *et al.* 2006; Resilience Alliance 2007a, 2010):

> *Accumulation, growth, exploitation or 'r' phase*. Period of relatively rapid 'constructive' change and high system resilience arising from readily available resources used (exploited) by system components that tend to be small, flexible and fast growing. It is when new components enter into the system, capital accumulates, structure is built up and connectedness among components increases. Growth is at a maximum. The transition of the system from this accumulation phase to the next (K) phase tends to be very slow and gradual.
>
> *Conservation or 'K' phase*. Period of gradual 'consolidative' change. It is marked by growing stasis and rigidity as increasingly more resources and energy are needed to maintain or conserve existing structures and connections (rather than building new ones) as the maturing system

approaches carrying capacity due to constraints imposed by the (natural and social) environment. Net growth slows and tapers off, and capital is aggregated and increasingly unavailable. That is, capital is progressively bound-up in relatively few components that tend to be slow growing, long lived, dominant and controlling. The system becomes increasingly efficient and interconnected but, paradoxically, less flexible and more vulnerable (less resilient) to external disturbances. The predictability of system behaviour diminishes. The longer the system remains in the conservation phase, the more vulnerable it becomes, even while becoming more efficient. 'It becomes an accident waiting to happen' (Holling 2001: 394).

Release or 'Ω' phase. Period of abrupt, rapid and chaotic 'deconstructive' change when disturbance triggers or drives the often rapid release (sometimes loss) of bound-up capital and the forced readjustment (unravelling) or collapse of accumulated structure and connectedness. The transition of the system to the next (α) phase is rapid.

Reorganisation, renewal or 'α' phase. Crucial period of restructuring, reorganisation and possibility. The disorder and released capital (which is now disaggregated and distributed among numerous independent components) of the previous (Ω) phase provide an opportunity for experimentation, learning and innovation. Processes of self-organisation lead to the emergence of a renewed (though usually modified) or even entirely new system state (configuration and behaviour). Reconfiguration leads to new combinations of components and new relationships between them. Not all innovations are successful and only some will establish themselves. Hence, new internal structures, forms of behaviour and other novelties may be introduced into the system. During reorganisation, system boundaries may temporarily weaken, blur or relocate before the system reacquires a dynamically stable state; this is achieved relative to either the current attractor (i.e. the system remains within the same regime or basin of attraction) or a different attractor (i.e. the system moves across a threshold into an alternative regime or basin of attraction). The now modified and stabilising system re-enters an accumulation (r) phase, this time in a new ‘adapted’ cycle in which the accumulation phase may be very similar or very different to the previous accumulation phase.

At its simplest, the adaptive cycle is represented as two opposing modes: a system development mode or fore loop and a system renewal mode or back loop (Figure 2.9). Both are essential in maintaining resilience. The fore loop is a relatively stable, long period of capital accumulation (positive growth or r phase) and maturity (conservation or K phase) or decline (negative growth or reverse r phase) characterised by slow, incremental change. The fore loop represents a gradual and fairly predictable pattern of development with relatively constrained dynamics, when complexity and organisation increase over a comparatively long period. A system may spend perhaps 80 to 90 per cent of its time in the fore loop (Walker 2007). The fore loop is intermittently punctuated by back loop dynamics consisting of an abrupt period of release (Ω phase) and a rapid transition to system reorganisation (α phase) that may occur subsequent to or concurrent with release.

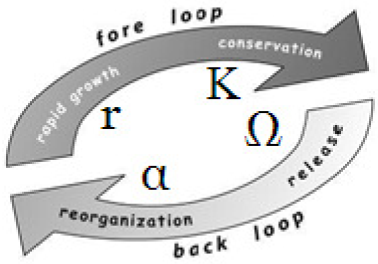

Figure 2.9 Adaptive cycle of two opposing modes: the development fore loop and renewal back loop. (Adapted from Walker and Salt 2006: 82).

The back loop represents a relatively short and chaotic pattern of adaptive renewal after a disturbance, when complexity and organisation are re-established following disorder. The back loop presents a window of opportunity for adaptive experimentation, innovation and learning (Holling 2004). It is a period during which diversity[30] can be generated and novelty (new connections, new arrangements, new functions and new ideas) can be introduced, subsequently to become incorporated into the fore loop of a new cycle. The back loop is when the

[30] ‘Diversity’ in the broad sense, meaning differentiation, heterogeneity and variation (Norberg and Cumming 2008: 9).

system is most open to the introduction of novelty in the form of new species, approaches or actors (Cumming and Collier 2005). It is also when the system is most open to the possibility of transformation. The back loop is inherently unpredictable and highly uncertain (Holling 2001).

The phase sequence of accumulation (r), conservation (K) and release (Ω) then reorganisation (α) is a familiar behavioural trajectory in many ecosystems, societies, economies, institutions and other CAS. However, the adaptive cycle is only a general metamodel (abstract representation) of intrinsic cyclicity in changing system behaviour. Though there may be a tendency for some systems to progress through all four phases in the typical sequence (r, K, **Ω** then α), the adaptive cycle is not fixed and patterns of change vary widely. For example, Abel *et al.* (2006) found from case studies of regional SES that the four phases generally did not occur in the typical sequence (nor did resilience decrease during the conservation phase nor disturbance events that trigger release generally occur in the late conservation phase). Different trajectories of change are possible (Figure 2.8 B). The Resilience Alliance (2007b: 38) give the example of a system in the accumulation phase that experiences an external disturbance so profound that it transitions directly into the release phase, bypassing the conservation phase. Some systems may transition directly from disturbance to accumulation, such as in the case of rapid acquisition of resources or capital during or immediately a following a disturbance or crisis. Other trajectories are possible, for example, a reorganisation without any prior release phase, or a persistent oscillation back and forth in the fore loop.

Panarchy

The adaptive cycle describes the dynamic state of a system (i.e. its configuration and behaviour in the current regime) at a particular scale or level of analysis. Different adaptive cycles can be used to describe multiple levels of organisation, size classes and other discontinuous properties of multiscale CAS (Garmestani *et al.* 2006, 2008-2009, 2009). Such systems are characterised by different sets of structures and processes that function over discrete ranges (‘levels’) of spatial and temporal scales (Garmestani *et al.* 2009). However, many patterns and processes observed at the focal level of organisation are somehow linked to dynamics operating at different levels in a hierarchy.

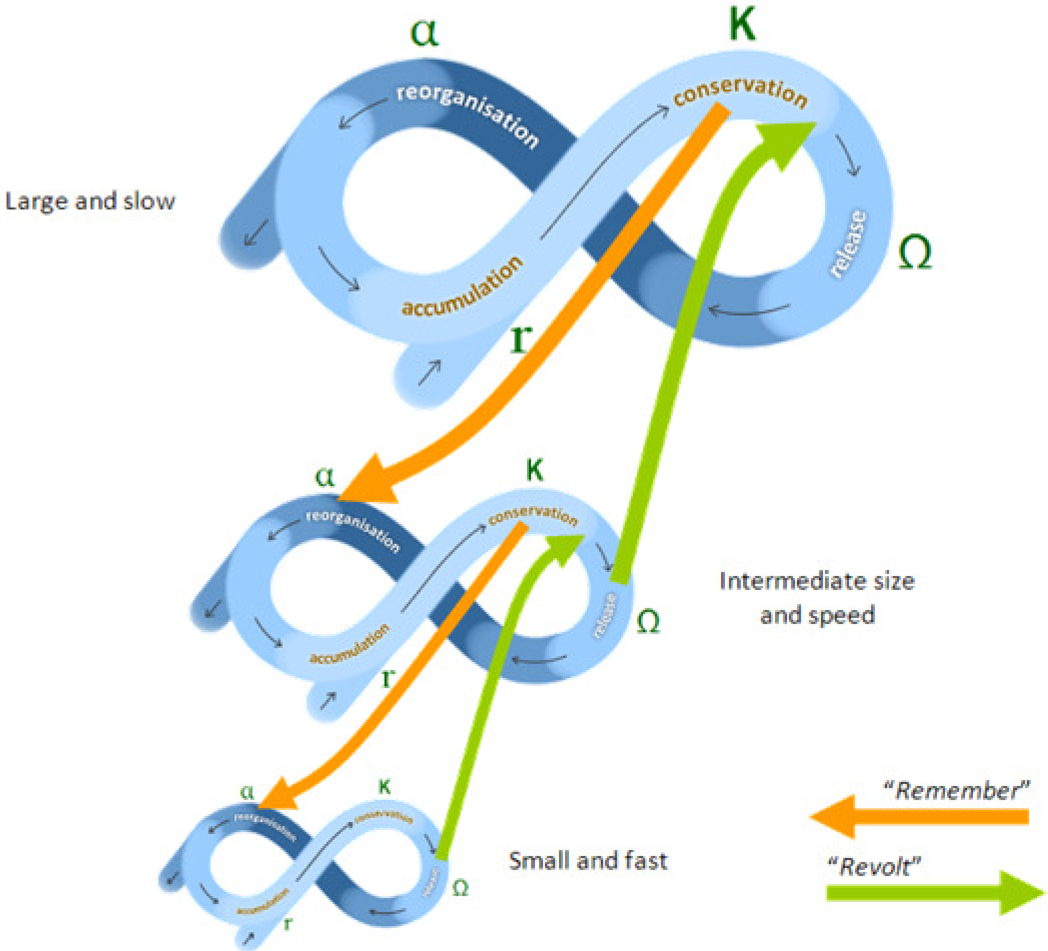

Figure 2.10 Panarchy: a metamodel of nested adaptive cycles emphasising key cross-scale interactions between three levels. (Adapted from Holling 2001; Holling *et al.* 2002; Folke 2006).

Drawing on work by Levin (1992, 1998, 1999, 2003, 2005, 2006, 2010a, 2010b; Levin *et al.* 2001): In general, macroscopic patterns and processes at higher levels of organisation may arise from and be maintained by evolutionary processes (local interactions and selection processes among adaptive agents) occurring at lower levels and smaller, faster scales.[31] In turn, the emergent macroscopic properties may feed back to influence the subsequent development of microscopic patterns and processes at lower levels of organisation. From a different perspective,

[31] With the caveat that Levin (2010b: 130) states the consistency, regularity or cyclicity of emergent patterns and processes implies that they are largely independent of many details of the myriad local interactions and lower-level processes from which they have ultimately emerged.

properties at the focal level of organisation may be either facilitated or constrained from above by patterns and processes occurring at higher levels and larger, slower scales. Therefore, dynamics at the focal level cannot be understood without taking into consideration the dynamics of, and interactions with, the levels above and below it (Walker *et al.* 2006: 2). These multilevel and cross-scale dynamics can be envisaged as a nested set of interacting adaptive cycles rather than as a hierarchy. This interconnectedness is represented by the conceptual model of a panarchy (Holling 2001; Holling *et al.* 2002), which is represented in Figure 2.10. Through the dynamic interplay and balance between rapid change ('revolt') and memory ('remember'), the panarchy is both creative and conserving; it sustains at the same time as it develops.

In the theoretical framework of panarchy, the state of a system changes along a trajectory in a particular basin of attraction (regime). This is viewed as a progression through the fore loop of an adaptive cycle: a gradual pattern of change that does not involve a critical transition. Periodically, endogenous or exogenous disturbances may induce back loop dynamics and possibly even a critical transition. During such a transition, one or more critical thresholds (the scale discontinuities between levels) are exceeded, resulting in abrupt release, reorganisation and then transition into a qualitatively different state: an alternative basin of attraction (regime). At the focal level, semi-autonomous fore loop dynamics, including processes of self-organisation and adaptation, are dampened through top-down interactions with adaptive cycles at successively higher system levels and invigorated through bottom-up interactions with adaptive cycles at successively lower levels. Hence, qualitative patterns of change at the focal level depend on a spectrum of controlling variables interacting across different scales of the panarchy: from large, slow and exogenous to small, fast and endogenous.

The panarchy model is important because it helps focus attention on key cross-level and cross-scale interactions and feedbacks that determine the resilience-related dynamics of the focal level or focal system. The adaptive cycle at each nested level in the panarchy functions at its own pace. There are potentially multiple panarchical connections between phases of the focal level adaptive cycle and phases of cycles at higher and lower levels. However, most representations of the panarchy model focus on two significant types of directional connections: the top-down 'remember' connection and bottom-up 'revolt' connection (Holling *et al.* 2002: 75).

Remember

The focal level adaptive cycle is affected by successively larger, slower cycles of encompassing levels via the top-down remember connection. Remember connections are processes that can either facilitate or impede reorganisation, innovation and renewal (α phase and transition to early r phase) in the focal level cycle by drawing on key sources of resilience. That is, by drawing on the accumulated memory and stored potential (capital and connectedness) built up in the fore loop of large, slow cycles. In other words, memory patterns belonging to higher levels provide a context for the recurrence of adaptive cycles at the focal level. (Conversely, when higher-level cycles are in a back loop and memory patterns are disrupted, the remember connection may facilitate collapse or impede the initiation of new adaptive cycles at the focal level.)

The concept of memory refers to a system's structural and processual store of learned history, cumulative experience and knowledge as well as capital, connections, adaptations and institutions; all of which are legacies of past adaptive cycles accumulated in patterns and processes at higher levels. The remember connection represents the mobilisation and transfer of memory down to the focal level. Depending on the circumstances, it may be that this process 'is not a remembering but a stipulating' (Sontag 2004: 76). That is, memory is either embodied and recalled by the focal level or mediated and imposed on it. (This is, of course, a blatant oversimplification of the complex concept of memory; see Assmann 2008; Assmann and Shortt 2012.)

Revolt

Intermediate level adaptive cycles are also affected by successively smaller, faster nested adaptive cycles via the bottom-up revolt connection. Revolt connections represent processes in which critical changes (as opposed to adaptive changes) are transferred upscale to the next larger, slower cycle. In this way, when the focal level cycle is moving through the fore loop it may be invigorated by the introduction of innovation and novelty passed upwards from smaller, faster cycles moving through the back loop at lower levels (Allen and Holling 2010).

Such invigorating connections from below can enhance resilience by counteracting accumulated constraints, inflexibility and vulnerabilities associated with the conservation (K) phase of the focal level cycle. But not always. For example, when a lower level cycle transitions to a release (Ω) phase as a result of disturbance, the critical change (a forced adjustment or collapse) and loss of resilience can pass upwards to the next (focal) system level. This is more likely to occur if the higher (focal) level cycle is already vulnerable (i.e. in the late conservation phase) with accumulated rigidities and reduced resilience.

Cascading effects

When significant phase synchrony exists between tightly interconnected adaptive cycles at different levels, a cascading panarchical crisis or collapse may be triggered (Holling *et al.* 2002: 93).[32] During such an event, a disturbance or critical change propagates rapidly within or across scales. Effects cascade upwards or downwards through successive levels until halted upon encountering different (asynchronous) phase conditions. In this case, revolt describes change originating when small, fast disturbance events propagate across scales to broader spatial or longer temporal scales, to possibly overwhelm higher levels of organisation. Avoiding an undesirable release (Ω) phase at the focal level may depend on maintaining asynchronous cycles at nested lower levels. For example, policy and management interventions that suppress back loops with the intention of avoiding a critical change may have the opposite effect of increasing synchrony and the probability that a crisis or collapse will cascade to other levels of organisation and across spatial–temporal scales (Kinzig *et al.* 2006; Duit and Galaz 2008; Galaz *et al.* 2011).

[32] A complex adaptive hierarchical system is potentially highly vulnerable (least resilient) when its set of nested adaptive cycles are synchronised to the most vulnerable phase, that is, the late conservation (K) phase.

Alternative models of system change

The adaptive cycle and panarchy metamodels are commonly used in resilience work. Together, they provide a heuristic framework for the study of CAS dynamics rather than testable hypotheses. As abstract models for describing and ordering ideas about SES dynamics, they have their limitations (Abel *et al.* 2006; Gotts 2007). The adaptive cycle is one of several alternative metamodels used to describe typical patterns of nonlinear and discontinuous change over time (Cumming and Collier 2005).

Examples of alternative models include the Dutch societal 'transitions' model involving a sequence of multiple development phases and patterns of change across multiple levels (Rotmans *et al.* 2001; van der Brugge *et al.* 2005; Geels and Schot 2007; Fischer-Kowalski and Rotmans 2009; Rotmans and Loorbach 2009); the Viennese sociometabolic regime transitions model (Fischer-Kowalski and Haberl 1998, 2007; Haberl *et al.* 2004, 2011; Krausmann *et al.* 2008a, 2008b; Fischer-Kowalski and Rotmans 2009); punctuated equilibria or stepwise changes model (Gersick 1991; Baumgartner 2006; Aunger 2007); and social macro-evolutionary phases model (Bondarenko *et al.* 2002; Grinin and Korotayev 2009; Grinin *et al.* 2011).

Other characteristic patterns of change involving phases and cycles are represented by archetypal rise and fall (growth and collapse) life cycles, and logistics/S-curves, either with or without chaotic transition periods between growth and decline (von Stackelberg 2009); the Kuznets inverted-U curve (Kuznets 1955); and Kondratieff waves (also known as economic long waves or K-waves), their phases (upswings and downswings) and superimposed harmonics including medium-wave Kuznets cycles/swings and short-wave Juglar cycles and Kitchin cycles (von Stackelberg 2009; Korotayev and Tsirel 2010).

2.6 Social–ecological systems theory

In *Spatial Resilience in Social-Ecological Systems*, Cumming (2011a: 7) points out that there is not yet a full-blown theory of SES. Instead, we have a number of identifiable elements of SES-related theory and some promising theory-oriented frameworks (e.g. Holling 2001; Norberg and Cumming 2008; Ostrom 2007; Waltner-Toews *et al.* 2008).

> 'SES theory incorporates ideas from theories relating to the study of resilience, robustness, sustainability, and vulnerability, but it is concerned with a wider range of SES dynamics and attributes than any one of these terms implies; and while SES theory draws on a range of discipline-specific theories, such as island biogeography, optimal foraging theory, and microeconomic theory, it is broader than any one of these individual theories alone' (Cumming 2011: 8).

Some authors use the expression 'social–ecological system' to refer to an intermediate state between fully separated social and ecological systems and fully integrated socioecological or ecosocial systems. Like Cumming, I use 'social–ecological system' in the sense of a fully integrated system, as I will now explain.

As previously stated, SES are complex integrated systems of people, human society, the economy and the rest of nature (Costanza 1996, 2003, 2011; Costanza *et al.* 2007a, 2012a). The term 'social–ecological system' is used to emphasise the integrative humans-in-nature perspective and to stress that the delineation between social and ecological systems is artificial and arbitrary (Berkes and Folke 1998b: 4). Walker *et al.* (2006) describe SES as neither humans embedded in an ecological system nor ecosystems embedded in human systems, 'but rather a different thing altogether' (p. 1).

The SES perspective recognises the hybrid and reciprocal character of human–environment relations. It acknowledges that social (human actors and institutions) and ecological (bio-geo-physical) entities are, in many cases, intricately interconnected and fundamentally interdependent. This is based on evidence that (1) human actions affect the biophysical environment and ecosystems, (2) biophysical and ecological factors affect human well-being, and (3) humans in turn respond to these factors (Berkes 2011a: 12). In effect, human social systems (including communities, societies, economies and cultures) and ecosystems are in a continuous dynamic interaction: a two-way feedback relationship. Both the social and ecological domains are integral subsystems of an emergent, complex co-evolving system (Redman *et al.* 2004: 163; Haberl *et al.* 2006: 2). Thus, a SES is a system

> 'in which the social and biophysical subsystems are so entwined that the system's condition, function, and responses to a hazard (or any external forcing) is predicated on the synergy of the two subsystems' (Turner 2010a: 170).

Structurally, a SES is a divisible whole, but functionally it is an indivisible unity with emergent properties (Laszlo and Krippner 1998: 53). Furthermore, a SES's dynamics are connected via cross-scale linkages to events and changes that occur (or have occurred) at other times and places (Chapin *et al.* 2009b). Thus, conceptualising and depicting a SES as a model or mind map presents a challenge (Glaser 2006). Interdependent social systems and ecosystems must be clearly expressed as a single, integrated system rather than a social–ecological coupling or nexus. That is, rather than a mere pairing or interface connection between two different entities that belong to epistemologically different worlds.

The question then is what key attributes can be used to map or model a SES? What attributes can be used to (1) define a SES's boundaries in spatial or functional terms in a specific problem context, and (2) describe SES in general and EASES in particular? In the preceding sections of this chapter I have framed the study of SES in the theoretical context of CAS and Holling's adaptive cycle. I use this system of concepts to define and describe SES, thus providing the theoretical basis for conceptualising EASES (see Chapter 6). Next, I look at the SES model used in this research.

Social–ecological systems model

With the growing popularity of the SES concept there is an increasing number of both generic and case-specific models of SES in the literature. It is beyond the scope of this thesis to review these. However, as Glaser (2006) points out, high generality mental models ('mind maps') of society–nature relations are important pre-analytical foundations. They help us simplify, visualise and analyse not only the components but also the cross-scale connections and dynamics of complex SES. Therefore, visual representations of the SES concept are important tools for sustainability researchers and decision makers. Here, I present the model that was used for the study of EASES (Figures 2.11 and 2.12). Figure 2.11 depicts key attributes of simplified internal structure and processes, external conditions influencing the system, and significant transboundary interactions.

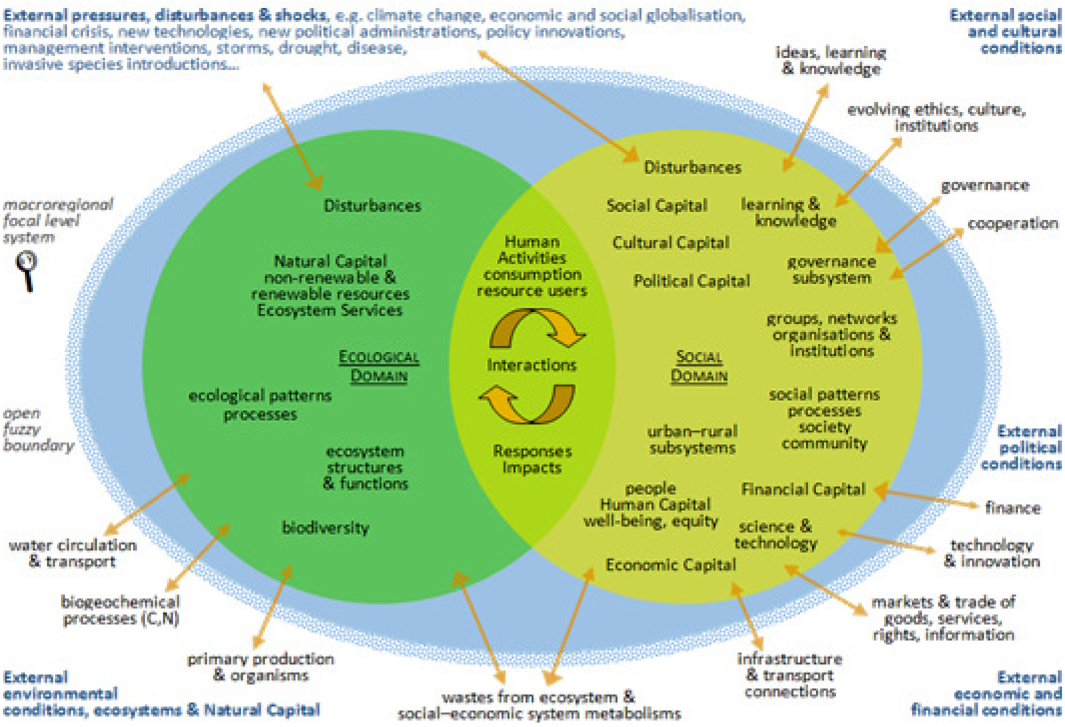

Figure 2.11 Conceptual model of a macro-regional level social–ecological system (EASES).

Social and ecological structures and processes tend to self-organise and occupy relatively discrete levels in space and time (Garmestani *et al.* 2009). Conceptually, a SES may be specified for any particular level of organisation. In practice they are identified at a particular focal level of interest depending on the combination of spatial, temporal, social and ecological scales considered relevant to the aims of governance, management or research. For example, a local level SES model may be constructed for a coastal zone management study concerning small-scale fisheries interactions with community wind power development; whereas for considering international governance of fisheries impacts on biodiversity, a global level SES model is appropriate.

The boundaries of the focal level system are established around functional groupings of social and ecological entities (e.g. actors, communities, social networks, institutions, cultures, territories, jurisdictions, landscapes/seascapes, natural resources, ecosystem services, ecosystems or biogeographic regions). The boundaries between nested and adjacent systems are open: permeable to flows of energy, mass and information. In a maritime macro-regional SES, transboundary trade, pollution, and movements of humans, fish or other animals are obvious examples of such flows. Identifying boundaries and their conditions is difficult due to intrinsic complexity, ambiguity (‘fuzziness’), interaction of multiple levels and scales, alternative viable system regimes, and spatial–temporal variance (Cumming and Collier 2005).

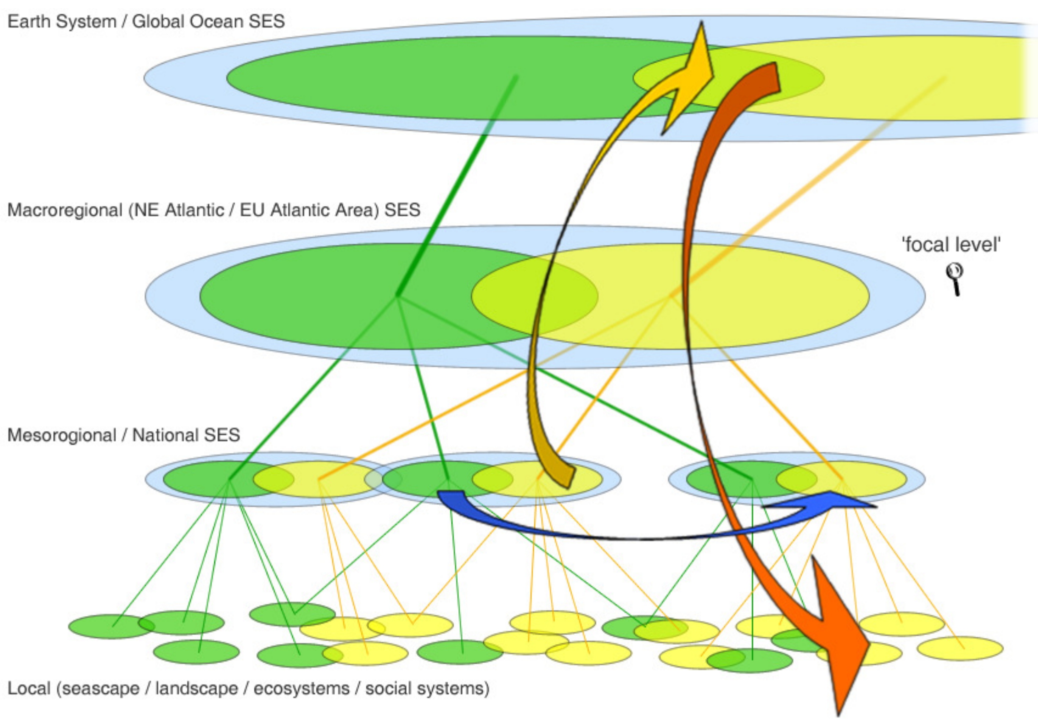

Figure 2.12 Systems hierarchy showing cross-level interactions (lines) and cross-scale interactions (arrows) between co-evolving social (yellow) and ecological (green) dimensions.

The world may be imagined as a hierarchical structure of nested, interconnected and interdependent CAS in which the SES at the focal level of interest is embedded in successively higher-level systems. At the same time, the focal level system (in this case EASES at the macro-regional level) encompasses successively lower-level systems (Holling 2001; Warren 2005). Accordingly, the focal level may consist of any number of lower-level nested, adjacent or overlapping SES and/or component social systems and ecosystems. The structural relationship between EASES at the macro-regional focal level and other interconnected system levels is represented in Figure 2.12.

Social–ecological networks

Instead of a hierarchy, SES can be conceptualised as social–ecological networks. From a network perspective, important structural characteristics of SES are represented as nodes and links (Janssen *et al.* 2006; Cumming *et al.* 2010; Bodin and Tengö 2012). In this view, nodes are human and social entities (individuals, groups, communities, organisations, economic sectors, etc.) and ecological entities (landscape properties, natural resources, ecosystems, etc.) that are interconnected in a network. The links between nodes, which may be active or inactive, are used to describe the structure of the relationships or interactions between nodes.

Like other CAS, SES are dynamic networks of many agents (actors) continually acting and reacting to other agents' behaviours as well as external changes. A significant change in the underlying network configuration implies a change in the fundamental function, structure, identity and feedbacks of a SES. The changes in configuration are facilitated and/or constrained by the social–ecological network structure and properties such as connectivity (reachability and density), centrality, modularity/fragmentation, redundancy and control of flow (Janssen *et al.* 2006; Webb and Bodin 2008). Such network properties are, of course, related to system resilience (see Chapter 3).

In addition to being integrative and useful for capturing dynamic aspects of SES, a network perspective is potentially useful for analysis of cross-level and cross-scale linkages; for example, by taking into account holarchic bottom-up and top-down processes such as cascading effects (Cumming *et al.* 2010).

2.7 Summary

This chapter described the first part of the conceptual framework that guided the study of EASES: a way of thinking about society–nature relations based on the theory of complex adaptive SES. It explained how such a framework is grounded in the concept of system and general systems theory, which underpin a complex systems approach to analysis. The chapter located SES research in the context of CAS theory. This provided a basis for understanding the complexity and dynamics of persistence and change in EASES. The chapter described key characteristics of CAS, including agents and interconnectedness, openness and fuzzy boundaries, inherent nonlinearity, feedback loops, path dependence, self-organisation, emergence and emergent properties, scale and hierarchy, cross-scale linkages, adaptation, co-evolution and, very briefly, robustness and resilience. The chapter then looked at the main concepts underlying the dynamics of complex adaptive SES, including system regimes, basins of attractions and stability landscapes; and multiple stable states, thresholds and regime shifts. The theory of the adaptive cycle and associated concept of panarchy were explained. In the context of nascent SES theory, I then outlined my understanding of what a SES is. Finally, the chapter looked at the conceptual SES model used in the study and, briefly, a network perspective. Overall, this chapter provided a foundation for the conceptualisation of EASES described in Chapter 6.

Chapter 3
Resilience theory

The previous chapter addressed complex adaptive social–ecological systems (SES) theory. This chapter describes a particular element of that: resilience theory. It presents a framework for the analysis of resilience in the European Atlantic social–ecological system (EASES).

3.1 Introduction

The multifaceted concept of resilience provides a theoretical framework and analytical lens through which complex relationships and interactions between humans and the rest of nature can be examined. The 'resilience perspective' (Folke 2006) or 'resilience thinking' (Walker and Salt 2006) is an organising framework for understanding the complex interplay between persistence and change, between adaptation and transformation, and between disturbance and reorganisation in complex adaptive SES (Berkes and Folke 1998b; Folke *et al.* 2002; Berkes *et al.* 2003a; Folke *et al.* 2010). Such dynamics are essential for maintaining the key functions, structures, feedbacks and therefore identity of whole SES (Walker *et al.* 2004: 6, 2006: 2). A resilience perspective emphasises a SES's capacity to deal with change and continue to develop in a changing world facing many uncertainties and challenges (Huitric *et al.* 2009: 32 & 41). The theory of resilience in SES provides a sound basis for understanding sustainability and sustainable development in maritime macro-regional SES.

The remainder of this chapter describes resilience thinking. Section 3.2 considers some of the different ways in which resilience is defined. Section 3.3 presents the conceptualisation of resilience adopted for this research. The different sources of resilience are outlined in section 3.4. The chapter then considers the factors involved in the loss (section 3.5) and increase (section 3.6) of resilience. Section 3.7 examines the interrelated concepts of adaptability and transformability. The chapter concludes with a summary (section 3.8).

3.2 Defining resilience

The term 'resilience' is widely used across different disciplines and intellectual traditions, resulting in different conceptual definitions and interpretations. The current popularity of the concept of resilience has been attributed to a generally heightened sense of uncertainty, insecurity and apprehension regarding contemporary environmental, economic and political crises and shocks, as well as the effects of globalisation (Christopherson *et al.* 2010: 3; Davoudi 2012: 299). Müller (2011: 1) attributes the concept's appeal to its positive connotations. Nevertheless, resilience is an often contested concept. Much of the contentiousness arises because, according to Davoudi (2012), 'it is not quite clear what resilience means, beyond the simple assumption that it is good to be resilient' (p. 299). In order to arrive at conceptual clarity we must first recognise that the concept of resilience has four principal points of departure: psychological resilience, social resilience, engineering resilience and ecological resilience. From these, the concept has evolved along different paths according to different schools of thought. At times the paths have variously diverged, converged, intersected or coalesced. Unfortunately, space precludes consideration of resilience at individual and group levels in the social sciences.

The concept of resilience as a material property has been in use in the physical sciences and civil and industrial engineering since the mid-19th century. The concept of resilience as a systemic property emerged much more recently in ecological studies. This was largely as a result of systems theoretical work concerning population and community ecology and ecosystem science undertaken by C.S. "Buzz" Holling. This led to publication of Holling's seminal 1973 article in which he proposed that the behaviour of ecological systems is defined by the interplay between two system properties: stability and resilience (p. 17). According to Holling (1973), in addition to stability

> '[…] there is another property, termed resilience, that is a measure of the persistence of systems and of their ability to absorb change and

disturbance and still maintain the same relationships between populations or state variables' (p. 14).

Holling also emphasised the practical implications of this ecological resilience theory for natural resource management. The concept of social–ecological resilience evolved from the ecological resilience lineage.

From ecological resilience to social–ecological resilience

Holling (1973) introduced the concept of resilience into the ecological literature in order to understand nonlinear ecosystems dynamics. In general usage, the term 'resilience' signifies the capacity of a system to rebound or recover after a disturbance. Holling recognised two different but complementary conceptions of resilience. One of these – traditionally emphasised in ecology (and economics) – is centred on stability and a single equilibrium; that is, on the tendency of a system to maintain a steady state condition (constancy) and return to a position of equilibrium following disturbance.[33] This conception assumes near to equilibrium behaviour as the norm, a fixed carrying capacity[34] and, therefore, a desirable management goal of minimising variability (Holling 2006: 6). In temporal terms, the measure of this type of resilience is how far in time the system has moved from equilibrium and the speed of return to equilibrium (Ludwig *et al.* 1997). Holling (1996: 33) calls this type of resilience 'engineering resilience'. According to Folke (2006), the engineering interpretation of resilience 'focuses on maintaining efficiency of function, constancy of the system, and a predictable world near a single steady state' and is 'about resisting disturbance and change, to conserve what you have' (p. 256). The equilibrium-centred stability view has helped shape conventional command and control approaches to environmental and natural resource management, which attempt to suppress natural variation and optimise control of resource flows (Holling and Meffe 1996).

The other conception of resilience identified by Holling (1973, 1986, 1996) assumes the existence of multiple equilibria and, therefore, more than one possible

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[33] A mechanical system is at equilibrium if the forces acting on it are in balance (Ludwig *et al.* 1997: 2).

[34] 'Carrying capacity' refers to the maximum population size or number of species that can be supported by a specific area or environment.

stable state (basin of attraction, stability domain or regime) in which an ecological system can exist (Gunderson 2000). This view emphasises far from equilibrium conditions and the boundaries of stability where even a minor disturbance can 'flip' a system into an alternative stable state. On the one hand, it recognises the role of high variability, spatial heterogeneity and nonlinear processes in maintaining the state of a system. On the other hand, it recognises the role of instability in facilitating transitions between alternative stable states. In this case, resilience is measured by the magnitude of disturbance a system can absorb before it shifts into a different stable state with different controls on structure and function (Holling 1996; Gunderson 2000; Carpenter *et al.* 2001; Folke *et al.* 2004: 558). Hence, resilience refers to the width or limit of a basin of attraction (Gunderson *et al.* 2002: 255). Holling (1996) calls this type of resilience 'ecological resilience'.

The two conceptualisations of engineering resilience and ecological resilience are not incompatible. For Gunderson (2010), the main difference between them 'is whether the system of interest returns to a prior state or reconfigures into something very different' (p. 2). Gallopín (2006: 299) points out that resilience can operate at different levels and scales, reflecting different types of system stability: the level of local stability or engineering resilience; the intermediate level of changes between multiple stable states or ecological resilience; and the level of changes to the entire stability landscape.

Since Holling's 1973 paper, many different definitions and interpretations of the concept of ecological resilience have appeared in the literature (see Table 3.1). Brand and Jax (2007: 11) conclude that, for greater conceptual clarity and practical relevance, the redefined and extended meaning of resilience may be termed 'social–ecological resilience'.

Table 3.1 Definitions of ecological resilience and social–ecological resilience.

Author and reference	Definition
Holling 1973: 14	Resilience is a measure of the persistence of ecological systems and of their ability to absorb

	change and disturbance and still maintain the same relationships between populations or state variables.
Holling 1986: 301	Resilience is the ability of an ecosystem to maintain its structure and patterns of behaviour in the face of disturbance. The size of the stability domain of residence, the strength of the repulsive forces at the boundary, and the resistance of the domain to contraction are all distinct measures of resilience.
Holling *et al.* 1995: 50	Resilience is the magnitude of disturbance that can be absorbed before an ecosystem changes its structure by changing the variables and processes that control behaviour.
Holling 1996: 33	Ecological resilience is the amount of disturbance that can be sustained before a change in system control and structure occurs.
Berkes and Folke 1998a: 6	Resilience is the buffer capacity or the ability of a social or ecological system to absorb disturbances.
Levin *et al.* 1998: 224	Resilience is the ability of a natural or socioeconomic to experience change and disturbance without catastrophic qualitative change in the basic functional organisation; it is a measure of the system's integrity.
Peterson *et al.* 1998: 10	Ecological resilience is a measure of the amount of change or disruption that is required to transform a system from being maintained by one set of mutually reinforcing processes and structures to a different set of processes and structures.
Gunderson 2000: 425 & 435	Resilience in ecological systems is the amount of disturbance that a system can absorb without changing self-organised processes and structures (defined as alternative stable states).
Carpenter *et al.* 2001: 766	In any study of resilience, we are concerned with the magnitude of disturbance that can be tolerated before a system moves into a different region of state space and a different set of controls, as originally conceived by Holling (1973, 1996). Based on this interpretation, resilience has the following three properties: (a) the amount of change the system can undergo (and implicitly, therefore, the amount of extrinsic force the system can sustain) and still remain within the same domain of attraction (that is, retain the same controls on structure and function); (b) the degree to which the system is capable of self-organisation (versus lack of organisation, or organisation forced by external factors); and (c) the degree to which the system can build the capacity to learn and adapt.
Holling and	Ecosystem resilience is the capacity of a system to

Gunderson 2002: 50	experience disturbance and still maintain its ongoing functions and controls. A measure of resilience is the magnitude of disturbance that can be experienced without the system flipping into another state or stability domain.
Walker *et al.* 2002: 6	Resilience is the potential of a social–ecological system (SES) to remain in a particular configuration and to maintain its feedbacks and functions, and involves the ability of the system to reorganise following disturbance-driven change.
Walker *et al.* 2004: 6-7	Resilience is the capacity of a SES to absorb disturbance and reorganise while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks. In other words, stay in the same basin of attraction. Resilience has the following four aspects: • Latitude: the maximum amount the system can be changed before losing its ability to recover; basically the width of the basin of attraction. • Resistance: the ease or difficulty of changing the system; related to the topology of the basin. • Precariousness: the current trajectory of the system, and how close it currently is to a limit or threshold. • Panarchy: how the above three attributes are influenced by the states and dynamics of the (sub)systems at scales above and below the scale of interest.
Walker *et al.* 2006: 2	Resilience is the capacity of a SES to experience shocks while retaining essentially the same function, structure, feedbacks, and therefore identity. It follows Holling's (1973) notion of resilience as the amount of disturbance a system can absorb without shifting into an alternate regime.
Walker and Salt 2006: 164	Resilience is the amount of change a system can undergo (its capacity to absorb disturbance) and remain within the same regime – essentially retaining the same function, structure and feedbacks.
Folke *et al.* 2010: 3	Resilience is the capacity of a SES to absorb disturbance and reorganise while undergoing change so as to still retain essentially the same function, structure and feedbacks, and therefore identity; that is, the capacity to change in order to maintain the same identity.
Stockholm Resilience Centre 2015*	Resilience is the capacity to deal with change and continue to develop. Specifically, ecosystem resilience is a measure of how much disturbance (like storms,

	fire or pollutants) an ecosystem can handle without shifting into a qualitatively different state. It is the capacity of a system to both withstand shocks and surprises and to rebuild itself if damaged.
Resilience Alliance 2015**	Resilience is the capacity of a SES to absorb or withstand perturbations and other stressors such that the system remains within the same regime, essentially maintaining its structure and functions. It describes the degree to which the system is capable of self-organisation, learning and adaptation.
* Source: http://www.stockholmresilience.org/21/research/resilience-dictionary.html [web page created 22/1/2015; accessed 23/11/2015]. ** Source: http://www.resalliance.org/index.php/resilience [accessed 23/11/2015].	

Natural resource science and management has traditionally viewed humans and their actions (e.g. fishing or polluting) as external drivers of ecosystem dynamics, and the manager as 'an external intervener in ecosystem resilience' (Folke *et al.* 2010: 2). However, it was increasingly recognised that this view fails to take into account the crucial interdependencies and feedbacks between ecosystem development and social dynamics, not to mention their cross-scale interactions (Gunderson and Folke 2005: 1). Consequently, the concept of ecological resilience has been extended and modified towards a concept of social–ecological resilience. In many cases, this has been accomplished through the work of the Resilience Alliance[35] community of scientists and practitioners from different disciplines who collaborate to explore SES dynamics.

Rather than a purely ecological interpretation, social–ecological resilience thinking is intended to be an integrative and transdisciplinary theoretical framework for exploring the dynamics of SES in the context of sustainability science (Folke 2006: 260; Walker and Salt 2006; Folke *et al.* 2010). A social–ecological resilience perspective views people and nature as interdependent systems. The cross-scale dynamics of SES and other CAS require a multidimensional conceptualisation of resilience. These dimensions are reflected in the Walker *et al.* (2004) definition of resilience as 'the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks' (p. 6).

[35] http://www.resalliance.org/

Much of the work on ecosystem resilience has focused on the capacity to absorb disturbance or the buffer capacity that allows persistence. However, social–ecological resilience is also about the windows of opportunity that disturbance opens up in terms of recombination of evolved structures and processes, renewal of the system and emergence of new trajectories (Folke 2006: 259). Therefore, the extended interpretation of social–ecological resilience makes it possible to explicitly address the cyclical adaptive interplay between disturbance and reorganisation that enables a system to continuously develop (Folke *et al.* 2010). Folke (2006) provides a table (p. 259, Table 1) summarising the concepts of engineering, ecological and social–ecological resilience; this is reproduced (with slight modifications) below (Table 3.2).

Table 3.2 A sequence of resilience concepts, from the more narrow interpretation to the broader social–ecological context.

Resilience concepts	Characteristics	Focus on	Context
Engineering resilience	Return time, efficiency	Recovery, constancy	Vicinity of a stable equilibrium
Ecological/ecosystem resilience, social resilience	Buffer capacity, withstand shock, maintain function	Persistence, robustness	Multiple equilibria, stability landscapes
Social–ecological resilience	Interplay disturbance and reorganization, sustaining and developing	Adaptive capacity, transformability, learning, innovation	Integrated system feedback, cross-scale dynamic interactions

Whether one takes the view that the original ecological meaning of resilience has been diluted (Brand and Jax 2007) or that the concept has evolved to become more broadly applicable and useful, the meaning of resilience has certainly shifted. As it currently stands, the term ‘social–ecological resilience’ describes a broad framework encompassing both persistence (i.e. resilience as a buffer for conserving and recovering) and the dynamic interplay of persistence, adaptability and transformability in SES across multiple scales and between multiple attractor basins or regimes (Folke *et al.* 2010: 6). This broad framework forms a starting point for the conceptualisation of social–ecological resilience in this thesis.

3.3 Conceptualisation of resilience

At the outset of this thesis, research planning and design was guided by Walker *et al.*'s (2004: 6) definition and conceptualisation of resilience (see Table 3.1). This formulation was useful, being neither too broad nor too narrow. Nevertheless, it was deemed necessary to adapt the conceptualisation of resilience to suit the particular circumstances of the study. The result presented below and in subsequent sections is elaborate, but it remains consistent with Walker *et al.* (2004) and similar definitions and conceptualisations (including Walker *et al.* 2006; Walker and Salt 2006; Folke *et al.* 2010).

Put simply, resilience is the capacity of a system to deal with change and continue to develop in a world facing many challenges and uncertainties (Huitric *et al.* 2009: 32). In this thesis, I use the concept of resilience to represent the capacity of an integrated SES to tolerate and deal with change in ways that sustain system integrity, adaptive capacity and options for future development and transformation of people, society and the rest of nature. More precisely (based on Walker *et al.* 2002, 2004, 2006; Folke *et al.* 2003, 2010; Folke 2006; Gallopín 2006; Chapin *et al.* 2009b), I define social–ecological resilience as

> *a social–ecological system's capacity to persist by absorbing, resisting and recovering from disturbances and shocks while adapting to, managing and, when necessary, initiating change; it is the capacity that enables a system to retain and develop the same fundamental functions, internal structure, external relations and, therefore, system identity.*

Assuming that social–ecological realities involve complex stability landscapes with multiple attractors and, therefore, that there are alternative stable states for a given SES – resilience is also the tendency of a system to remain within a particular basin of attraction (stability domain or regime). That is, resilience is the tendency to retain (1) the same controls on structure and function; and (2) essentially the same configuration (system components and their relationships) and patterns of behaviour. In this sense, resilience is a system's potential to undergo some degree of change without exceeding critical threshold levels on key controlling variables, which would result in abrupt changes in patterns and processes, including important feedbacks. In other words, resilience is the potential to avoid a critical transition or regime shift into a qualitatively different alternative state (Carpenter *et al.* 2001; Scheffer and Carpenter 2003; Kinzig *et al.* 2006). Therefore, resilience is a critical dimension of a SES's overall ability to persist and evolve in continually changing conditions.

Resilience is not a single concept, but rather 'a broad, multifaceted, and loosely organized cluster of concepts, each one related to some aspect of the interplay of transformation and persistence' (Carpenter and Brock 2008: 1). Key aspects of the resilience capacity of a SES include:

> *Absorption*. The capacity of a system to persist by absorbing a spectrum of recurrent exogenous and endogenous disturbances, that is, to absorb shocks and generally buffer change, so reducing the risk of a regime shift (Holling 1973; Gunderson 2000). Buffering refers to the moderation (lessening) of impacts from disturbance (Gunderson 2010).

> *Resistance*. The capacity of a system to withstand disturbance and resist change (Nyström *et al.* 2000). Resistance is also a measure of the relative ease or difficulty of changing a system, which is represented by the depth of the basin of attraction (Walker *et al.* 2004). Resistance is represented in Figure 2.5.

> *Measure*. The amount (magnitude, rate, frequency, etc.) of variability, drift or disturbance a system can tolerate (absorb or resist) and the corresponding amount or latitude (Walker *et al.* 2004) of change the system can undergo in response, without a regime shift (Holling 1973; Carpenter *et al.* 2001).

Reorganisation and renewal. The capacity of a system to recover following disturbance and continually renew itself by regenerating and reorganising disturbed structure and processes, and rebalancing feedbacks. Latitude is the maximum amount a system can be changed before losing its ability to reorganise, recover and renew within the same basin of attraction (i.e. before crossing a critical threshold). Latitude is represented by the width of the basin of attraction. Precariousness is how close the current state of a system (on its current trajectory) is to a critical threshold (Walker *et al.* 2004). Latitude and precariousness are represented in Figure 2.5.

Self-organisation. The degree to which a system is capable of self-organising. That is, the extent to which system reorganisation or modification is endogenous and autonomous rather than exogenously imposed (Carpenter *et al.* 2001). Put another way, there are limits to a system's ability – through social actors and their agency (Bohle *et al.* 2009) – to deliberately and opportunistically configure itself and maintain structures, patterns, processes and other emergent properties.

Adaptability or adaptive capacity. The ability of a system to incrementally adjust its responses to changing internal demands and external circumstances (Carpenter and Brock 2008) and thereby continue to develop along a trajectory within the current basin of attraction (Folke *et al.* 2010). Walker *et al.* (2006: 3) define adaptability as the capacity of the actors in a system to manage resilience. In effect, it is the ability of human actors, both individually and in groups, in a SES to respond to, create and shape variability and change in the system in an informed manner (Berkes *et al.* 2003a; Chapin *et al.* 2009a). Such adaptive collective behaviour determines whether actors can successfully avoid crossing thresholds into an undesirable regime (persistence) or succeed in crossing thresholds into a desirable one (transformation) during periods of rapid change. Adaptations in the system arise from processes of self-organisation and allow for continual development and renewal, hence the metaphor of the adaptive cycle (Holling 1986; Gunderson and Holling 2002). Capacity to adapt implies an ability to maintain or even improve system conditions through longer term or more sustainable adjustments; or an ability to broaden the range of conditions to which the system is adapted (Gallopín 2006; Smit and Wandel 2006). Adaptability or adaptive capacity reflects the emergence of system processes and actor behaviours (concerning creative experimentation, innovation, evolution of novelty, and social learning) during windows of opportunity opened up by disturbances (Carpenter *et al.* 2001).

Transformability or transformative capacity. The capacity of human actors to transform a SES if and when it becomes necessary. That is, the ability of actors to provoke a transformation when the existing system is trapped in a very resilient but undesirable regime (basin of attraction); or when ecological, social (including political) or economic conditions make continuation of the existing system unsustainable, and incremental adjustments to maintain adaptability (adaptive capacity) and resilience are not an option. In effect, transformability is the capacity to reconceptualise and create a fundamentally new system configuration with a different development trajectory (Walker *et al.* 2004, 2006; Chapin *et al.* 2009a; Huitric *et al.* 2009). This amounts to the capacity to transform the stability landscape of attractors and basins in order to create new regimes for development, and cross thresholds to achieve a new development trajectory (Folke *et al.* 2010).

Anticipation. The capacity of human actors in social systems to look forwards, anticipate and plan for future variability and change, including surprises[36] and unknowable risks, despite irreducible uncertainty and inherent unpredictability (Berkes 2007). Holling (2001) referred to this capacity as human foresight and intentionality.

Panarchy. The influence of cross-scale and cross-level dynamics on other aspects of resilience (e.g. latitude, resistance and precariousness) at the focal level (Walker *et al.* 2004). Multiscale resilience is essential for understanding

[36] Holling (1986) describes surprise as 'a condition in which perceived reality departs qualitatively from expectations' (p. 294). Surprises emerge and evolve along many dimensions: political, economic, ecological and biophysical, among others (Longstaff 2009).

the interplay between persistence and change, and between adaptability and transformability (Folke *et al.* 2010; see also Zurlini *et al.* 2008).

3.4 Sources of resilience

Despite the growing number of case studies and recent conceptual advances regarding resilience in SES, there is no definitive list of system characteristics that contribute to resilience. Using the characteristics of resilient SES suggested by Walker and Salt (2006: 145-148, 2012: 193-195) and Leslie and Kinzig (2009: 60) as a starting point, this research developed a set of characteristics of SES that have potential to constitute crucial sources of resilience in a maritime macro-regional SES such as EASES. These are: redundancy, modularity, diversity, novelty and innovation, social capital, social memory, social learning, bridging organisations and leadership, and stewardship. I elaborate on each characteristic below. Although presented as distinct categories, in reality many of these system characteristics overlap and merge into one another. Furthermore, it may be that some characteristics are interdependent. For example, the maintenance of functional redundancy is helped by the maintenance of diversity and modularity (Levin 2000).

Redundancy

Redundancy among social and ecological components (agents and processes), their relationships and system properties (structures, capacities, behaviours and functions) is a key factor enabling SES to cope with disturbance and change. Redundancies are overlapping and duplicated entities and attributes: insurance and backups. Redundancy increases the likelihood that a SES as a whole will retain its essential integrity, functioning and controls when an entity or attribute is impaired, fails or is lost; that is, when the redundant entity or attribute successfully compensates for, or takes over from, the compromised one (Janssen and Osnas 2005).

Modularity

Structural modularity is another key factor enabling systems to cope with disturbance and change. Modularity refers to the internal compartmentalisation of the system in space, time or organisational structure (Levin and Lubchenco 2008). Modularity means a system has a tendency to form multiple functional parts (different groups, clusters, communities, departments, modules or sub-systems) that can, to some extent, behave and evolve independently of each other. However, modularity does not imply isolation or absence of functional interdependence within or across scales. In a 'nearly decomposable' system (Simon and Ando 1961) with a high degree of modularity, each subsystem functions nearly independently while having only weak interactions with, and impact upon, other subsystems (Hagedorn 2008). Emergent patterns of modularity are phenomena widely observed in nature. Modularity is also a key design principle in technological and organisational innovation.

Whereas redundancy and diversity facilitate the replacement of entities and attributes lost to disturbance, a modular structure directly maintains system functioning by reducing the spread and impact of disturbance (Webb and Bodin 2008). In other words, local interactions in one module may successfully absorb a local disturbance or suppress its effects, thus reducing the risk of contagion to other modules.

Diversity

Diversity (differentiation, heterogeneity and variation) is an important contributor to social–ecological resilience. Whereas redundancy is the immediate source of replacement of lost functions, diversity provides the material or building blocks for adaptive responses over longer time scales (Levin 2000: 202).

Diversity helps a system absorb or resist different types and amounts of disturbance. By spreading risk, diversity provides insurance against uncertainty and surprise. Diversity provides a mix of components (agents and processes) whose history and accumulated experience (memory) help a system cope with change and crisis, for example, through experimentation, innovation, and social and institutional learning. Depending on availability of capital, diversity supplies the resources, opportunities, alternatives and flexibility for dealing with change: factors that facilitate system self-organisation, recovery, renewal and development following recurrent disturbance (Folke *et al.* 2002, 2003; Gunderson *et al.* 2010).

Novelty and innovation

Novelty and innovation are critical for creating adaptability (adaptive capacity) and maintaining resilience. Allen and Holling (2010) assert that complex adaptive systems require novelty and innovation to keep them resilient and functioning, capable of adapting and evolving, and capable of creating new structures and dynamics following system crashes.

Innovation is the result of interactions among a diversity of individual and social agents (actors) who are willing to experiment, test new learning and explore new configurations, strategies and activities. Innovation is fundamental to a SES's capacities for adaptive renewal and radical transformation. The creative processes of experimentation and innovation generate and introduce novelty (e.g. new institutions, governance arrangements, organisational structures or policies) during periods of system reorganisation (α phase). Incremental novelty and innovation help create the adaptability for maintaining essential system functions and the continuity of development. During a crisis or following a major disturbance (Ω phase), reorganisation presents a vital window of opportunity; this is when more radical novelty and innovation create the options necessary for fundamentally reconfiguring a system and influencing its development trajectory. Without novelty and innovation, a system may become over-connected and dynamically locked, with capital tied up and unavailable.

Social capital

Complex social dynamics such as social capital and social memory constitute sources of resilience that are essential to a SES's capacity to respond to, shape and create change (Folke *et al.* 2003, 2005). Social capital is an important slow variable; typically slow to develop, but can degrade quickly if there is a breakdown in institutions (Kofinas 2009).

Social capital is a multidimensional concept that represents certain key social assets and capacities.[37] Social capital is a property of groups rather than individuals. It is a product of the social relationships between actors embedded in social structures. Social structures are the recurring patterns of social interaction among actors. Different structural forms emerge from different qualities of social relationships. Social structures emerge at different levels of organisation and range in scale from small (families and communities) to large (societies and nation states). They include network structures and social institutions. Social capital is a product of social organisation that benefits (enhances) the mutual social and economic well-being of both individuals and groups (Putnam 1993). During social interactions, which occur at various levels and across scales, actors simultaneously build and use social capital by drawing on different categories of social resource (Falk and Kilpatrick 2000).

Despite divergent theoretical perspectives and different definitions across disciplines, social capital broadly refers to a range of properties and synergies emerging from repeated social interactions. These include social norms, shared values and attitudes; constraints and sanctions (institutions); reciprocity and trust; association, group bonds, understanding within groups, and membership in formal and informal and horizontal and vertical social networks; information flows within and between social networks; shared identities, sense of belonging, commitment and social cohesion; collective social agency; civic engagement and other forms of connection in societies, including connections that allow people to gain access to resources – all of which enable participants to act together more effectively and to proactively pursue shared objectives (Putnam 1995; Pretty 2003; Parissaki and Humphreys 2005; Vermaak 2009). These emergent social properties facilitate coordination and strengthen cooperation between individuals or groups, thus contributing to social capacity and opportunities for mutually beneficial and more effective collective action, and the proactive pursuit of shared objectives (Putnam 1993, 1995, 2000).

[37] Hauser *et al.* (2007: 84) caution that social capital is a general notion that is not appropriate for empirical analyses because it consists of multiple independent dimensions.

Social memory

Social memory is the collective (rather than collected) experience and history of a SES, including its ecosystem dynamics. It functions as a collectively shared mental map for dealing with a complex world (Barthel *et al.* 2010).[38] Social memory is accumulated and embedded in the diversity of individuals, social structures (groups, communities, social networks and societies), institutions and cultures, and the various cross-scale relationships between them. Social memory draws on reservoirs of practices, knowledge (including traditional ecological knowledge), beliefs, values, heritage, world views and other social legacies. These legacies are the lasting effects (remnants) of past events and the social–ecological responses to them (including adaptation, or maladaptation, and innovation) that continue to affect current social conditions; an accumulated source of knowing how to tolerate and deal with change under different circumstances (Adger *et al.* 2005; Chapin *et al.* 2009c).

Social memory contributes to resilience by providing three crucial functions: (1) an account of how things used to be, that is, previous states of the system, including supply of vital ecosystem services; (2) understanding of how actors and the system responded (successfully or unsuccessfully) to change in the past; and (3) insight into the possible alternatives for responding to ongoing and future global and regional environmental and social changes (Kofinas and Chapin 2009).

Social learning

Reed *et al.* (2010) define social learning as a change in understanding (at either superficial or deeper levels in the individuals involved) that goes beyond the individual to become situated within wider social units or communities of practice; this change occurs through social interactions between actors within social networks (either through direct interaction or through other media).

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[38] Here, the concept of social memory either overlaps or encompasses other forms of collective memory, such as 'communicative memory' of social groups and 'cultural memory' of cultural groups (Assmann 2008), 'institutional memory' (Linde 2009) between and across organisations or agencies, or 'organisational memory' (Rowlinson *et al.* 2010) within an organisation or agency.

Bridging organisations

Bridging organisations have an intermediary role in building and mobilising social capital. Olsson *et al.* (2007) conclude that they play a crucial role in the dynamic relationship between key individuals, social memory and resilience. Bridging organisations span the scale discontinuities among social, cultural, political and economic structures; and function as cross-scale social networks connecting multiple institutional, organisational and spatial levels, including in governance and natural resource management systems. Bridging organisations can take many forms, including transnational associations and networks, supranational political coalitions, social movements, cross-sector partnerships and public/civil society partnerships.

Bridging organisations are similar to boundary organisations but have a much broader scope than boundary organisations (Cash and Moser 2000). Traditionally, boundary organisations have had a more narrow focus on the two-way interactions across the science–policy interface, and have more clearly defined organisational arrangements, such as structures for accountability (Crona and Parker 2012: 4). Brown (1991) argues that bridging organisations and their constituents are shaped by values and visions, their tasks, member diversity and external threats.

Stewardship

The concept of resilience-based stewardship recognises that, in addition to being integral components of the SES they are seeking to influence, actors have responsibility for sustaining and restoring critical capital that supports human and ecological well-being.[39] System actors include individuals, groups and organisations: policy makers, managers, scientists, businesses, NGOs, communities and citizen groups, among others. At different levels of government (local, regional, national or EU), policy makers and public administration organisations are responsible for the careful management or stewardship of the various social, economic and ecological systems at their level of competence. As

[39] The term 'critical capital' refers to stocks of non-substitutable natural, social, cultural, economic and other capital assets, as well as the capacities to produce and maintain them. This includes the supply of natural resources and ecosystem services that are essential for human well-being and environmental integrity (Walker and Pearson 2007).

part of their system stewardship function, these governance actors perform a variety of responsibilities.

Whether organised and acting from the bottom up or top down, through partnerships or multilevel networks, stewardship groups are vital enablers of and contributors to social–ecological resilience. Stewardship may benefit from cumulative and synergistic effects arising from multiple stewardship groups and their different stewardship intervention strategies and actions (Wolf *et al.* 2013).

3.5 Loss of resilience

Instead of behaving in a predictable linear manner, it is normal for SES to go through adaptive cycles of increasing and decreasing resilience (Gunderson and Holling 2002). (Adaptive cycle theory is described in Chapter 2.) During the development mode or fore loop, resilience capacity reaches its maximum potential somewhere in the capital accumulation (r) phase before decreasing as the system gradually transitions towards the capital conservation (K) phase (i.e. as the basin of attraction shrinks). In other words, resilience decreases as capital becomes increasingly aggregated and unavailable, growth progressively slows, specialisation supersedes opportunism, variability is dampened and controlled, structure becomes more interconnected, novelty is excluded, institutions become more constraining, processes become more efficient, redundancies are eliminated, organisation becomes less flexible, and dependence on existing structures and processes increases (Walker and Salt 2006).

The consequences of a gradual loss of general resilience[40] include reduced opportunities for system reorganisation and adaptation without the system undergoing significant declines in essential functions. Loss of resilience constrains options and restricts the potential for generating innovation and novelty during vital periods of reorganisation and renewal (α phase). The net effect may

[40] The notion of 'general resilience' (Walker 2005) refers to resilience of the whole system (i.e. system-level properties) to a range of disturbances, including unidentified ones, as opposed to 'specified resilience' (Carpenter *et al.* 2001) which deals with resilience of a particular part of the system to a specific disturbance, in relation to a possible threshold effect (Walker *et al.* 2009a; Folke *et al.* 2010).

be that the SES develops its configuration and behaves (evolves) along a trajectory relative to an undesirable attractor.

Furthermore, when general resilience is diminished or lost, the system's vulnerability (exposure and sensitivity) to pressures and smaller or less frequent disturbances increases. This puts the system or various subsystems at higher risk of crossing critical thresholds and undergoing an abrupt response with dramatic and far-reaching consequences (Folke *et al.* 2004; Eakin and Luers 2006). Such a critical transition or regime shift is likely to be extremely difficult to predict and therefore surprising, especially in the absence of any new or obvious disturbance. A regime shift begins when one threshold is crossed, but may continue as a cascade in which multiple thresholds across scales of space, time and organisational complexity are breached. Such a cascading effect has a tendency to produce an alternative stable state (basin of attraction or regime) that is very resilient, less desirable and highly resistant to, for example, management strategies that might seek to restore the earlier regime (Kinzig *et al.* 2006). The regime shift (or precursor such as an environmental, social and economic crisis) may be the first widely acknowledged signal that the system's resilience has been diminished. However, recent work in different scientific fields concerning a range of complex systems that exhibit multiple stable states now suggests the existence of generic early-warning signals of an approaching critical threshold and impending regime shift; for example, signals or indicators such as increased temporal variability or flickering (Scheffer *et al.* 2009; Brock and Carpenter 2010; Dakos *et al.* 2010; Hewitt and Thrush 2010; Scheffer 2010).

Loss of resilience through the cumulative, combined and synergistic effects of multiple pressures may increase the vulnerability of SES to changes that previously could be absorbed (Eakin and Luers 2006), thereby increasing the risk of a regime shift (Folke *et al.* 2004, 2009). In some cases, the progression towards increased vulnerability may be slow, incremental and unrecognised: the cryptic loss of resilience (Adger *et al.* 2005; Nyström *et al.* 2008). In other cases, a deliberate loss of resilience may be sought, such as when policy and management interventions are required to overcome a highly resilient but undesirable regime and transform a SES's trajectory toward a desirable attractor (Walker *et al.* 2002).

3.6 Increasing resilience

The renewal mode or back loop of the adaptive cycle is relatively rapid. Disturbance and disruption lead to release of capital and readjustment or collapse of structure and connectedness (Ω phase). This is closely followed by reorganisation and renewal (α phase) at the start of a new 'adapted' cycle during which resilience 'returns'. This is when previously accumulated, now disrupted, capital is reorganised, and restructuring and reconnection take place. Resilience capacity increases during the progressive transition from the reorganisation (α) phase to the accumulation (r) phase.

During reorganisation, complex processes of self-organisation[41] allow for creative experimentation, innovation (of new ideas, policies, institutions, industries, etc.), learning, and recombination of experience and knowledge, leading to a modified or even entirely new system configuration. Thus, when a disturbance, shock or crisis provokes a release (Ω) phase it leads to a reorganisational window of opportunity during which deliberate human interventions and manipulations can influence how a SES is renewed and reconfigured. The extent to which actors make use of such a window of opportunity depends on adaptability and transformability: the capacities to adjust responses to either avoid or succeed in crossing critical thresholds respectively (Folke *et al.* 2010). Successful transformation to a more desirable system configuration and trajectory (essentially a new basin of attraction or regime) involves three phases as follows (Figure 3.1):

1. Preparing actors and the system for change by exploring alternative system configurations and developing strategies for choosing from among possible futures.
2. Navigating the transition by making use of a crisis as a window of opportunity for change.

[41] Self-organisation processes include the changing rules of local interaction, competition, selection, assembly and arrangement among a diversity of individual adaptive components; emergence of patterns (complexity); reinforcement of local dynamics via feedbacks; adaptation (adjustment) in response to variability and directional changes; and evolution toward collective behaviour (cooperation) and toward modularity that buffers against cascade effects (Levin 2000, 2005).

3. Building resilience of the new social–ecological stability regime (Olsson *et al.* 2006).

In terms of the basin of attraction metaphor, management interventions aimed at increasing resilience might seek to deepen and widen the basin (i.e. enhance resistance and increase latitude) through strengthening feedbacks that maintain a desirable configuration. (But with the caveat that efforts to enhance specified resilience to various known threats and disturbances can unintentionally reduce the general resilience of the whole system to other disturbances, including disturbances that are subject to high uncertainty or that are currently unknown. This requires some form of resilience trade-off to be considered (Janssen and Anderies 2007; Walker *et al.* 2009a)). Conversely, if the state of the system is persisting along a trajectory relative to an undesirable attractor, then resilience management might seek to deliberately decompose or reduce the resilience of the current configuration (lessen resistance and decrease latitude, i.e. shrink and narrow the basin) in order to produce a transformation (critical transition) into an alternative basin.

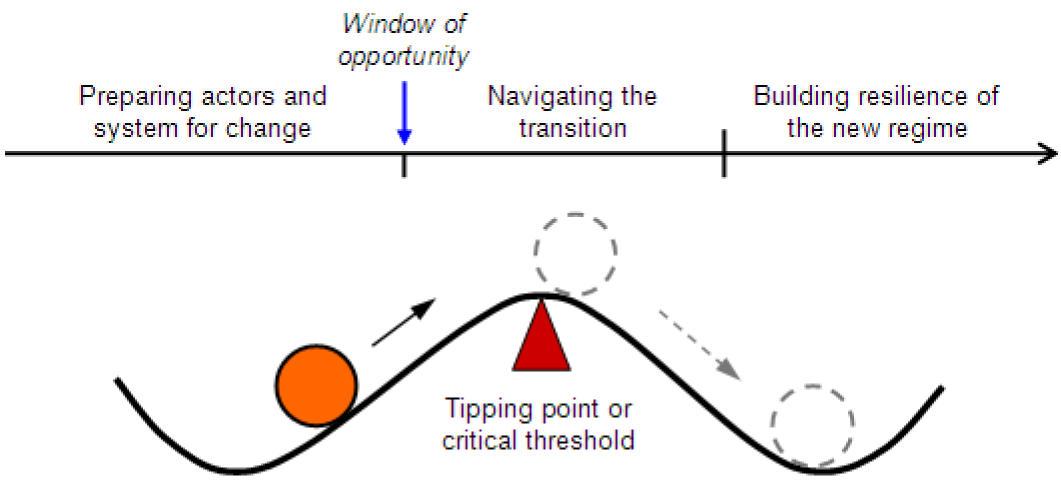

Figure 3.1 Three phases of deliberate social–ecological transformation (critical transition), linked by a window of opportunity. (Adapted from Folke *et al.* 2009: 121, Fig. 5.4).

Such interventions are part of achieving the fundamental goal of resilience management, which is to preserve and nurture the vital characteristics and capacities (redundancy, modularity, diversity, innovation, trust, memory, networks, learning, stewardship, etc.) that enable the system to adapt, transform, reorganise, renew and continue to develop following major disturbance and disruption (Walker *et al.* 2002).

Strategies and actions for building resilience

In many cases, human strategies and actions aimed at deliberately increasing social–ecological resilience are simply reactive to unintentional reductions and losses of resilience. That is, they are not part of any proactive, semi-autonomous, self-organising approach. Resilience thinking emphasises the necessity of adapting and 'learning to manage by change' (Folke 2006: 255) against a background of modified resilience, increased likelihood of surprises, and unpredictable and enhanced variability in essential resource flows (Folke *et al.* 2003). There are diverse management practices and social mechanisms that could be applied to enhancing and building resilience in SES. Many of them are interrelated and interact across spatial, temporal and organisational scales. These strategies for building resilience are summarised in the following paragraphs.

> *Conserving and developing*. Managing the dynamic interplay between stabilising feedbacks that (1) sustain system properties (i.e. control system function and maintain the current configuration) and the disturbance regime that provokes incremental adjustments (adaptations) during SES co-evolution; and (2) create 'destructive' opportunities for 'creative' reorganisation and renewal (i.e. system development) (Folke 2006; Chapin *et al.* 2009c).
>
> *Diversity and diversification*. Fostering different types of diversity, including spatial heterogeneity, across the social and ecological domains. Diversifying patterns of resource use and dependency in order to spread risk. These strategies necessitate deepening our understanding regarding the important role of diversity in SES dynamics (i.e. in creating and maintaining options and choices that facilitate reorganisation and renewal following disturbance), including the fundamental role and value of biological diversity in supplying ecosystem services (Folke *et al.* 2003, 2004; Adger *et al.* 2005; Berkes and Seixas 2005; Folke 2006; Chapin *et al.* 2009c).

Redundancy. Investing in, nurturing and, if possible, restoring redundancies across the social and ecological domains (Folke *et al.* 2004, 2005; Folke 2006).

Restructuring. Reorganising system structure and managing the balance between modularity (independence) and interconnectivity (interdependence) between sub-systems or system components (Janssen and Osnas 2005; Webb and Bodin 2008).

Memory. Nurturing and sustaining ecological and social memory, and using social memory more effectively as a source of innovation, creativity and adaptability (adaptive capacity). Memory provides the framework of accumulated collective experience for coping with change (Berkes and Seixas 2005; Abel *et al.* 2006).

Learning and adaptation. Building and nurturing the ability to learn and adjust responses so as to live (cope) with change, uncertainty and unexpected shocks. In other words, to build and nurture social learning and adaptability. This involves building the capacity of different levels of organisation to (1) acquire knowledge and understanding of social–ecological dynamics and cross-scale interactions and apply it to a situation or anticipated situations (preparedness); (2) learn from previous crises, successes and mistakes, including those affecting other actors or systems; and (3) learn to self-organise and manage across scales without losing critical social relations, economic options or political stability (Folke *et al.* 2003; Adger *et al.* 2005; Berkes and Seixas 2005; Gardner and Dekens 2007).

Knowledge and understanding. Building the capacity to acquire (through experience, observation and inference), combine, adapt, share and utilise different types and scales of knowledge systems and understanding (e.g. local ecological knowledge and scientific understanding of ecosystem processes and functions) for social learning, adaptation, collective organisation and action, development of institutions and management of critical capital (Folke *et al.* 2002, 2003, 2005; Berkes and Seixas 2005; Abel *et al.* 2006; Gardner and Dekens 2007).

Experimentation and innovation. Facilitating small-scale transformative experiments that allow cross-scale learning and new initiatives to emerge. Building adaptive capacity and creating opportunities for novelty and sociotechnical innovation (Darnhofer *et al.* 2010; Folke *et al.* 2010).

Monitoring and responding. Building the capacity to monitor, detect and respond effectively to signals (feedback) from environmental change and ecosystem dynamics (Olsson *et al.* 2004a; Berkes and Seixas 2005; Folke *et al.* 2005).

Self-organisation. Building capacity and creating opportunities for self-organisation among actors within SES. For example, establishing and adapting institutions, agencies or collaborative management arrangements. Self-organisation also involves learning to recognise (1) the dynamic interplay between diversity and disturbance; (2) cross-scale interdependencies; (3) the need to match scales of governance with scales of ecosystems; and (4) the role of exogenous social and economic drivers (Folke *et al.* 2002, 2003; Berkes and Seixas 2005).

Participation and deliberation. Building and nurturing social norms, shared values, trust, reciprocity, cooperation among actors, shared understanding, science–policy–stakeholder interactions, collective action and other forms of relationships (i.e. social capital) between individuals, groups, communities and organisations; to do so through inclusion, participation, deliberation, creating enabling environments, empowerment of people's institutions, democratisation, representation and accountability. This includes eliminating the barriers (Berkes and Seixas 2005; Folke *et al.* 2005; Lebel *et al.* 2006; Bohle *et al.* 2009; Chapin *et al.* 2009c).

Vision and leadership. Building and communicating vision and values. Fostering transformational leadership (opinion leaders, policy entrepreneurs, etc.) at different levels of organisation (Olsson *et al.* 2004a, 2004b; Folke *et al.* 2005).

Social networks. Developing multilevel social networks and transforming collaborative network configurations so as to build up and better utilise social capital, including supporting legal, political and financial institutional frameworks. Furthermore, ensuring good information flows within and between networks (Olsson *et al.* 2004a, 2004b; Adger *et al.* 2005; Folke *et al.* 2005; Abel *et al.* 2006; Chapin *et al.* 2009c).

Institutions. Nurturing, restructuring and sustaining a diversity of institutions (rules and arrangements) over the long term. In particular, institutions that are variously capable of (1) responding more adaptively to present-day change; (2) buffering against future risks such as those associated with climate change; (3) improving the fit (resolving scale mismatch) between knowledge, action and social–ecological contexts; and (4) framing participation, learning, memory and innovation within management structures, regulatory frameworks and polycentric, multi-layered governance systems. In addition, establishing and developing cross-scale (external and internal) institutional linkages and partnerships (Adger *et al.* 2005; Berkes and Seixas 2005; Lebel *et al.* 2006; Gardner and Dekens 2007).

Governance and management. Creating, experimenting with and developing adaptive, multilevel social–ecological governance systems, co-management approaches and associated networks within institutional and collaborative frameworks. Such frameworks can be designed and built to be more flexible, inclusive, accountable and collaborative; open to learning from experience (i.e. reflexive); capable of constantly adjusting to changing social–ecological contexts (i.e. responsive); linked across spatial, temporal and organisational scales; and scale matched to ecosystems (Adger *et al.* 2005; Berkes and Seixas 2005; Folke *et al.* 2005; Lebel *et al.* 2006).

Cultural development. Fundamentally transforming actor perceptions and behaviours towards an inclusive view of human interdependence with ecological factors. Encouraging diversification of livelihood activities and lifestyles in order to spread socioeconomic risk and help sustain ecosystem services. Increasing sensitivity to differing perspectives and knowledge systems (Adger *et al.* 2005; Chapin *et al.* 2009c).

Conflict management. Building capacity and mechanisms for conflict management (Berkes and Seixas 2005; Sanginga *et al.* 2007; Gruber 2010).

Incentives. Creating and increasing social incentives. For example, incentives for sustaining biodiversity or generating ecological knowledge and translating it into ecosystem stewardship and information useful for governance; to do so while simultaneously reducing the perverse incentives that destroy natural capital (Adger *et al.* 2005; Folke *et al.* 2005; Anderies *et al.* 2006; Chapin *et al.* 2009c; The World Bank 2009).

3.7 Adaptability and transformability

The interrelated concepts of adaptation, adaptability (adaptive capacity), transformation and transformability (transformative capacity) are crucial to understanding resilience and processes of change in SES. Adaptability and transformability are essential prerequisites for the persistence and development of SES (Folke *et al.* 2010). These change-related concepts have broad relevance to sustainability science and social–ecological research. Research on adaptation and transformation in SES largely originated within the conceptual frameworks of vulnerability (see Adger 2006; Smit and Wandel 2006) and resilience (see Folke 2006). Vulnerability and resilience research each emerged from different research traditions (Gallopín 2006; Janssen and Ostrom 2006; Nelson *et al.* 2007; Engle 2011). This has resulted in a variety of definitions and interpretations of these concepts among scientific disciplines and across the science–policy interface. Furthermore, cross-theorising between different literatures (e.g. concerning resilience, learning, governance and social-technological transitions) continues to provide complementary perspectives and additional insights that further enrich the understanding of adaptation and transformation (Löf 2010).

Rather than discuss definitional nuances or argue the primacy of one definition over another, this section explains adaptation, adaptability, transformation, transformability and related concepts from a hybrid actor and system-oriented perspective. (In Chapter 7, section 7.6, I reconceptualise the processes of adaptation and transformation as constituting a continuum.)

Adaptation

Here, we are concerned with adaptation in the context of SES and the human dimensions of regional and global change, not adaption in the context of evolutionary biology. Adaptation comprises incremental adjustments to a system's configuration and behaviour. These adjustments are made in response to, or anticipation of, actual, perceived or expected environmental, social and economic variability and directional changes and their effects. Ongoing processes of adjustment and self-organisation enable a complex adaptive SES to persist and continue to develop. Adaptation is a process, action or outcome that enables human actors (both individually and in groups), institutions, governance systems or an entire SES to better cope with, manage or adjust to some changing condition, stress, risk or opportunity (Smit and Wandel 2006). In other words, adaptation maintains resilience, where resilience is the capacity of a SES to cope with disturbance and deal with change while (1) maintaining essentially the same function, structure, identity and feedbacks (and therefore stay within the same basin of attraction or regime); and (2) retaining options for future social and economic development (Walker *et al.* 2004; Nelson *et al.* 2007).

Because human activities dominate the dynamics of SES, adaptation is primarily a function of the agency and capacity of human actors. Agency and capacity are essential resources for initiating and maintaining social adaptation (and transformations, as will be seen). Here, the term 'agency' refers to the power and ability of actors to act independently and to make their own free choices. The term 'capacity' refers to the power and ability of actors to perform the choices they make. Concerning the emergence of 'agency beyond the state' in global (environmental) governance, Biermann and Pattberg (2008: 280) describe agency as the power of individual and collective actors to change the course of events or the outcome of processes. Therefore, adaptation is ultimately about decision making and the power and ability of individuals and groups to implement those decisions; that is, decisions regarding coping with change, shaping change, managing risk and exploiting new opportunities. Nelson *et al.* (2007: 398) describe adaptation as

> ‘a process in which knowledge, experience, and institutional structures combine together to characterize options and determine action. The process is negotiated and mediated through social groups, and decisions are reached through networks of actors that struggle to achieve their particular goals’ (p. 398).

Regardless of whether it is reactive or anticipatory, spontaneous or planned, adaptation is a manifestation of social adaptive capacity (Smit and Wandel 2006; Tol *et al.* 2008).

Adaptability (adaptive capacity)

The ability of SES to undergo adaptation in response to, or anticipation of, changing internal demands and external circumstances is a key aspect of system resilience (Carpenter and Brock 2008). This ability to make incremental adjustments to the state of a system – enabling it to persist and develop within the same basin of attraction or regime – is primarily a function of the agency (adaptability) and capacity (adaptive capacity) of human actors in the system. In other words, adaptability or adaptive capacity derives from deliberate action and self-organisation in the social domain.

The concept of adaptive capacity is integral to both the vulnerability and resilience paradigms. Both frameworks generally accept that adaptive capacity is a desirable system property. Furthermore, the concept’s positive connotation and emphasis on governance, institutions and management help in translating the concept to decision makers.

In the vulnerability literature, adaptive capacity is considered critical for managing risk and reducing vulnerability to possible future harm. Adaptive capacity represents the ability of actors to (1) modify the exposure and sensitivity of human systems to hazards, stresses, disturbances or shocks; and (2) moderate the harm resulting from perceived or projected change (Turner *et al.* 2003a, 2003b; Adger 2006; Eakin and Luers 2006; Gallopín 2006; Smit and Wandel 2006; Turner 2010b; Hinkel 2011; Nelson 2011). In the climate change literature, adaptive capacity is generally defined as the potential or ability of a system, region or community to adapt to the effects or impacts of climate change (Smit and Pilifosova 2001: 881).[42]

In the resilience literature, adaptive capacity is often treated as synonymous with adaptability, which is generally defined as 'the capacity of actors in a system to influence resilience' (Walker *et al.* 2004: 3). Because the adaptive dynamics of SES are dominated by human decisions and actions, adaptability is mainly a function of social agency. Therefore, adaptability is the collective capacity and willingness of human actors (both individuals and groups) in a SES to act in ways that strongly influence, that is, manage resilience (Walker *et al.* 2004, 2006). More precisely, adaptability is the actors' collective capacity to anticipate and bring about adaptation at different levels and scales, and thus determine whether a system can successfully adjust its responses to avoid crossing a critical threshold (tipping point) into an undesirable basin of attraction (i.e. to avoid a regime shift).

In terms of the adaptive cycle (see Chapter 2), adaptability defines the options for renewal and reorganisation (α phase) following disturbance. In terms of the stability landscape described by Walker *et al.* (2004), adaptability entails the capacity to:

- Reduce precariousness by changing the trajectory of the system; that is, by changing the current state of a system so as to move away from a threshold (deeper into a desirable basin of attraction).
- Increase latitude (widening the basin) by altering the position of a threshold so that it is further away from the current state of the system.

[42] Concerning adaptation to climate change, in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), Adger *et al.* (2007) define adaptive capacity as 'the ability or potential of a system to respond successfully to climate variability and change, and includes adjustments in both behaviour and in resources and technologies' (p. 727).

- Increase resistance (deepening the basin) so that a threshold is more difficult to reach.
- Manage cross-scale interactions (altering the panarchy) to avoid loss of resilience (and loss of adaptability).

According to Walker *et al.* (2006), preventing a system from crossing a critical threshold, or being able to change the underlying structure and behaviour of the system in order to move a threshold or move relative to a threshold, 'requires innovation and skills, agreement on what to do, and a combination of options in terms of access to natural capital, financial resources, and infrastructure' (p. 7).

Chapin *et al.* (2009b: 23) argue that adaptability depends on four interrelated factors:

1. Diversity across the range of available (natural, social, cultural, human, political, economic and financial) capital.
2. Capacity of individuals and groups to augment diversity by introducing novelty through learning, experimentation and innovation.
3. Willingness to experiment and innovate in order to test new learning and understanding and to explore new approaches.
4. Social capital (including social networks and institutions), bridging organisations and leadership are key components of adaptability.

Building adaptability (adaptive capacity) is generally considered complementary to building resilience within SES. By definition, CAS have a high adaptive capacity (Pahl-Wostl 2007: 53). Systems with a high capacity to adapt are able to reconfigure themselves without significant declines in critical functions (Walker 2003). Therefore, it seems reasonable to assume that, in SES with high adaptability, actors are more able to reorganise subsystems and other components in order to maintain resilience and increase the likelihood that the system will persist and continue to develop (Folke *et al.* 2009). However, just as 'resilience is not always a good thing' (Walker *et al.* 2004: 5), neither is high adaptability.

Walker *et al.* (2006) suggest that intentionally increasing adaptability to known or predictable disturbances occurring at one spatial–temporal scale may unintentionally lead to loss of adaptability and resilience to unknown or unforeseen disturbances at a different spatial–temporal scale. In other words, efforts to build adaptability in one part of the system or at one scale may inadvertently increase vulnerability in another part of the system or at a different scale.

Sometimes, a more radical change is desirable, and management actions dedicated to overcoming resilience and lowering adaptability may be needed to bring about transformation of a SES into a different basin of attraction (regime).

Transformation

Adaptation is a conservative process focused on maintaining or improving human well-being within a particular SES (Nelson 2011: 116). Transformation, on the other hand, represents a radical, often substantial change involving fundamental system reorganisation leading to a qualitatively different and potentially more beneficial SES. Hence, transformations can be seen as both processes and outcomes.

Though the term ‘transformation’ basically means change, its use and meaning varies between different research traditions. In this thesis, transformation is conceptualised in terms of the SES, resilience and adaptive management literatures. In this sense, transformation is a fundamental change in a SES, which results in different control variables that define the system state, new patterns of behaviour, and changes in the scale of critical feedbacks (Chapin *et al.* 2009c: 328, 2010: 241). This is distinct from the conceptualisation and use of transformation in the Dutch sociotechnical transitions and transition management literature (Rotmans *et al.* 2001; Martens and Rotmans 2005; Genus and Coles 2008; Fischer-Kowalski and Rotmans 2009; Geels 2010, 2011; Loorbach 2010; Smith and Sterling 2010) or the Viennese sociometabolic regimes and transitions literature (Fischer-Kowalski and Haberl 1998; Krausmann *et al.* 2008a, 2008b; Fischer-Kowalski and Rotmans 2009; Haberl *et al.* 2011) or the long-term socioecological research (LTSER) literature (Haberl *et al.* 2006; Singh *et al.*

2013) or the emerging social macro-evolutionary and the World System development literature (Bondarenko *et al.* 2002; Kowalewski 2004; Grinin and Korotayev 2009; Grinin *et al.* 2011), for example.

Transformation may be necessary when a SES becomes trapped in an undesirable but very resilient (self-reinforcing) basin of attraction (regime); or when persistence in the current basin becomes unsustainable due to changing ecological, social, economic or political conditions (i.e. when it is necessary to avoid a trap or collapse); and, in both cases, when adaptation is neither an option nor a solution (Walker *et al.* 2004, 2006). Escaping a persistent maladaptive basin (trap) or transforming an unsustainable basin (to avoid a trap or collapse) each entail a regime shift. This requires one or more critical thresholds to be deliberately crossed in the direction of a new attractor (or set of attractors), resulting in a new system configuration and different development trajectory (Folke *et al.* 2009). Of course, the outcome may be deemed either successful or unsuccessful depending on the normative criteria applied.

The characteristics of transformations differ, depending on the context and capacity of actors in the system concerned to undergo transformational change. The three principal types of transformation are:

> *Forced*. Transformation may be imposed on actors by changing conditions (e.g. the degradation of ecosystem functions, which in turn feed back to affect social and economic systems) that lead to thresholds being crossed unintentionally.
>
> *Anticipated*. Transformation may be deliberately initiated by actors in anticipation of an impending (Ω phase) collapse of system functions, structure, feedbacks, panarchical relationships and identity (Abel *et al.* 2006).
>
> *Escape*. Another type of transformation deliberately initiated by actors in an effort to unlock a 'locked-in' regime and escape a trap. That is, to escape an undesirable, dysfunctional, but nevertheless persistent system state.

For reasons already explained in connection with adaptability, the transformation of a SES is primarily a function of the agency and capacity of human actors in the system. Olsson *et al.* (2006) and Folke *et al.* (2010) consider transformations within the social domain in terms of changes involving shifts in perception and meaning, social network configurations, social coordination, patterns of interactions among actors (including political and power relations, and leadership), and associated institutional arrangements and organisational structures. 'Transformations also include redirecting governance into restoring, sustaining, and developing the capacity of ecosystems to generate essential services' (Olsson *et al.* 2006: 2).

In terms of the adaptive cycle and panarchy (see Chapter 2, section 2.5), the processes of experimentation and innovation are critical to adaptation and transformation. They generate novelty and options: the crucial reservoir of fuel for system reorganisation and renewal (α phase). Transformation depends on innovation and novelty for re-establishing, maintaining or building resilience and adaptability; and for creating new structures and dynamics following system (Ω phase) crashes and navigated transformations. Innovation and novelty allow actors the latitude to explore alternative structures and dynamics that enable the system to evolve. Novelty originates from the inherent interactions between dynamics at different levels and scales of the panarchy. Scale discontinuities or thresholds are particularly important for the generation of novelty (Allen and Holling 2010). In contrast to adaptation, transformation involves changing the underlying stability landscape (state space) of the system through introducing new state variables and eliminating others. Furthermore, by modifying the number and topology of alternative basins of attraction, transformation is also likely to change the character of cross-scale interactions across the panarchy (Walker *et al.* 2006).

Transformability

SES can sometimes become trapped in a very resilient but undesirable basin of attraction (regime) in which adaptation is not an option. 'Escape from such regimes may require large external disruptions or internal reformations to bring about change' (Walker *et al.* 2006: 3). At other times, various conditions (e.g. ecological resource crisis, shift in social values, failure of political policies or financial crisis) can make the existing system untenable (Walker *et al.* 2004). The ability to undergo either forced (unintended) transformation or deliberate transformation (to avoid collapse or escape a trap) depends on the degree of activatable transformative capacity or transformability as it is commonly referred to in the resilience literature.

The concept of transformability represents the agency and capacity of human actors to reconceptualise and, when necessary, create a fundamentally different, potentially more beneficial, and therefore more desirable SES (Walker *et al.* 2004; Chapin *et al.* 2009b). More precisely, transformability is the collective capacity of actors in a SES to envision, define, create and subsequently manage a new stability landscape with alternative basins for sustainable development. In other words, to create a fundamentally new system configuration and development trajectory. But transformability is also the capacity to undertake an actual transformation or regime shift by crossing thresholds between the current basin and an alternative basin. That is, to undergo a critical transition and move towards a new attractor and development trajectory by modifying values of existing state variables, introducing new ones (or allowing them to emerge) or losing others (Walker *et al.* 2004).

According to Folke *et al.* (2010), the attributes required for transformability have much in common with those of general resilience. They include high levels of all forms of capital; diversity in landscapes and seascapes and among institutions, actor groups and networks; learning platforms; collective action; and support from higher levels in the governance structure. From case studies, Walker *et al.* (2006) identify the following determinants of transformability: incentives to change versus not to change; cross-scale awareness, panarchical responsiveness and networking both within and between SES; a willingness to experiment; capital reserves and highly convertible assets; and governance. Hence, adaptive governance and adaptive management approaches are essential in creating transformability (and adaptability) in SES (Walker *et al.* 2004; Folke *et al.* 2005; Gunderson and Light 2006; Olsson *et al.* 2006).

Adaptability, transformability: tension and latency

Adaptive and transformative capacities are closely related and have overlapping attributes. Consequently, there is no distinct cut-off point between adaptability and transformability. However, they are not necessarily mutually reinforcing (Löf 2010). There may be tension between the two, involving a trade-off between building adaptability to maintain system resilience in the face of known (and some unknown) disturbances and simultaneously building transformability, should it be needed (Walker *et al.* 2004). The tension may rise at times when deliberate efforts are required to undermine and reduce resilience in the short term in order to bring about large-scale transformational change (Nelson 2011).

To some extent, adaptability is latent and may be realised, mobilised or harnessed only when sectors or systems are exposed to actual or expected stimuli (Bohensky *et al.* 2010). In turn, this latent condition will likely affect the activation of transformability needed to overcome resilience in system transformations (Nelson *et al.* 2007). Arguably, it is the anticipatory types of adaptability and transformability that are most crucial in terms of developing capacity in advance of exposure. In reality, however, it is often easier to detect signs of adaptability and transformability when the system in question has had to deal with actual risks and impacts (Vincent 2007).

Cross-scale transformation

SES transformations are not scale independent; that is, transformations at one level take place in a context of cross-scale interactions (Olsson *et al.* 2010). Transformational changes in lower level dynamics (smaller, faster adaptive cycles) can trigger an upward cascade of transformational changes ('revolution') affecting successively higher level dynamics (larger, faster adaptive cycles) in the panarchy. Conversely, transformational changes at higher levels can open up windows of opportunity for a downward cascade of transformations to lower levels (Gunderson and Holling 2002).

Agency and capacity for transformation at one level may require sources of resilience and adaptability (e.g. social memory of experiences for creating novelty through innovation) drawn from other levels or other systems (Olsson *et al.* 2010:

268). In terms of connections, the linking and bridging aspects of social capital are vital to such interactions across scale discontinuities (thresholds or boundaries) and between systems (Olsson *et al.* 2007). Löf (2010) draws attention to the essential bridging role of learning, which provides the necessary link between the individual level and system level. Networks are also essential, particularly those types of social network (e.g. bridging organisations involved in co-management systems) that directly connect institutions and organisations across levels and scales, and that facilitate information flows (Olsson *et al.* 2004a, 2004b; Adger *et al.* 2005; Berkes 2009). Nevertheless, the mere presence of a network is insufficient for social innovations, knowledge and actions for sustainable change to bridge the boundaries that separate local solutions from broad-scale system transformation; strategic agency must also be present within networks for cross-scale interactions to occur. Moore and Westley (2011) argue that institutional entrepreneurs with specific skill sets (e.g. that enable pattern generation, relationship building and brokering, knowledge and resource brokering, and network recharging) are key to animating effective social networks that enable social innovations to cross scales. Once animated, the networks become a powerful force for connection and dissemination.

3.8 Summary

This chapter described the second part of the conceptual framework that both guided and emerged from the study of EASES. The chapter presented the conceptualisation of social–ecological resilience used in this research. The various sources of resilience in SES were explained. This was followed by an examination of arrangements and processes by which resilience is diminished and lost or, conversely, gained and increased. Finally, the chapter described the interrelated concepts of adaptation/adaptability and transformation/ transformability and discussed their role in understanding resilience and change in SES.

Chapter 4

Governance architecture for maritime regional sustainability

This chapter describes the research context. It presents the background of the research problem and justification for the study using the conceptual European Atlantic social–ecological system (EASES).

4.1 Introduction

> A problem never exists in isolation; it is surrounded by other problems in space and time. The more of the context of a problem that a scientist can comprehend, the greater are his chances of finding a truly adequate solution.
>
> — Russell L. Ackoff (1962: 429)

The concept of social–ecological systems (SES) has important implications for Europe's relationship with the oceans and seas. This thesis argues that a multilevel governance architecture based on SES is necessary for the European Union's (EU) integrated maritime policy to address the challenges of global change and sustainable development. More specifically, it argues that the design of governance architecture for maritime regional sustainability in Atlantic Europe should be informed by theories concerning complex adaptive systems (CAS), especially SES.

The notion of governance was introduced in Chapter 1. The theory of complex adaptive SES is described in Chapter 2. The purpose of this chapter is to contextualise the research problem. It is organised as follows. After this introduction, section 4.2 describes the general background of the research in terms of the social–ecological sustainability context. Section 4.3 outlines the notion of governance for sustainability followed by section 4.4, which considers key elements of architecture for sustainability governance. Section 4.5 looks at the European maritime dimension in general, including the policy landscape, while section 4.6 describes the maritime macro-regional approach in particular. The chapter ends with a summary, discussion and conclusion, which identify the gap in knowledge and justify the focus of the study (section 4.7).

4.2 Sustainability context

The anthropogenic (human-driven) transformation of the Earth system has accelerated since the beginning the Industrial Revolution (Vitousek *et al.* 1997; Schellnhuber 1999; Crutzen 2002). The growing scale of human activities is undermining the long-term sustainability of the Earth system: 'the common dwelling, the *oikos*' (Latour 2004: 180). The effects of climate change, natural resource scarcity, biodiversity loss and ecosystem degradation are jeopardising human well-being both now and in the future (MA 2005). There is a risk that continuing human pressures on the planet will trigger abrupt and irreversible changes with catastrophic outcomes for human societies and ecological systems (UNGSP 2012). Barnosky *et al.* (2012) review evidence in the scientific literature that the Earth's biosphere – the global ecosystem as a whole – has undergone planetary-scale state shifts in the past. Their findings support the view that the biosphere is approaching a critical threshold (tipping point) as a result of human influence; the resulting critical transition has 'the potential to transform Earth rapidly and irreversibly into a state unknown in human experience' (p. 52); and that the occurrence of such a global-scale state shift 'is highly plausible within decades to centuries, if it has not already been initiated' (p. 57). Yet, the notion that global civilisation is threatened with collapse by an array of environmental problems (Ehrlich and Ehrlich 2013a) remains contested (Kelly 2013; Ehrlich and Ehrlich 2013b).

Anthropogenic global change has many dimensions. Growing human populations, new and more powerful technologies, contemporary globalisation processes and the prevalence of neoliberalism mean that our human societies, economies, cultures and political institutions are becoming increasingly globally interconnected and integrated. This is manifested in the higher number and density of connections, increasing scale and speed of interactions, further homogenisation of system components, and changing global patterns of production and consumption (Young *et al.* 2006a). Global inequalities and the perilous state of the environment are linked with geopolitical and economic developments, but also with individuals' values and lifestyle choices (UNGSP 2010). This kind of cross-scale linkage has been demonstrated in relation to the maritime dimension. For example, the EU Sixth Framework Programme project on European Lifestyles and Marine Ecosystems (ELME)[43] investigated the causal relationships between changing lifestyles, sociopolitical and economic drivers, pressures on marine ecosystems, and environmental changes in Europe's regional seas (Langmead *et al.* 2007).

Anthropogenic global change is a complex of interacting human, social (including cultural, economic, institutional and political), technological, environmental and ecological processes at local, regional and global scales. In short, we may call it 'social–ecological change'.

Against this background, the ability of social systems and ecosystems to sustain, and be sustained by, each other is of vital importance to human well-being and security. Until relatively recently, sustainability-related research has tended to address social and ecological systems separately. This despite the increasingly popular conceptualisation of sustainability as the intersection between three interlocking dimensions or pillars: environmental/ecological, social and economic (see Keiner 2004). Alternatively, we can consider social and ecological systems together, holistically, as components of an integrated whole. In doing so, the focus of sustainability-related research shifts to investigating complex society–nature relations and interactions in order to (1) understand the dynamic relations between humans, society and nature; and (2) provide knowledge for use in dealing with complex, continually changing social–ecological realities. This leads to the notion of integrated SES (described in Chapter 2).

The sustainability of SES is challenged by problems of unprecedented complexity. In most real-world situations it is not enough to isolate and consider

[43] http://cordis.europa.eu/result/report/rcn/50751_en.html [accessed 23/11/2015].

individual sustainability problems. Potential solutions must address what Özbekhan (1970: 13) calls the 'meta-system of problems' or the *problématique*, which consists of interlinked, non-segregable sets of complex problems that are 'highly confused, overlapping, and often blurred' (Özbekhan 1977: 526). Schmandt (2006: 2352) refers to 'complex problem clusters' that arise from multiple, cumulative and interactive natural and social stresses. Global change is a multidimensional *problématique*. Various 'syndromes of global change' emerge in different regions of the world as a result of society–nature interactions. Each syndrome represents a characteristic pattern or cluster of core sustainability problems and symptoms of unsustainable development associated with human activities and environmental changes (Schellnhuber *et al.* 1997; Hurni *et al.* 2004; Lüdeke *et al.* 2004).

There is a growing recognition that developing solutions to such interwoven, messy and seemingly intractable clusters of sustainability problems depends on our ability – as scientists, policy makers, managers and other stakeholders – to understand the dynamics of SES. Among other things, this means understanding (1) the interplay between social and ecological processes across different spatial–temporal scales; and (2) the interplay between the processes of development, disturbance, reorganisation and persistence in CAS in general (Kauffman 1993; Gell-Mann 1994, 1995; Holland 1992a [1975], 1992b, 1995, 2012; Levin 1998, 1999, 2003, 2005, 2010a; Holling 2001; Lansing 2003; Miller and Page 2007) and SES in particular (Gallopín *et al.* 1989; Gallopín 1991; Berkes and Folke 1998b; Levin *et al.* 1998, 2013; Westley *et al.* 2002; Berkes *et al.* 2003a; Folke 2006; Norberg and Cumming 2008). However, understanding is only part of the task. Sustainability also depends on our collective ability and willingness to govern (i.e. control, steer, manage or otherwise purposefully influence) the dynamics of SES.

4.3 Governance for sustainability

In the words of Adger and Jordan (2009a): 'the crisis of unsustainability is, first and foremost, a crisis of *governance*' (p. xvii, emphasis in original). Conventional incrementalist (Biermann *et al.* 2012: 57), command and control (Holling and

Meffe 1996) and neoliberal (Heynen *et al.* 2007) approaches to governing human–environment relations have met with varying degrees of success or failure in terms of their effectiveness in solving sustainability problems (Young 2011). Sustainability-oriented institutional frameworks, governance systems and systems linking knowledge to action have generally struggled to address the challenges posed by complex social–ecological dynamics. In other words, they lack the ability to deal with rapid, interconnected and multiscale changes in SES (Duit *et al.* 2010: 363).

New governance challenges emerge from the intersections and interactions between global social change and global environmental change: changes that occur along key dimensions of globalisation.[44] Governance must deal with the emerging complexity and synergistic effects resulting from these and other dynamics of globalisation. This includes dealing with multiple interacting social–ecological crises involving financial volatility, economic insecurity, food price inflation, food insecurity, climate change and climate-induced shocks (Sachs 2008). The synergistic effects of interacting crises exacerbate the global scale impact on society (Parenti 2011; Homer-Dixon *et al.* 2015). Governance must also deal with the possibility of contagion, cascading effects and other types of dynamic interactions that occur across scales and levels. The challenges posed by these complex cross-scale dynamics are augmented by large zones of uncertainty surrounding the precise position of possible thresholds, and by insufficient knowledge of their dynamics (Rockström *et al.* 2009: 3-4; Galaz *et al.* 2012a: 81). Issues of scale, levels of organisation and cross-scale dynamics are discussed in Chapter 2.

The processes of globalisation are accompanied by widespread rescaling of territorial governance (Swyngedouw 2004; Gualini 2006) associated with an increasingly complex and fragmented governance landscape (Andonova and Mitchell 2010: 272; Stead 2014). For example, complexity may arise from the

[44] Young *et al.* (2006a: 308-311) identify four analytical dimensions of contemporary globalisation: (1) the multiplication and intensification of connections between components; (2) the acceleration of global processes and interactions; (3) the stretching of human activities and key social processes across spatial boundaries and up to the global scale; and (4) declining diversity due to homogenisation.

inclusion of greater numbers and different types of actors and institutions. This, together with high degrees of institutional fragmentation, poses yet another set of challenges to governance for sustainability and sustainable development (Biermann *et al.* 2009; Folke *et al.* 2011a: 730; van Asselt 2011; Galaz *et al.* 2012b). Consequently, there is an urgent need for innovative governance architectures.

4.4 Governance architecture

Governance requires architecture. Bearing in mind the maxim that 'governance cannot be designed, it can only be designed for' (paraphrasing Wenger 1998)[45] – in this thesis, I use the term 'architecture' in a normative sense to convey the notion that governance (however it is defined) is more than just a governing process or institutional framework for decision making and policy implementation. Environmental governance and governance for sustainable development, including ocean and coastal governance, require architectures that are context based, visionary, integrative, function oriented and experimentalist. I will elaborate on these aspects of governance architecture below.

Context based

It is generally accepted that context matters in governance (Griffin 2012: 216). On the one hand, governance may be partially decoupled from its context. At higher levels of conceptual abstraction it is possible to make generalisations and identify broadly applicable principles of governance that are largely independent of context. Take, for example, the six Lisbon principles developed by Costanza *et al.* (1998) as a core set of guidelines for sustainable governance of the oceans;[46] or the suite of eight good governance principles for sustainable natural resource management (NRM) developed by Lockwood *et al.* (2010).[47]

[45] The original text by social learning theorist Etienne Wenger (1998: 229) is: 'Learning cannot be designed: it can only be designed for – that is, facilitated or frustrated.'
[46] The Lisbon principles of sustainable ocean governance are: responsibility, scale-matching, precaution, adaptive management, full cost allocation and participation.
[47] The NRM governance principles are: legitimacy, transparency, accountability, inclusiveness, fairness, integration, capability and adaptability.

On the other hand, many elements of governance are context dependent and reflexive: the context shapes decision making, which shapes the context (Dietz and Henry 2008; Torfing *et al.* 2012: Chapter 5). Governance is influenced by a variety of endogenous (internal) and exogenous (external) factors associated with specific circumstances, events, locations, and spatial–temporal scales. Governance outcomes are generally shaped by a mix of interacting political, institutional, economic, social, cultural, technological, environmental, ecological and historical factors. These factors are dynamic and thus contexts change over time. For example, de Vivero and Mateos (2004: 185) discuss how ocean governance is confronted with new contextual factors concerning maritime safety and security in addition to traditional economic ones such as access to marine natural resources. Furthermore, governance usually takes place in the context of uncertainty, a lack of information and incomplete knowledge concerning local variations and complex cross-scale dynamics (Grunwald 2007; Voß *et al.* 2007: 196-198).

Visionary

The production of sustainability-oriented governance requires vision. According to the Oxford Dictionary (2015), vision is 'the ability to think about or plan the future with imagination or wisdom' or 'a mental image of what the future will or could be like'. In other words, vision is forethought or foresight. In this thesis, I use the term 'vision' in two ways. First, in the sense of envisioning common aspirations and strategic goals in the area of 'governance for sustainability'. Second, in the sense of reflecting on the 'sustainability of governance'. Both are essential, as 'without sustainable governance there cannot be successful development' (Wiener 2002: 144). The first sense refers to governance actors forming a collective image (e.g. a vision of human security, well-being and sustainable development) to guide a social transition towards sustainability (NRC 1999a). However, I am more interested in the second sense, in which governance deliberately confronts its own image with the benefit of hindsight. This notion, which stems from Beck's (1992) thesis of reflexive modernisation, refers to situations in which actors with a role in 'reflexive' (Voß *et al.* 2006a) and 'deliberative' (Bäckstrand *et al.* 2010a) modes of governance are continuously engaged in developing individual and collective competencies, including

- self-awareness, self-understanding and self-critical reflection about governance, the unintended consequences of previous attempts to steer social development, and possible alternatives (Stirling 2006: 227; Voß *et al.* 2006b: 421);
- systemic and long-term thinking (Grothmann and Siebenhüner 2012: 302); and
- social learning which, in addition to the importance of multi-actor, multilevel and multi-loop learning processes (Armitage *et al.* 2008: 88-89; Berkes 2009: 1697; Pahl-Wostl 2009; Löf 2010), emphasises the need for collaboration between actors and some form of organisation to facilitate and sustain collaborative activities (Mostert *et al.* 2007: 1).

Another important reflexive deliberative competence is 'creative destruction' (Schumpeter 1994 [1942]: 82-85) which, in this instance, refers to a coupled process of vision deconstruction and reconstruction. For example, a participatory foresight process may involve 'a deconstruction of implicit visions and expectations and a conjoint reconstruction of various alternative, but more explicit and coherent views on the future' (Truffer *et al.* 2008: 1361).

Integrative

Achieving the normative goals of sustainable development requires a governance approach that is broadly integrative (Gilek *et al.* 2015). That is, an approach to systemic coherence that involves multi-actor collaboration to coordinate, integrate (combine) and reconcile disparate aspects of the 'system-to-be-governed', its 'governing system' and their 'governance interactions' (Kooiman *et al.* 2005, 2008: 3; Jentoft 2007; Kooiman 2008: 173. See subsection 4.4.2).

Proceeding from the assumption that integration is beneficial, desirable, achievable and, therefore, justified (see Box 4.1); to be effective, governance architecture must accommodate different types and degrees of integration according to the specific social–ecological context. Here, 'integration' is understood to mean a medium to long-term process, or set of processes, leading to a more holistic and coherent entity (i.e. an integrated outcome). Fundamentally, integration entails harmonising the economic, social and environmental dimensions of development in order to achieve sustainability (Drexhage and Murphy 2010; UNGA 2012: Annex para. 3). This is tantamount to integrating different worldviews (van Kerkhoff 2005: 457). For the most part, however, integrative approaches to governance seek better coordination and integration both within and across substantive areas of interest. For example, a sustainable development strategy may (hypothetically) promote policy coordination across national and regional jurisdictions, different economic sectors, multiple levels of decision making, nested spatial scales, and short and long-term time frames. At the same time, it may promote the integration of environmental policy objectives into various social and economic sectoral policies, scientific advice into decision making, while also attempting to integrate different types of knowledge, balance stakeholder interests and foster territorial cohesion (Brown 2009a). Notions of integrative governance and integrated governance architecture are clearly anything but simple. In addition, integration may not always be necessary, desirable or possible to achieve, as outlined in Box 4.1.

Box 4.1 Integration: not always necessary or desirable

Integration is widely perceived as a *sine qua non* for sustainable development and for governance in general. Integrated approaches are increasingly presented as superior ways to consider the environment in policy and decision making (Scrase and Sheate 2002: 275). This is usually for valid reasons. As Lyall and Tait (2005) state:

> 'Demands for more integrated approaches are driven by the increasing realisation that policies often deliver much less than is expected or intended, because of counter-productive interactions among the key actors, or because the policies arising from different sectors of the policy environment conflict with one another' (p. 9).

Such demands come with 'an underlying sense that integration can only be for the good' (Scrase and Sheate 2002: 290). Furthermore, despite the implicit assumption that they are conducive to integration, the mechanisms through which integration may promote sustainable development are often unclear (Owens and Cowell 2002: 64-65). However, as Scrase and Sheate (2002: 275) warn, if used in an uncritical way, assertions about integration and integrated approaches could become a hindrance to good practice and could undermine efforts directed towards sustainability. This leads to some areas of concern. On the one hand, integration appears to be

> ‘the desire by some practitioners to re-exert an apparent ‘objectivity’ over more value-based decision-making, abetted by some politicians who would rather be able to say their decisions are based on scientific advice than make difficult political decisions’ (Scrase and Sheate 2002: 291).

Integration at this level may be achieved by applying more complex and technical methodologies such as computer modelling. On the other hand, some forms of integration are highly normative and value laden. For example, the integrated sustainability appraisal process presents results in a format (explicit trade-off options) conducive to politically-determined decision making (trade-off choices) in accordance with agreed sustainable development objectives. The concern is that integration of information may produce distortion through overcomplication or oversimplification, even before decision makers introduce value judgements and trade-offs (Scrase and Sheate 2002: 291).

There are also concerns relating to participants, power and influence. Democratic, participatory architectures for planning, management and governance need to accommodate multiple actors. A tendency towards integration may disguise the fact that there are multiple conflicting goals that do not generally complement each other (Stead and Meijers 2009: 328). In other words, integration is challenged by some interests or stakeholders in opposition to others. Integration may not be perceived by some to be in their best interest, resulting in arguments in defence of the *status quo* and against (additional) integration. Power differentials and other asymmetries mean that relatively powerful (sectoral) interests may argue that more integration is not necessary (e.g. problems can be managed without integrating a wider range of interests); the costs of integration outweigh the benefits; there are limits to the desirability of integration or limits to how much integration can be achieved in practice; or otherwise seek conditionality on integration. Scrase and Sheate (2002) advise against viewing integration unreflectively as a panacea or shortcut to sustainable development. Owens and Cowell (2002) consider it important to ask: 'Who is being asked to integrate what, with whom and how, and what conceptions of sustainable development are different parties being invited to share?' (p. 65).

Integration is not a question of either/or. For Olsen and Christie (2000), with regard to coastal management, it is rather a case of selecting the appropriate degree of (sectoral) integration to suit the circumstances. They consider one important lesson to emerge from worldwide experience in coastal management is that – from a pragmatic, political and operational point of view – 'more integration is not always better than less integration' (Olsen and Christie 2000: 7). Regarding the need for integrated resource and environmental management, Ewert *et al.* (2004) state: 'An integrated approach is best used where there are complex problems and a need can be established amongst stakeholders that there is value in coordinating interests' (p. 74).

Whether or not integration is considered necessary or desirable, or even possible, as Scrase and Sheate (2002) state: 'Far from providing a panacea, integration would appear to create as many challenges as it might resolve in seeking to achieve more sustainable development' (p. 275).

It is generally assumed that a more integrated (as opposed to fragmented) architecture for sustainability governance is advantageous or even necessary. As pointed out by Adger and Jordan (2009b: 16), the origin of this assumption can be traced back to *Our Common Future*, the Brundtland Commission report (WCED 1987a). Since the Second World War, international relations have experienced a proliferation of institutions, resulting in a densely populated, overlapping and fragmented institutional and legal framework (Raustiala 2013). Indeed, reform of the institutional framework for sustainable development was a major theme at the 2012 UNCSD (Rio+20).

A state of fragmentation (alternatively referred to as 'institutional diversity', 'decentralisation' or 'polycentricity') is considered by Biermann *et al.* (2009) to be a ubiquitous structural characteristic of present-day global (environmental) governance architectures: 'All global governance architectures are fragmented to some degree; that is, they consist of distinct parts that are hardly ever fully interlinked and integrated' (Biermann *et al.* 2009: 17). The degree of institutional fragmentation varies considerably across policy domains[48] and their respective architectures (Zelli and van Asselt 2013: 3-4). Nevertheless, the relative benefits and drawbacks of different types and degrees of fragmentation remain contested; different strands of academic literature identify a variety of potential consequences (Biermann *et al.* 2009: 14-15; Biermann 2010: 286; Zürn and Faude 2013: 126).

Moreover, it is worth noting that many scholars have hitherto focused on fragmentation and overlap at the global and international levels of governance. However, this argument also applies to the supranational, transnational macro-regional, national, subnational regional and local levels; levels at which governance fragmentation has a more distinctly spatial implication (Balsiger 2012: 59).

Function oriented

Effective governance rests on the performance of multiple overlapping governance functions by different actors at different levels, and the coordination of their activities (Haas *et al.* 2004: 266). Therefore, the design of organisational structures, institutional arrangements, governing processes and policy instruments – the form governance takes – needs to reflect and respond to the dynamic pattern of key governance functions in each specific context.

[48] Burstein (1991) defines a policy domain as 'a component of the political system that is organized around substantive issues' (p. 328).

Regardless of specific governance functions, it can be said that governance architecture will generally reflect functionality in the given context. At first glance, architect Louis Sullivan's (1918 [1896]) dictum that 'form follows function'[49] would seem to apply to the goal of good design for governance. This is the design principle that the actual or intended use or purpose of something should determine its form, structure or organisation. In other words, design as an expression of function. Alternatively, there is architect Frank Lloyd Wright's (2005 [1943]) integrative notion that 'form and function are one' (p. 146) in the sense that they 'become one in design and execution' (p. 338). That is, function neither necessarily precedes nor follows form: design as an integrated whole.

Nevertheless, design for governance is unlikely to be based on purely functional criteria; it is nearly always subject to a variety of preconceived ideas, models, conventions and constraints about what constitutes ideal structures, institutions and processes for governance (see subsection 4.4.1). As Juda (1999) observes with regard to the design and development of architecture for ocean governance systems,

> 'there is an existing governance status quo and not a blank slate on which to draw. The best developed plans and schemes will remain unimplemented if they do not take into account political realities' (p. 98).

Le Corbusier (2007 [1928]) wrote that structural 'architecture is a "matter of relationships," a "pure creation of the mind."' (p. 97). In this constructivist/ constructionist sense, governance architecture may be described as a strategic interrelationship between form and function that is mediated through power and knowledge.

Experimentalist

Clearly, governance can be understood primarily in functional rather than structural or institutional terms. It then follows that governance functions, taken

[49] Sullivan's (1918 [1896]) dictum was originally stated as 'form ever follows function' (p. 208) to capture his belief that building design should follow this natural law.

either individually or as a set, can be performed by different combinations of public and private actors through various organisational and institutional structures, governing processes and policy instruments. This architectural flexibility is one of the defining features of pragmatic or experimentalist forms of governance (de Búrca 2003: 814; Sabel and Zeitlin 2008: 274, 2012a: 170; Zeitlin 2011a: 188-191; Overdevest and Zeitlin 2014: 25).

Zeitlin (2011b) defines experimentalist governance as 'a recursive process of provisional goal-setting and revision based on learning from the comparison of alternative approaches to advancing them in different contexts' (p. 5).[50] In the EU, United States of America (USA), Canada and elsewhere, different forms of experimentalist governance have emerged and proliferated across different sectoral policy domains and institutional settings (see de Búrca and Scott 2006; Sabel and Zeitlin 2010). This emergence can be understood as 'a widespread response to a secular increase of environmental volatility and complexity in the global economy over the past three decades' (Zeitlin 2011a: 188).

In its most developed form, experimentalist governance architecture is dynamic, participatory, multilevel and cross-sectoral. Based mainly on the work of Sabel and Zeitlin (Sabel and Zeitlin 2008: 273-274, 2012a: 169-170, 2012b: 411; Zeitlin 2005: 224, 2011a: 190, 2011b: 6; Overdevest and Zeitlin 2014: 4 & 25), such an architecture is composed of four interdependent elements organised as an iterative cycle, as follows:

1. *Participatory goal setting*. Broad framework goals (e.g. 'sustainable fisheries' or 'good environmental status of marine waters') and metrics for gauging their achievement are provisionally established by some combination of higher level or central units (e.g. European Commission or other supranational EU political institution) and lower level or local units (e.g. government departments or regulatory agencies, and the actors with whom

[50] In the experimentalist governance literature, the term 'recursive' is used in the sense that 'the output from one application of a procedure or sequence of operations becomes the input for the next, so that iteration of the same process produces changing results' (Sabel and Zeitlin 2012a: 169).

they collaborate, in EU member states) in consultation with relevant stakeholders.

2. *Decentralised experimentation with alternative implementation approaches*. Local units and actors are given broad discretion to achieve the agreed framework goals in their own way (in accordance with the principle of subsidiarity in EU law).
3. *Performance monitoring, information pooling and comparative review*. As a condition of the considerable degree of autonomy afforded to them, local units and actors are required to: monitor and report regularly on their performance against agreed indicators; pool and share information; participate in peer review to compare results of local experimentation with alternative approaches pursued by other units and actors; and, if adequate progress is not being made, respond by taking appropriate corrective measures, 'informed by the experience of their peers' (Zeitlin 2011b: 6).
4. *Revision and reorganisation*. The framework goals and metrics, and the procedures for making and implementing rules and decisions are periodically revised. This involves a widening circle of participating actors, who propose measures for self-correction and improvement in response to problems and possibilities revealed by the review process; and the cycle is repeated.

Governance processes organised according to the principles outlined above are experimentalist because they

> 'systematically provoke doubt about their own assumptions and practices; treat all solutions as incomplete and corrigible; and produce an ongoing, reciprocal readjustment of ends and means through comparison of different approaches to advancing common general aims' (Sabel and Zeitlin 2012a: 170).

4.4.1 No blank slates or panaceas

The design of architecture for governance of sustainability does not, of course, start with a blank slate. A complex state of affairs exists in most policy domains, both in Europe and elsewhere. Therefore, any 'new' governance approach has to deal with an existing governance landscape that is complex, dynamic and contested; an evolving social, cultural, political, administrative and economic arena replete with multiple state and non-state actors, policies, institutions, organisational structures, programmes and procedures. The current governance landscape plays two important but contrasting roles: it simultaneously constitutes a constraining and enabling environment.

There is no single blueprint for the design of architecture for sustainability governance. Social–ecological contexts and governance landscapes are inherently complex, dynamic and interactive. Therefore, efforts to apply single or universal solutions (so-called 'panaceas') to the governance of human–environment interactions are seldom effective, often fail and may even be counterproductive (Tucker 2010: 698-699; Johnson *et al.* 2012; Pahl-Wostl *et al.* 2012: 25). Yet there remains a strong tendency among researchers, policy makers and other governance actors to prescribe and apply panaceas; for example, when a simplistic model of SES dynamics, or an optimal institutional design, or a single style of governance is applied generically to a variety of social–ecological contexts. However, panaceas do not address the diversity, complexity, dynamics or context specificity of social–ecological problems. This is recognised by a growing number of scholars concerned with sustainability and the governance of SES (Ostrom 2007; Ostrom *et al.* 2007; Kofinas 2009: 100; Ostrom and Cox 2010; Glavovic 2013a: 915, 2013b: 936).

Ostrom (2011-2012: 21) states that overcoming the 'panacea trap' is one of the primary challenges in achieving sustainability. I have endeavoured in this thesis to avoid falling into such a trap. Accordingly, I have sought neither to create nor recommend a single architectural blueprint for the governance of diverse SES across different European maritime regions. Nevertheless, I still require a set of general principles for governance upon which to build a conceptual architecture for governance. For this, I have chosen the interactive governance approach as a starting point.

4.4.2 Interactive governance perspective

Approaches to sustainability governance involve more than just effective processes and structures for performing key governance functions. The design and development of governance architecture must consider the whole governance system: its contextual boundaries, diverse components, and their complex relationships and dynamic interactions across scales and levels (see Jentoft and Chuenpagdee 2009: 557-559). One theoretical perspective that takes into account the diversity, complexity, dynamics and scale of governance systems is the social-political or interactive governance approach, as proposed by Kooiman (1993a, 1993b) and developed by Kooiman (1999, 2003) and (Kooiman *et al.* 2005, 2008) in regard to fisheries governance.

Central to the interactive governance perspective is the notion that the processes of governing a social, sociopolitical or SES occur mainly in the interactions between multiple actors at multiple levels of the system. Therefore, governance is the totality of the governing interactions taken to solve social problems and create social opportunities; governance includes the formulation and application of principles guiding those interactions and care for the institutions that enable them (Kooiman 2003: 5; Kooiman and Bavinck 2005: 17). In the governance-as-interaction perspective, governance architecture is based on the integral relationship between three analytical components: the system-to-be-governed, governing system and the governance interactions between them (Jentoft 2007; Kooiman *et al.* 2008: 3; Kooiman 2008: 173, 2010: 74-84). The system-to-be-governed is a SES (e.g. fisheries system). The governing system is a social system in its own right, comprising institutions and steering mechanisms (Jentoft 2007). The governance interactions reflect the diversity, dynamics and complexity of the social–ecological context in which governance takes place.

In the interactive governance approach, governance is conceptually divided into three main categories of attributes: elements, modes and orders of governance (Kooiman 2003: 29-189; Kooiman and Bavinck 2005: 19-22; Kooiman 2008:

179-181; Kooiman *et al.* 2008: 6-8; Kooiman and Jentoft 2009: 820-827). These are further divided into subcategories, summarised as follows:

> *Elements of governance* as an intentional activity. The three elements are the guiding 'images' or the how and why of governance (e.g. visions, models, knowledge, assumptions, judgements, beliefs and goals); intermediate 'instruments' that link images to actions (e.g. information, advice and regulations); and 'actions' that put governing instruments into effect (e.g. policy implementation and mobilising actors).
>
> *Modes of governance*, that is, the context-specific styles and structural configurations of governance. The interactive governance perspective recognises three ideal modes or styles of governance.[51] Modern governance of social sectors usually involves mixes of these three structural elements: 'self-governance', which refers to situations in which actors take care of themselves, outside the purview of government; 'co-governance', which is characterised by horizontal interactions (such as cooperation, coordination and communication) between social actors, without the dominance of a single centre of authority; and 'hierarchical governance', which refers to the classical top-down style of intervention involving steering and control of social dynamics using instruments such as policies and laws.
>
> *Orders of governance*. Three basic and closely-related orders of governance activity are recognised: 'First-order governance' deals with day-to-day activities (e.g. decision making) that take place wherever people and their organisations interact to identify, formulate and solve social problems, create opportunities and perform other governing tasks. 'Second-order governance' focuses on the design and maintenance of the institutional arrangements within which first-order governance takes place; that is, arrangements regarding the institutions applied by first-order actors to make decisions. 'Third-order' or 'meta-governance', which refers to the normative principles

[51] 'Modes' or 'styles' of governance refers to the distinct, context-specific ways in which governance occurs; that is, the particular configurations or patterns of interactive relationships, institutional arrangements and governance practices required to perform the function of governing.

governing the governance system and its interactions with the system-to-be-governed. Meta-governance refers to a coherent and explicit set of values, norms and principles that underpin decision making and responsibilities within the governance system. In other words, meta-governance can be considered 'the mortar that binds all attributes of governance and makes it a whole' (Kooiman and Jentoft 2009: 824).

To these main categories can be added:

Governance functions. For example, problem framing and problem solving, creating opportunities, decision making, social learning, and the design and maintenance of institutions that fit the context and match the scale of the problem.

Attention now turns to the European maritime dimension (section 4.5) and maritime macro-regional context (section 4.6).

4.5 European maritime dimension

This thesis is primarily concerned with the maritime dimension of sustainability and sustainable development in the European context. I use the term 'maritime' to mean the linked marine and coastal dimensions of a SES and its components, regardless of scale or location. Europe's relationship with the oceans and seas is longstanding, complex and dynamic (see François and Isaacs 2001). Throughout history this maritime relationship, for better or worse, has been fundamental in shaping the economic, social, cultural and political structures and identities of Europe and other continents (Smith 1992; Phillips 2008; Sicking and Abreu-Ferreira 2009).

European maritime economy and blue growth

The oceans, seas and coasts have been the setting for human economic activities for millennia. A great deal of Europe's accumulated economic wealth and power derives from the maritime dimension. Furthermore, according to Eurostat (2016), in 2011, 40.8% (or 205 million people) of the EU population lived in coastal regions which covered 40.0% of the then EU-27 territory. Clearly, the maritime economy[52] is extremely important for the EU.

At the time of writing this thesis, EU policy towards the maritime economy continues to be dominated by the aftermath of the 2007–2009 global financial and economic crisis. More precisely, dominated by EU-level efforts to coordinate a political response to the crisis and deal with the knock-on effects in Europe, for example, the sovereign debt, banking, eurozone, political and democratic crises, and their economic and social impacts on Europe's citizens. This is the context in which the European Commission is actively promoting 'blue growth': sustainable economic growth and employment derived from the oceans, seas and coastal areas.

The European Commission's Blue Growth strategy (European Commission 2012e) provides the maritime dimension of the Commission's Europe 2020 strategy for sustainable growth of the European economy. Delivering long-term economic growth and employment is a priority objective under the EU's Integrated Maritime Policy, which is coordinated by the European Commission's Directorate-General for Maritime Affairs and Fisheries (DG MARE).

According to a 2012 study by Ecorys *et al.* on 'blue growth' in the EU, economic activities associated with the oceans, seas and coastal regions[53] were, in 2010, contributing an estimated gross value added[54] of €488 billion[55] annually to the European economy. These activities supported an estimated 5.4 million jobs. This

[52] 'The maritime economy consists of all the sectoral and cross-sectoral economic activities related to the oceans, seas and coasts. While these activities are often geographically specific, this definition also includes the closest direct and indirect supporting activities necessary for the functioning of the maritime economic sectors. These activities can be located anywhere, also in landlocked countries' (Ecorys *et al.* 2012: 26).

[53] In 2010, of the EU's 1,342 NUTS 3 level regions, 446 were coastal regions (Eurostat 2016).

[54] Gross value added is defined as output value at basic prices less intermediate consumption valued at purchasers' prices. Gross value added is calculated before consumption of fixed capital. Source: Eurostat, http://ec.europa.eu/eurostat/web/main [accessed 20/5/2016].

[55] More specifically, a total GVA of €488.5 billion comprising (by major maritime function): maritime transport and shipbuilding €182.9 billion (37%); coastal tourism €159 billion (32%); energy and raw materials €124 billion (26%); food, nutrition, health and ecosystem services €10.6 billion (2%); maritime monitoring and surveillance €8 billion (2%); and coastal protection €4 billion (1%). Source: Ecorys *et al.* 2012.

was forecast to increase to an estimated gross value added of €590 billion annually and 7 million jobs by 2020. The Blue Growth study, performed for DG MARE, defined a set of 27 maritime economic activities and focused on 11 activities seen as essential for Europe's maritime economy now and into the future. These are grouped by Ecorys *et al.* according to life cycle stage as follows:

Mature economic activities: 'the bedrock of blue growth'

- Short-sea shipping
- Offshore oil and gas
- Coastal tourism and recreation (e.g. yachting)
- Coastal protection

Growth-stage: 'creating new jobs now'

- Marine aquaculture
- Renewable energy from offshore wind power
- Cruise shipping including port facilities
- Maritime monitoring and surveillance

Pre-development stage: 'investing in the jobs for tomorrow'

- Marine research and technologies including marine biotechnology
- Ocean renewable energy from tidal and wave power
- Marine (seabed) minerals mining

The European Commission's Blue Growth strategy rests on: (1) comprehensive and robust analysis of Europe's maritime sectors and their economic value chains; and (2) foresight assessment of the future growth potential of promising economic activities and possible policy options to support them (Ecorys *et al.* 2012). The Blue Growth strategy aims to remove regulatory barriers and other obstacles to growth (e.g. knowledge gaps, spatial use conflicts and skills shortages) and establish institutional and financial conditions conducive to sustainable growth and employment across all sectors and borders of the European maritime economy (Barroso 2012a). The strategy pays special attention to supporting innovation and the development of established and emerging activities judged to have the greatest potential to serve Europe's future needs (European Commission 2014a).[56]

Under EU law (EU 2011), the political ambition to maximise the contribution of the maritime economy to European economic recovery and growth must be reconciled with the obligation to maximise the sustainable development and social cohesion of member states (EU 2011: Article 1).[57] Therefore, the EU's strategic objective of blue growth must accommodate the EU's political commitment to meet the challenges of sustainable development, as set out in the renewed EU Sustainable Development Strategy (Council of the EU 2006).[58] Reconciling economic, social and environmental/ecological dimensions of sustainable development is, in my opinion, the fundamental challenge facing the contemporary EU policy and governance landscape regarding maritime affairs.

It is a policy landscape shaped by two Directorates-General of the European Commission: DG MARE and the Directorate-General for Environment (DG ENV) which, since 2014, are both under the political responsibility of Karmenu Vella, EU Commissioner for Environment, Maritime Affairs and Fisheries. The key marine and coastal related policy instruments are the EU's Integrated Maritime Policy (subsection 4.5.1), Blue Growth strategy (see above), Maritime Spatial Planning Directive (subsection 4.5.2), Sea Basin strategies (e.g. the Atlantic Strategy and Action Plan; see section 4.6) and reformed Common Fisheries Policy (subsection 4.5.3), which fall under the remit of DG MARE; and the Marine Strategy Framework Directive (subsection 4.5.4), Integrated Coastal Zone Management approach, Water Framework Directive and Biodiversity Policy

[56] The European Commission identifies five 'blue growth focus areas': offshore renewable 'blue' energy; aquaculture; maritime, coastal and cruise tourism; marine mineral resources; and blue biotechnology (European Commission 2012e: 6-12). These areas of the maritime economy economy are singled out for further analysis, policy making and specific initiatives at EU level because they are considered to have the greatest potential for sustainable growth and job creation, in line with the Europe 2020 strategy objectives (Barroso 2012a; Damanaki 2013a).

[57] Article 1 of Regulation (EU) No 1255/2011 states: 'The Union's Integrated Maritime Policy ('IMP') shall foster coordinated and coherent decision-making to maximise the sustainable development, economic growth and social cohesion of Member States, in particular with regard to coastal, insular and outermost regions in the Union, as well as maritime sectors, through coherent maritime-related policies and relevant international cooperation.'

[58] The renewed EU Sustainable Development Strategy is 'a framework for a long-term vision of sustainability in which economic growth, social cohesion and environmental protection go hand in hand and are mutually supporting' (European Commission 2009b: 2).

(including the Biodiversity Strategy, Habitats and Birds Directives, and Natura 2000 ecological network), which are under the responsibility of DG ENV.

4.5.1 Integrated Maritime Policy

Contemporary notions about the sustainable development of the European maritime economy are inseparable from the EU's Integrated Maritime Policy (IMP). The IMP is a political instrument for achieving the sustainable development of oceans, seas, coastal regions and maritime sectors (European Commission 2007a). It provides a coherent policy framework for a new intersectoral approach to the EU's internal (member states and regions) and external (international) sea-related relationships and activities. In other words, it provides an EU-wide strategic and integrated approach to maritime affairs. In this sense, an integrated approach is a basic tool for policy making and implementation across different sectors, governance levels and borders (European Commission 2008a: 3). The primary aim of the IMP is to change the way Maritime Europe deals with its marine and coastal assets. It does this by promoting a holistic perspective, improved cooperation and coordination, an integrated governance framework and the cross-cutting policy tools needed for joined-up policy making at different decision-making levels (European Commission 2007a).

Evolution of the IMP

The idea of the IMP emerged in 2004. The European Commission set the strategic objective of establishing 'an all-embracing maritime policy aimed at developing a thriving maritime economy and the full potential of sea-based activity in an environmentally sustainable manner' (European Commission 2005a: 9). President of the European Commission (2004–2014) José Manuel Barroso and Commissioner for fisheries and maritime affairs (2004–2010) Joe Borg outlined their rationale for a future EU maritime policy in a joint Communication (European Commission 2005b). It emphasised the great economic and social importance of the oceans and seas, and vital importance of protecting the marine environment and using and managing marine resources in a sustainable manner.

The Communication made a case for a comprehensive and holistic approach to maritime affairs, and for policy intervention at EU level. It also laid out the framework for a Commission consultative document or Green Paper on a future EU maritime policy (European Commission 2006a). The Green Paper, titled *Towards a future Maritime Policy for the Union: A European vision for the oceans and seas*, represented the first concrete step towards the development of the IMP. Among other things, it identified better multilevel governance in maritime affairs as a key target for policy intervention at the EU level.

The Green Paper advocated the need for a European maritime policy that is 'integrated, inter-sectoral and multidisciplinary, and not a mere collection of vertical sectoral policies' (European Commission 2006a: 5). The core message was that a systematic approach is needed that explores the overlaps, interactions and interdependencies between different sectoral activities and policy domains; and how sectoral interests and policies can be combined horizontally to complement each other and create synergies. To achieve this and avoid fragmented decision making, it is necessary to increase cooperation and promote effective coordination and integration of sea-related policies at all levels of governance from local, regional, national and EU to international (European Commission 2006a: 5).

The Green Paper stated that the EU maritime policy should rest on twin pillars. First, the Lisbon Strategy to stimulate economic growth, competitiveness and employment in the EU (2000–2010, succeeded by the Europe 2020 strategy). Second, an ecosystem-based approach to management, built on scientific knowledge, to maintain and improve the status of ocean resources upon which all maritime activities are based (European Commission 2006a: 5). Regarding the latter, the Thematic Strategy on the Protection and Conservation of the Marine Environment (European Commission 2005c) and subsequent proposal (European Commission 2005d) that led to the adoption of the Marine Strategy Framework Directive (MSFD; EU 2008) paved the way towards greater protection for Europe's marine ecosystems. The MSFD constitutes the environmental pillar of the IMP.

Subsequently, in October 2007, the Commission published its revised vision and proposal for the IMP in a Communication titled *An Integrated Maritime Policy for the European Union*, the so-called ‘Blue Book’ (European Commission 2007a). Accompanying the Blue Book was an Action Plan for the first programme of work towards implementing the IMP (European Commission 2007c). With the Blue Book, the Commission proposed an integrated, intersectoral approach to sea-related policy making, maritime governance and sea-use management; an approach covering all aspects of Europe’s relationship with the oceans and seas.

The IMP became official EU policy with the endorsement of the Blue Book and accompanying Action Plan by the European Council on 14 December 2007 (Council of the European Union 2008a: para. 58) and by the European Parliament on 20 May 2008 (European Parliament 2008a). Since then, there have been two progress reports on the IMP (the first in October 2009, the second in September 2012) summarising the main achievements and charting further development and implementation actions.

Aims and objectives of the IMP

According to the website of DG MARE (European Commission 2015b), the IMP seeks to provide a more coherent approach to maritime issues, with increased coordination between different policy areas. In doing so, it focuses on issues (e.g. blue growth) that do not fall under a single sector-based policy, and issues (e.g. marine knowledge) that require the coordination of different sectors and actors. This follows the rationale of the IMP as a policy framework and procedural approach to ‘coordinating existing sectoral approaches and creating new initiatives in areas only where a genuine cross-sectoral approach is needed’ (European Commission 2007d: 27).

The overarching objectives in developing and implementing the IMP are to change the way policy is made and decisions are taken, and to develop and deliver a programme of work (i.e. the Action Plan). These objectives are based on the clear recognition that all sea-related matters are interlinked, and that sea-related policies must develop in a joined-up manner if sustainable maritime development is to be realised (European Commission 2007b: 2). In addition to the overarching objectives, the IMP seeks to achieve a set of specific strategic objectives and actions (European Commission 2007a, 2007c, 2007d, 2009a, 2010a, 2010c, 2010d; EU 2011):

Integrated maritime governance. To develop and implement integrated maritime governance at all levels of decision making (EU institutions, member states and regions), including making governance more inclusive and cooperative. To do this by promoting integrated approaches to maritime governance within member states and coastal regions, identifying and exploiting policy synergies between sectors, and improving stakeholder involvement in maritime governance on every level. Essentially, to build a multi-actor, multilevel governance framework for maritime policy structures within member states and coastal regions (see Committee of the Regions 2012: 14). Below, I elaborate on a new European approach to maritime governance.

Sea basin strategies. To develop and implement integrated sea basin strategies tailored to the macro-regional needs and specificities of each of Europe's transnational sea basins (Adriatic and Ionian Seas, Arctic Ocean, Atlantic Ocean, Baltic Sea, Black Sea, Mediterranean Sea, and North Sea). To lay the foundations of sea basin strategies by providing better information, identifying legal options for achieving basin objectives, assessing the economic, social and environmental impact of these options, and monitoring progress in implementing strategy action plans (European Commission 2010a: 5). I elaborate on macro-regional sea basin strategies in section 4.6.

Cross-cutting tools for integrated policy making. To develop and implement planning and management tools that cut across sea and coast-related sectoral policies and support joined-up policy making. Such tools include: a common information sharing environment and European network for maritime surveillance; maritime spatial planning and integrated coastal zone management (ICZM), which together provide a fundamental planning framework for ecosystem-based management and sustainable development of transboundary marine areas and coastal regions; and building a comprehensive and publicly accessible high-quality marine data and knowledge base, and associated infrastructure, necessary to enable the implementation of integrated policies. (See subsection 4.5.2 for further elaboration of MSP and ICZM.)

Boundaries of sustainability. To promote the protection of the marine environment, in particular its biodiversity, and sustainable use of marine and coastal resources; and to define the boundaries of sustainability of human activities that have an impact on the marine environment, paying due attention to their cumulative impacts; and to do so 'in the framework of the Marine Strategy Framework Directive, which constitutes the environmental pillar of the IMP, as well as the Water Framework Directive' (EU 2011: 3). To achieve this through actions supporting implementation of the MSFD such as coordination between the different marine regions in implementing the ecosystem approach.

International dimension. To promote the international dimension of the IMP and 'work towards more efficient international governance of maritime affairs and effective enforcement of international maritime law' (European Commission 2007a: 13). To do this by improving and fostering external dialogue, cooperation, and coordination of integrated cross-sectoral actions with third countries, including those bordering a European sea basin, or actors in third countries, as well as with partners and organisations in key international fora, in relation to the objectives of the IMP.

Maritime economy. To renew the focus on sustainable economic growth, employment and innovation in Europe's maritime sectors and coastal regions, thereby meeting the objectives set out in the Europe 2020 strategy for smart, sustainable and inclusive growth. To accomplish this by supporting joined-up policy making and actions promoting the sustainable use of marine and coastal resources, with the aim of developing a thriving maritime economy and fulfilling the growth and employment potential of sea-based activity.

Maritime Europe. To raise the profile of Maritime Europe in terms of achieving greater awareness of the maritime dimension, the opportunities it offers, and the state of the marine environment. To achieve this by promoting and facilitating the sharing and dissemination of maritime information; enabling stakeholders to debate on maritime governance and sectoral policy issues of common interest, and to disseminate information on their activities and best practices to wider audience; clarifying the spatial dimension of EU policies with an impact on the oceans, seas and coasts; and developing the identities of individual sea basins.

Through developing and implementing these objectives and action, the European Commission's IMP forms a significant part of the new European context of governance for maritime sustainability and sustainable development.

A new European approach to maritime governance

The IMP forms a significant part of the new European context of governance for maritime sustainability and sustainable development. The current EU Regulation on the European Maritime and Fisheries Fund (EMFF) includes the objective to 'foster the development and implementation of integrated governance of maritime and coastal affairs' (EU 2014b: Article 82(a)). This includes by 'promoting actions which encourage Member States and their regions to develop, introduce or implement integrated maritime governance' (Article 82(a)(i)). Here, it is worth noting that the European Commission originally envisaged actions to foster integrated maritime governance 'at all levels' (European Commission 2010d: 9), that is, 'at local, regional, national, sea basin, EU and international level' (European Commission 2011a: 72).

Regardless of the nuances arising from differences between supranational and national level political views, the Europeanisation of maritime policy requires a significant rethinking of how to approach maritime governance. The existing maritime governance situation has in general been unsatisfactory. This was acknowledged from the start by European Commission (2005a). As the European Commission states in its June 2008 Communication titled *Guidelines for an*

Integrated Approach to Maritime Policy: Towards best practice in integrated maritime governance and stakeholder consultation:

> 'In Europe, maritime affairs have traditionally been dealt with by a number of separate sectoral policies. Such compartmentalisation of maritime governance continues to predominate the different levels of power at international, European, national, regional and local levels' (European Commission 2008a: 6).

Furthermore, the expertise and capacity needed to deal with the multiple challenges of maritime affairs are spread between numerous public and private actors at these different levels of governance. Therefore, a coherent and more integrated framework for governance of the oceans, seas, coastal regions and maritime sectors is needed if the full potential of the IMP is to be achieved. Such a framework must facilitate enhanced cooperation between policy makers and closer coordination of decision making and action taken at different levels of government. It must also facilitate the widespread adoption of a holistic and integrated approach at every level of government, by all actors and stakeholders involved, and across sectoral activities and the science–policy interface (European Commission 2008a).

In the European Commission's view, the responsibility for developing and applying an integrated, cross-sectoral approach to governance of maritime affairs is shared by EU institutions, member states and coastal regions (European Commission 2009a: 11). In addition, stakeholder involvement in maritime policy making should be incorporated more permanently into governance structures; in turn, this should lead to a more intense dialogue and cooperation on cross-cutting maritime issues among decision makers, experts and other stakeholders at EU, member state, regional and sea basin level (European Commission 2009a, 2010d). Consequently, the Commission set out guidelines aimed at encouraging member states and other actors to introduce an integrated approach to maritime affairs and stakeholder consultation within their governance frameworks at national, regional and local levels (European Commission 2008a). This guidance is based on common elements observed in integrated approaches to maritime affairs existing or emerging in the EU and elsewhere (European Commission 2009c).

4.5.2 Maritime spatial planning

Multiple uses of the sea and the growing demand for the limited resource of marine space can lead to (1) competing claims between different sectors (e.g. between sea fisheries and marine aquaculture installations or between offshore renewable energy production and maritime shipping lanes) and (2) increasing competition between sectors and environmental/ecological interests (e.g. between coastal and marine tourism and marine biodiversity conservation). In addition to competition and ambiguities caused by poor planning in general, the current situation is exacerbated by single-sector[59] marine zoning (if zoning exists at all) such as no-take zones/reserves (marine protected areas for biodiversity conservation) that exclude commercial and recreational fishing sector activities (Klein *et al.* 2010).

The 1982 United Nations Convention on the Law of the Sea (UNCLOS) states in its preamble[60] that the problems of ocean space are closely interrelated and need to be considered as a whole. Planning of marine space is a logical way to structure the rights and obligations of EU member states and a practical tool to assist in the management of this (EU 2014c). Marine or maritime spatial planning (MSP)[61] has rapidly become the most commonly endorsed management regime for sustainable development in the marine environment (Flannery *et al.* 2016: 121). It is a subactivity of the overall planning activity of sea use management (Douvere and Ehler 2009). The sea use management toolkit includes, *inter alia*:

[59] There are basically two ways of managing marine space: single-sector management (i.e. one economic sector or human activity at a time) or integrated management (i.e. across multiple sectors, activities, agencies or levels of organisation).

[60] http://www.un.org/depts/los/convention_agreements/texts/unclos/preamble.htm [accessed 24/5/2016].

[61] The terms ‘maritime spatial planning’ and ‘marine spatial planning’, both abbreviated to MSP, are both used in the literature. There is no appreciable difference in meaning. The European Commission (2008b: 2) favours ‘maritime’ over ‘marine’ spatial planning to underline the holistic cross-sectoral approach of the process. Other authors use ‘marine’ spatial planning (e.g. Douvere 2008, Ehler and Douvere 2009) to emphasise planning is ultimately bound by the environmental limits of the marine system (Gilbert *et al.* 2014). Given the IMP-dominated context of this thesis, I use ‘maritime spatial planning’.

- Ecosystem-based integrated management
- Maritime spatial planning
- Comprehensive ocean zoning (applying MSP to specific places, separating incompatible uses and protecting vulnerable ecosystems from particular threats)
- Regulatory mechanisms (policies and laws set limits; licensing and permits allow activity)
- Codes of conduct
- Certifications (e.g. Marine Stewardship Council)
- Economic incentives
- Decision support (including geographic information and decision support systems)

Clear spatial and temporal allocations of three-dimensional space in the marine environment can help avoid conflicts between different, potentially competing uses (or non-uses) and integrate human activities into an ecosystem approach (Douvere 2008; Douvere and Ehler 2009). As Ehler and Douvere (2009) remind us, ‘we can only plan and manage human activities in marine areas, not marine ecosystems or components of ecosystems’ (p. 18). The EU (2014c) directive establishing a framework for MSP obliges member states – in keeping with the objectives of the MSFD – to apply an ecosystem-based approach to MSP in order to ‘promote the sustainable growth of maritime economies, the sustainable development of marine areas and the sustainable use of marine resources’ (p. 137). In addition, the MSP Directive requires an ecosystem-based approach to be adapted to the specific ecosystems and other specificities of the different marine regions.

EU MSP

The IMP (European Commission 2007a) identifies MSP as a key cross-cutting policy tool for improved decision-making and furthering the objectives of integrated policy making (including implementing the Blue Growth strategy). The MSP Directive (EU 2014c) requires member states to, in a transparent way, plan (in consultation with stakeholders, authorities and the public), establish and implement maritime spatial plans that take into account various anthropogenic pressures and land-sea interactions, and which apply a transboundary approach.[62]

MSP is a process of analysing the spatial and temporal distribution of human activities in marine areas and allocating parts of three-dimensional marine space (or ecosystems) to specific uses, to achieve ecological, economic and social objectives that are usually specified through a political process (Ehler and Douvere 2009: 18; UNESCO 2016). In this regard, the European Commission (2010f) considers MSP to be

> 'a process for planning and regulating all human uses of the sea, which also sets out to protect the marine ecosystems in which these activities take place and safeguard marine biodiversity' (p. 6).

MSP is designed to promote the rational organisation and multipurpose use of the sea by balancing sectoral interests and using marine space more efficiently, thereby contributing to sustainable development. MSP provides a framework for arbitrating between competing human activities and managing their impact on the marine environment (European Commission 2008b). In addition, MSP 'should provide enhanced legal certainty to those who are developing activities at sea' (European Commission 2010f: 6). Indeed, the European Commission's emphasis is on the role of MSP in creating new opportunities for economic 'blue growth' and job creation in Europe by providing greater confidence and certainty for investors, equal opportunities for all maritime sectors and environmental sustainability (European Commission 2010f; EU 2014c).

The MSP Directive provides an EU-wide framework for MSP. Member states remain responsible for designing and determining the format and content of maritime spatial plans within their marine waters (EU 2014c). To ensure consistency and legal clarity, the directive requires member states to design the

[62] For effective cross-border cooperation, member states are obliged to consult and coordinate their maritime spatial plans with relevant member states and cooperate with third-country authorities in the marine region concerned (EU 2014c: 138).

geographical scope of MSP to conform with existing EU legislative instruments and international maritime law, in particular UNCLOS. The MSP Directive promotes synergy (and, where relevant, coordination of timelines) with the aims of other EU directives including the MSFD, Water Framework Directive, Birds Directive and Habitats Directive); the CFP reform framework regulation on the conservation and sustainable exploitation of fisheries resources (Council Regulation 2371/2002); various European Commission communications (e.g. the EU Strategy on adaptation to climate change[63]); as well as with the relevant aims of EU regional policy 'including the sea-basin and macro-regional strategies' (EU 2014c: 137).

EU ICZM

The European Commission (2013a) communication that led to the MSP Directive had consisted of a proposal to establish a framework for both MSP and integrated coastal management or ICZM. According to the EU-funded Mare Nostrum (2014) project, the intention was to require member states to prepare ICZM strategies for coastal planning and management in addition to the maritime spatial plans. However, the adopted directive text (EU 2014c) contained only the MSP component, along with a general stipulation that member states' MSP processes 'should take into account land-sea interactions' (pp. 136 and 138). The European Commission's press release of 17 April 2014[64] made no explicit mention of the fate of the original ICZM component of the directive. Mare Nostrum (2014) explains the reasoning as follows:

> 'According to Mare Nostrum Project Head Prof. Rachelle Alterman, the ability of member states to reach an agreement on an ICZM directive has been in doubt for some time, since under the European Union's existing legal structures, policy areas such as land-use planning, property rights and building permits are under the authority of member states alone, with little intervention by the EU. The willingness to change that is apparently not yet ripe, she added.

[63] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: An EU Strategy on adaptation to climate change. COM(2013) 216 final, 16/4/2013. Brussels: European Commission.
[64] http://europa.eu/rapid/press-release_IP-14-459_en.htm

> Pablo Gorostiza Frieyro of Spain's Port Institute for Studies and Cooperation in the Valencian Region (FEPORTS), a Mare Nostrum partner, said that opposition to EU legislation on coastal management had come mainly from the regional level. He pointed to a position paper published last year by the Committee of the Regions, a group that represents the interests of regional and local governments in the EU legislative process, which argued that a directive on ICZM would impinge upon regional and local governments' spatial planning powers.'

Meanwhile, the EU Recommendation on ICZM (EU 2002a) and the EU-ratified Protocol to the Barcelona Convention on ICZM in the Mediterranean (EU 2009) remain the principle guidance to member states regarding integrated coastal planning and management for sustainable coastal development. As Mare Nostrum (2014) point out, such norms are largely flexible and provide plenty of room for local discretion; there are no direct mechanisms to enforce implementation of coastal management strategies as there would have been under the European Commission's intended coherent framework directive for MSP and ICZM for improving land-sea interface planning and management. The MSP Directive merely states that MSP 'should aim to integrate the maritime dimension of some coastal uses or activities and their impacts' (p. 138). Nevertheless, the text is clear that the MSP Directive

> 'does not interfere with Member States' competence for town and country planning, including any terrestrial or land spatial planning system used to plan how land and coastal zone should be used. If Member States apply terrestrial planning to coastal waters or parts thereof, this Directive should not apply to those waters' (EU 2014c: 138).

4.5.3 Common Fisheries Policy

Fisheries, aquaculture and seafood processing are important 'blue growth' sectors of the European maritime economy. The Common Fisheries Policy (CFP) is the EU umbrella framework and set of rules[65] for managing European fishing fleets and for conserving fish stocks. The CFP is designed to manage a common resource, give all European fishing fleets equal access to EU waters and fishing grounds, and allow EU fishermen to compete fairly (European Commission 2016a). CFP regulations apply directly to members states and do not require incorporation into domestic legislation.

2002 CFP reform

Since its inception in 1983, the CFP has been reformed three times: in 1992, 2002 and 2013. (For a comprehensive history of CFP enlargement and reforms, see the book *The Common Fisheries Policy: The Quest for Sustainability* by Ernesto Penas Lado (2016) Director for Policy Development and Coordination at DG MARE.) Due to the political environment at the time, the first reform (1992) was limited in its ambition and scope (Penas Lado 2016: 292). The next round of (2002) reform was focused on introducing a more coherent fisheries management system. Following several years of reflection (e.g. Sissenwine and Symes 2007), consultations with key stakeholders and months of negotiations between fisheries ministers, in December 2002 the Council reached agreement on CFP legislative reforms, including the new basic regulation for the conservation and sustainable exploitation of fisheries resources (Regulation (EC) No 2371/2002).

The 2002 reform sought to ensure that the European fishing industry remains viable and does not threaten fish stock size and productivity over the long term. It did this by combining traditional fisheries management tools (catch limits and technical measures such as gear restrictions) with new ones (particularly fishing effort limits such as limiting the days a vessel can operate at sea); and combining

[65] As of 11 June 2016, the CFP has 1208 pieces of legislation (mainly regulations and decisions) of which 1075 concern the conservation of resources. Source: EUR-Lex, http://eur-lex.europa.eu/search.html?displayProfile=allRelAllConsDocProfile&qid=1465637668029&type=named&CC_1_CODED=04&name=browse-by:legislation-in-force&CC_2_CODED=0410 [accessed 11/6/2016].

these with a new fleet policy setting national fishing sleet capacity (in terms of total power and gross tonnage) ceilings to ensure a balance between fishing effort and resource availability; and with a more selective use of public funds (economic incentives) to support, rather than undermine, the development of the fisheries sector and diversification in coastal communities. The reformed CFP would move towards a longer-term perspective on fisheries management by introducing multi-annual recovery and management plans for fish stocks. These would reduce the risk of stock collapse, while moving away from the political yearly negotiations ('horse trading') on catch limits.

The other main changes of the 2002 reform included an increased commitment to ensuring the integration of environmental concerns into fisheries management, and increased stakeholder involvement by establishing the Regional Advisory Councils (RAC) (IEEP 2003; European Commission 2009g). The creation of stakeholder-led RAC (or Advisory Councils as they are called since the 2013 reform[66]) afforded representatives of the fishing industry (including fishers, ship owners, producer organisations, processors, traders and market organisations) a greater say in decisions affecting them.[67]

Framework Regulation (EC) No 2371/2002 required exploitation under the CFP to be based on sound scientific advice and the precautionary approach to fisheries management.[68] Furthermore, member states were required to minimise the impact of fishing activities on marine ecosystems and progressively implement an ecosystem-based approach to fisheries management (EU 2002b: 61). In other words, the 2002 reform realigned EU fisheries policy, shifting the emphasis from a narrow preoccupation with fish stock management towards a more holistic or

[66] See http://ec.europa.eu/fisheries/partners/advisory-councils/index_en.htm

[67] The main task of the Advisory Councils is to provide the European Commission, other EU institutions and respective member states with recommendations and advice on fisheries management and sustainable development of the fisheries and aquaculture sectors in their specific regions. 60% of the available seats in each Advisory Council are allocated to representatives of the fisheries sector from the region. 40% is allocated to other interest groups, including fisheries management scientists, representatives of other sectors related to fisheries and aquaculture, regional and national authorities, environmental organisations, consumers and recreational or sport fishermen.

[68] The 'precautionary approach to fisheries management' means that the absence of adequate scientific information should not be used as a reason for postponing or failing to take management measures to conserve target species, associated or dependent species and non-target species and their environment (EU 2002b: 61).

ecosystem-based approach that includes sustainable use of both resources and the supporting marine ecosystems of which fish are a part (Pope and Symes 2000: 2).

However, the objectives agreed in 2002 to achieve sustainable fisheries were not met. Despite improvements, serious problems including overfishing, fleet overcapacity, heavy subsidies, low economic resilience and declining fish catches remained. Other environmental problems were not addressed adequately, including bycatch and discards. As the European Commission (2009g) concluded, 'The current CFP has not worked well enough to prevent those problems' (p. 5).

2013 CFP reform

In 2009 the European Commission published a Green Paper (European Commission 2009g) and launched a public consultation beginning a new round of reform of the CFP.[69] The Commission proposed undertaking fundamental reform to reverse the current situation: 'This must not be yet another piecemeal, incremental reform but a sea change cutting to the core reasons behind the vicious circle in which Europe's fisheries have been trapped in recent decades' (European Commission 2009g: 5). The third reform would seek to integrate new principles of fisheries management, such as the ecosystem-based approach and the principle of maximum sustainable yield (MSY), into the rules governing EU fisheries in the 21st century.

In 2011 the European Commission presented a package of CFP reform proposals, including a new fund for the EU's maritime and fisheries policies for the period 2014-2020: the European Maritime and Fisheries Fund (EMFF).[70] After a long debate, the new framework regulation (Regulation (EU) No 1380/2013) was adopted by the Council and European Parliament in December 2013 (EU 2013). The new EU fisheries regime should ensure that fishing and aquaculture sector activities are managed in a way that is consistent with long-term environmental, economic and social sustainability. The new CFP came into effect from 1 January 2014. Key elements of the new policy and their intentions (European Commission 2013c; European Parliament 2016) include:

[69] See http://ec.europa.eu/fisheries/reform/index_en.htm
[70] See http://ec.europa.eu/fisheries/reform/proposals/index_en.htm

Multi-annual ecosystem-based management to reinforce the role that in the previous reform had been given to multi-annual management plans, but also to take a more ecosystem-based approach, moving from single-species stock plans to multi-species stock and fisheries management plans. EU fisheries management will be governed by the ecosystem approach and the precautionary approach to ensure that the impacts of fishing activities on marine ecosystems are limited; this will safeguard resources and maximise long-term yields. Stocks will also be managed by annual fishing opportunities fixed by the Council, and other conservation and technical measures which are part of the toolbox of instruments.

Maximum sustainable yield (MSY). Fishing sustainably means fishing at levels that do not endanger the reproduction of stocks while at the same time maximising long-term catches for fishermen. Under the new CFP stocks must be exploited at sustainable levels, defined as the highest catch that can be safely taken year after year and which maintains the fish population size at maximum productivity: a level known as 'MSY'. This MSY objective is set out in UNCLOS and was confirmed at the 2002 World Summit on Sustainable Development. The new CFP will set fishing levels at MSY levels by 2015 where possible, and at the latest by 2020 for all fish stocks.

Banning discards. The unacceptable practice of discarding (the practice of throwing unwanted fish overboard) will be progressively phased out in all EU fisheries between 2015 and 2019. Fishermen will be obliged to land all the regulated commercial species that they catch. Residual catches of under-sized fish cannot in general be sold for human consumption. This ban will lead to more reliable data on fish stocks, support better management and improve resource efficiency. It is also an incentive for fishermen to avoid unwanted catches by means of technical solutions such as more selective fishing gear.

Management of fishing fleet capacity. Member states have to adjust their fishing fleet capacity so that it is in balance with the fishing opportunities.

Member states must draw up plans for reducing capacities whenever an overcapacity develops in any segment of the fleet. Failure to do so may result in suspension of EMFF funding.

Support for small-scale fisheries. Small-scale coastal fisheries often play an important role in the social fabric and cultural identity of many of Europe's coastal regions. Therefore, they require specific technical and financial support. The new CFP extends to 2022 the right of member states to restrict fishing in a zone within 12 nautical miles of the coastline. The EMFF will include measures beneficial to small-scale fisheries and which help local economies and coastal communities adapt to changes. In addition, recommendations are to be made to member states regarding a differentiated regime to protect small-scale coastal fleets; that is, to allocate them a greater share of quotas given their low environmental impact and high labour intensity (European Commission 2009g).

Developing sustainable aquaculture. The new CFP will provide an improved framework for aquaculture to increase production and supply of seafood in the EU, reduce dependence on imported fish, and boost growth in coastal and rural areas. This will be done through national plans to remove administrative barriers and uphold environmental, social and economic standards for the aquaculture sector. A new stakeholder-led Aquaculture Advisory Council is being established to give advice on industry-related issues.[71]

Improving scientific knowledge. New obligations require member states to reinforce the role of science in supporting sound management decisions by increasing the collection of data and sharing of information on stocks, fleets and the impact of fishing activities at sea-basin level.

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[71] See http://ec.europa.eu/newsroom/mare/itemdetail.cfm?item_id=29290 [accessed 11/6/2016]. NB. At the time of writing, the Aquaculture Advisory Council had appointed an interim chairman (Mr Jean-Claude Cueff) and was working to establish a structure and engage representatives; see http://ec.europa.eu/fisheries/news_and_events/events/20160524/doc/cueff_en.pdf [accessed 11/6/2016].

Decentralised governance. The new CFP aims to achieve more decentralised governance by bringing the decision procedure closer to the fishing grounds. It promises to end micro-management from Brussels so that EU legislators will only define the general framework, basic principles and standards, overall targets, performance indicators and timeframes. Member states will be responsible for cooperating at regional level to develop the actual implementing measures.

4.5.4 Marine Strategy Framework Directive

EU Coastal and Marine Policy is the responsibility of DG ENV rather than DG MARE, which has responsibility for the IMP. Both policies are to some extent united under the umbrella of a single EU Commissioner for Environment, Maritime Affairs and Fisheries. According to DG ENV, EU legislation to protect Europe's marine and coastal environments has been progressively implemented in many relevant areas, including through the CFP and Water Framework Directive (WFD). However,

> 'these pieces of legislation, although crucial complementary tools to the protection of marine waters, contribute to the protection of the sea only from specific pressures resulting in a fragmented and sectoral approach' (European Commission 2016b).

For this reason, the European Commission has pursued two instruments: the EU Recommendation on ICZM[72] (in conjunction with the MSP Directive; see subsection 4.5.2) and the European Marine Strategy. Together, these offer a comprehensive and integrated approach to the protection of European coasts and marine waters (European Commission 2016b).

[72] The EU Recommendation on ICZM (2002/413/EC) defines the principles of sound coastal planning and management to be taken into account by member states when formulating their national strategies.

European Marine Strategy

In the EU Sixth Environment Action Programme (6th EAP 2002-2012) member states committed themselves to halt the loss of biodiversity before 2010 and to develop a thematic strategy for the protection and the conservation of the European marine environment. In 2002 the European Commission DG ENV outlined its vision for the development of a European Marine Strategy to protect and conserve the marine environment (European Commission 2002). Following a lengthy stakeholder consultation[73] there was broad support for the notion that the strategy should be based on the following criteria (see European Commission 2006b):

- A holistic and integrated approach that addresses all human uses impacting on the marine environment, rather than through a sector-by-sector approach.
- A common vision and general approach regarding strategic goals and objectives for all sea areas in view of seeking common solutions for common and/or transboundary problems.
- A regional approach recognising specific regional contexts, problems and priorities and an ecosystem approach to the management of all human activities having an impact on the marine environment. Together, these should take into account the regional specificity and ecological diversity of different seas and their subregions (including marine ecoregions), their quality status, specific pressures and threats acting on sea regions, the political, social and economic situations in different regions, and the role of international institutional arrangements, including regional seas conventions (e.g. OSPAR and HELCOM).
- A dual EU/regional approach involving setting at EU level common cooperation approaches among member states and third countries bordering EU oceans and seas (particularly in devising marine strategies) while leaving planning, implementation and management of measures to the regional level (taking into account the diversity of conditions, problems and needs of marine regions and subregions requiring tailor-made solutions).

[73] This involved two major stakeholder conferences (in Køge, Denmark in December 2002 then in Rotterdam, The Netherlands in November 2004) and follow-up Internet consultation (March-May 2005).

- A sustained long-term political commitment to implement the European Marine Strategy.

It was widely acknowledged at the time that the European Marine Strategy did not propose the means to develop a fully coherent marine policy covering all uses of the marine environment; and that a new multilevel governance approach and management structure, including a regional stakeholder platform, was needed to deliver truly sustainable development in the marine environment. Developing proposals for this purpose was beyond the mandate of the 6th EAP and required initiatives within the broader framework of the then future IMP under the remit of DG MARE (EU Presidency 2002a, 2002b; European Commission 2004, 2006).

MSFD

In 2005 the European Commission simultaneously published two key documents that paved the way towards greater protection for Europe's marine biodiversity and marine ecosystems. One was the Thematic Strategy on the Protection and Conservation of the Marine Environment (European Commission 2005c). The other was a proposal for a directive (European Commission 2005d) that subsequently led to the adoption of the Marine Strategy Framework Directive (MSFD).

The MSFD on the protection and conservation of the marine environment (EU 2008) came into force in 2008. It represents the environmental pillar of the IMP and a framework for achieving the sustainable use of marine waters and conservation of marine ecosystems and natural resources. It sets the stage for future development of IMP (Juda 2010). The MSFD is the most important legislative instrument at EU level to implement the ecosystem approach in the European seas and oceans. The overarching goal of the MSFD is for member states to put in place the necessary measures that will achieve or maintain 'good environmental status' (GES) of the EU's marine environment at the level of marine regions or subregions by 2020 at the latest (EU 2008).[74] In order to

[74] GES has to be determined at the level of the marine region or subregion on the basis of 11 qualitative descriptors: biological diversity; non-indigenous species; populations of all commercially exploited fish and shellfish; elements of marine food webs; anthropogenic

achieve this target, each member state is required to develop and implement a strategy for its marine waters, to be reviewed every 6 years.[75] Due to the transboundary nature of the marine environment, member states sharing a marine region or subregion are encouraged to cooperate with relevant neighbouring states and third countries to ensure the coordinated development and implementation of marine strategies.[76] Furthermore,

> 'Where practical and appropriate, existing institutional structures established in marine regions or subregions, in particular Regional Sea Conventions, should be used to ensure such coordination' (EU 2008: 20).

Without affecting member states' jurisdictions, the MSFD extends the EU maritime space and identity seaward from the coastal zone by designating spatial subdivisions of Europe's marine environment for planning and management purposes. The directive establishes European marine regions and subregions within the geographical boundaries of existing regional seas conventions.[77] These transnational marine regions and subregions are determined mainly on the basis of oceanographic and biogeographic ecoregion features (ICES 2004).

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eutrophication; sea floor integrity; alteration of hydrographical conditions; concentrations of contaminants; contaminants in fish and other seafood for human consumption; marine litter; and introduction of energy, including underwater noise (EU 2008: Annex I). Furthermore, the Commission Decision 2010/477/EU on criteria and methodological standards on GES of marine waters contains a number of criteria and associated indicators for assessing GES.

[75] For further details of the marine strategy development and implementation timeline see (1) http://mcc.jrc.ec.europa.eu/dev.py?N=12&O=16&titre_chap=About%20MSFD, (2) http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/marine-strategy-framework-directive/index_en.htm and (3) http://www.msfd.eu/knowseas/msfd.html.

[76] Successful implementation of the MSFD is vital. This involves many implementation challenges (see van Leeuwen *et al.* 2014), which are addressed through an informal programme of coordination, the Common Implementation Strategy, between the Commission and the member states (see http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/implementation/index_en.htm).

[77] The MSFD divides Europe's marine environment into four sea basin marine regions: Baltic Sea, North-East Atlantic Ocean, Mediterranean Sea, and Black Sea. The North-East Atlantic Ocean is subdivided into four marine subregions: Greater North Sea, including the Kattegat and English Channel; Celtic Seas; Bay of Biscay and Iberian Coast; and the Macronesian biogeographic region, being the waters surrounding the Azores, Madeira and the Canary Islands.

Interaction with other policies

According to Juda (2010, the MSFD highlights the need for cross-cutting coordination of present efforts to protect the marine environment with a host of other EU-wide policies such as the CFP, the Common Agricultural Policy and WFD as well as with relevant requirements of international agreements. In this sense, the MSFD is seen as 'a corrective reaction to the failures associated with earlier sectoral policies taken on a compartmentalized basis that have addressed particular marine uses' (Juda 2010: 38). In other words, the MSFD should not be seen as an end in itself, but rather another step in an ongoing process of policy evolution.

In relation to EU water policy, the MSFD complements the landward vision of the WFD (EU 2000) for the protection of inland surface waters, transitional waters, coastal waters and groundwater. The WFD is coupled to, but not truly integrated with, the MSFD (Cinnirella *et al.* 2014; European Commission 2016c). It is intended to improve water quality in river catchments (Borja *et al.* 2010). The WFD provides general, normative environmental quality standards for the management and use of freshwater and coastal water ecosystems. The overarching goal is to achieve 'good status' of all waters by 2015 (tying in with the goal of achieving GES under the MSFD).[78] Water management takes place on a river basin basis. Member states, EU candidate and European Economic Area countries are required to develop and implement river basin management plans in a cooperative and coordinated way, through a Common Implementation Strategy.

Regarding EU fisheries policy, Penas Lado (2016) states that the MSFD represents the opposite approach to the one implemented around the CFP:

> 'instead of an incremental process of gradual addition of new elements into the picture, the MSFD starts with the whole picture, and sets out to reach objectives in all areas that are relevant for the management of the marine ecosystem. Of course these differences are originated in the different starting point of the fisheries and environmental policies: for

[78] The second management cycle extends the implementation timetable to 2021 and the third cycle to 2027 (see http://ec.europa.eu/environment/water/water-framework/info/timetable_en.htm).

the CFP this is the fishing activity, for the MSFD it is the whole sustainability of the marine environment' (p. 244).

Nevertheless, despite these differences of approach, the MSFD and CFP should ideally fit seamlessly. The objective of keeping marine ecosystems healthy and productive to ensure sustainable exploitation 'is fully compatible with and conducive to the achievement of the objectives of the CFP' (p. 244). The MSFD also enshrines the principle of regionalisation, based on the need to act jointly at the level of sea basins, in a way that anticipates the regionalisation of the CFP (Penas Lado 2016).

Following the 2013 reform, the new basic CFP regulation (EU 2013) stresses that the CFP should be coherent with EU environmental legislation and contribute to the protection of the marine environment, sustainable management of all commercially exploited species and, in particular, the objective of achieving GES by 2020 as set out in the MSFD. The new CFP regulation requires member states to implement the ecosystem approach in fisheries management (see subsection 4.5.3) to ensure that negative impacts of fishing activities on the marine ecosystem are minimised. Furthermore, it is appropriate that member states adopt conservation measures under the CFP in order to fulfil certain obligations imposed under the MSFD, that is, regarding marine protected areas (EU 2013: 24).[79] Penas Lado (2016: 242) states that the implementation of the MSFD will represent a new frontier in the implementation of the ecosystem approach not just in relation to fisheries policy but also in connection to all EU maritime policies.

4.5.5 Policy coherence and interaction

The evolving European maritime policy landscape is complex and interactive (Boyes and Elliott 2014). Different EU policies dealing with the sustainable use of the sea, conservation of marine resources and protection of the marine environment are not always entirely coherent. Approaches for implementing legal instruments are still far from being truly integrated among the member states.

[79] Likewise for special areas of conservation under the Habitats Directive and special protection areas under the Birds Directive.

Environmental policies in general, and marine policies in particular, have different priorities in different countries and mostly operate at different time scales (Cinnirella *et al.* 2014). In addition to maritime-specific instruments (including the IMP, CFP, MSFD and MSP Directive) there is also a body of legislation that is significant to how these policy areas are managed; for example, the WFD as it applies to coastal and transitional waters, the Habitats and Birds Directives, which provide for the protection and conservation of important habitats and species, the Bathing Water and Shellfish Water Directives, and directives for environmental impact assessment, strategic environmental assessment, environmental liability, and public access to environmental information (O'Mahony *et al.* 2014: 7). The following paragraphs illustrate the maritime policy landscape with some examples of coherence (or lack of) and interactions.

IMP and MSFD

In furtherance of the IMP, the EU adopted the MSFD in 2008. Both the IMP and MSFD instruments are aimed at governing the marine environment. The success of the IMP largely depends on whether marine habitats and resources can be lastingly protected from anthropogenic impacts (Salomon 2009: 365). The MSFD is intended to support the EU's position on halting biodiversity loss (Wakefield 2010).[80] Yet both the MSFD and IMP each have a differing signature in policy formulation and implementation (van Hoof and Tatenhove 2009). Regarding the emerging policy landscape for MSP in Europe, Qiu and Jones (2013: 186-187) identify differences in how the MSFD and IMP each address sustainability, resulting in two different approaches to MSP (Table 4.1).

[80] The MSFD is also intended to augment the obligation on member states to designate sites as part of the EU Natura 2000 network of protected areas for threatened species and habitats under the Birds Directive (2009/147/EC) and the Habitats Directive (92/43/EEC). The Birds Directive requires member states to establish special protection areas and the Habitats Directive requires special areas of conservation for other species and habitats. The MSFD requires member states to devise and implement spatial protection measures that contribute to coherent and representative networks of marine protected areas, 'adequately covering the diversity of the constituent ecosystems, such as special areas of conservation pursuant to the Habitats Directive, special protection areas pursuant to the Birds Directive, and marine protected areas as agreed by the Community or Member States concerned in the framework of international or regional agreements to which they are parties' (EU 2008: 29. Article 13).

Table 4.1 Comparison between the MSFD and the IMP.

	MSFD	**IMP**
Overarching aim	A framework for implementing an ecosystem-based approach	A framework for promoting maritime economic development and integrated management of different activities
Role of MSP	MSP as a mechanism for achieving ‘good environmental status’	MSP as a mechanism for balancing different uses of sea space
Role of MPAs	Conservation through MPAs at the core of its implementation	Conservation and MPAs as one of the uses of sea space
Legal power	Legally binding (Member States can be taken to the European Court of Justice for non-compliance)	Soft policy (no legal actions will be taken for non-compliance)
Authority	DG Environment	DG MARE
Approach to sustainability	Based on ‘hard’ sustainability	Based on ‘soft’ sustainability
Source: Qiu and Jones (2013: 187, Table 1)		

While the MSFD does provide for sustainable development, it does not explicitly promote economic development. In contrast, the IMP is primarily focused on delivering sustainable maritime economic development (i.e. blue growth). The MSFD provides for an ecosystem-based approach for achieving GES. In comparison, the IMP envisages MSP as an instrument for implementing an ecosystem-based approach (de Vivero and Mateos 2012; Qiu and Jones 2013). The MSFD is based on ‘hard’ sustainability in which MSP is more likely to be used as a preventive strategy to conserve ecosystem health. In contrast, the IMP is based on ‘soft’ sustainability in which MSP is more likely to be developed as an integrated use framework for balancing the needs of different sectors and ensuring that strong growth in certain maritime sectors does not lead to undesirable consequences for other sectors. ‘From an IMP perspective, ecosystem conservation is likely to be considered as one type of ‘sectoral’ use of marine space, which is considered in relation to other sectors’ (Qiu and Jones 2013: 187).

The fact that responsibility for oversight and implementation of each instrument falls under the aegis of one of two different European Commission departments (DG ENV and DG MARE) underlines the issue of potential tensions between the MSFD and IMP (Qiu and Jones 2013). There appears to be little connection between the two instruments, resulting in different interpretations of, for example, MSP. This has implications: with the coming into effect of the MSFD, a dual institutional course for MSP seems to be opening up in the EU, leading to uncertainty regarding the policy landscape for MSP in Europe (de Vivero and Mateos 2012; Qiu and Jones 2013).

MSFD and WFD

O'Mahony *et al.* (2014: 18) state that both the MSFD and the WFD incorporate certain common principles such as integration, an ecosystem-based approach and public participation. Table 4.2 summarises common and related aspects of both directives.

Table 4.2 Summary of common and related aspects for the MSFD and the WFD.

MSFD	**WFD**
Marine strategies	River basin management plans
6 year review cycle for marine strategies	6 year review cycle for management plans
Initial assessment and determination of Good environmental status and the environmental targets in 2012 plus every 6 years	Environmental and economic analyses
Monitoring 2014	Monitoring 2006
Measures 2015/16 plus every 6 years	Measures 2012/15 plus every 6 years
Good environmental status by 2020	Good ecological status by 2015
Source: O'Mahony *et al.* (2014: 18, Table 3-2)	

Both the MSFD and WFD work within an overarching management framework: river basin management plans created according to the WFD provisions and marine strategies created under the MSFD. Both directives have a regional approach and an ecosystem-based approach. The MSFD anticipates a degree of potential overlap in geographic application between the two directives; but the MSFD and WFD are intended to complement each other rather than contradict or result in a duplication of effort (O'Hagan 2013; O'Mahony *et al.* 2014). Nevertheless, the

> 'definition of coastal waters is complex and does not lend itself to easy interpretation or application with the result that it is routinely not applied in a way that includes coastal waters. This potentially results in a situation whereby neither the WFD nor the MSFD apply to coastal waters' (O'Hagan 2013: 89).

Similarly, problems may arise due to the absence of instructions on whether either the MSFD or WFD would take precedence in cases where marine and coastal ecosystem conservation objectives potentially overlap (O'Mahony *et al.* 2014).

CFP and IMP

From the fishing industry's perspective, the emergence of the MSFD and IMP present a change in institutional setting; major policy measures no longer descend from the CFP alone, but increasingly are derived from general environmental policy developments (van Hoof and van Tatenhove 2009). A major challenge for EU fisheries managers is the integration of fisheries management with broader marine management. This requires addressing tensions between different levels of scale of different frameworks and the specific characteristics of the policy arrangements. In particular, the CFP is traditionally the platform for the conservation of commercially exploited fish stocks; the MSFD is designed from an ecosystem conservation perspective in the tradition of directives already influencing the marine sphere such as the Habitats and Birds Directives and the WFD; whereas the IMP is a policy instrument that seeks integration over a number of different sectoral activities and policies, including the CFP and MSFD (van Hoof *et al.* 2012). As Wakefield (2010) puts it,

> 'Essentially, the IMP is designed to overcome the discordance between competing demands on the marine environment. No preference is given

to any one policy over another and it is anticipated that all will reach an accommodation under its terms' (p. 329).

The IMP is an attempt to establish an all-embracing European maritime policy (European Commission 2006a) that provides a coherent policy framework that allows for the optimal development of all sea-related activities in a sustainable manner (European Commission 2007a: 4). The first goal of the IMP is to create optimal conditions for the sustainable use of the oceans and seas, enabling the growth of maritime sectors and coastal regions (European Commission 2007a: 7). The IMP states that fisheries management must take greater account of the welfare of coastal communities, the marine environment and the interaction of fishing with other activities. It also promises that 'The recovery of fish stocks will be energetically pursued' (European Commission 2007a: 10). This requires sound scientific information and reinforcement of the shift to multi-annual planning. The IMP states that the European Commission will take action to ensure that the CFP reflects the ecosystem-based approach of the MSFD, and will work to eliminate illegal, unreported and unregulated fishing in EU waters and on the high seas. Furthermore, in line with the EU's international commitments, the IMP includes the target of managing fish stocks at MSY by 2015.

However, in an article predating the 2013 CFP reform, Wakefield (2010) considers the greatest impediment to an EU integrated approach to maritime affairs to be the failure to subject the CFP to the objectives of the IMP: 'Instead, all decisions concerning fisheries will continue to be made in accordance with the [CFP] Fisheries Regulation which demands exploitation of the fragile resource' (p. 323). Wakefield argues that, regardless of the IMP's worthy intentions towards fisheries management, 'the reality of implementation will be set by the harsh and relentless CFP' (p. 332). Essentially, within the CFP, fish are a resource open to exploitation by those engaged in the extraction industry, 'who have subjected it to rapacious stripping' (p. 332). Although the MSFD is put forward as the solution to the degradation of marine ecosystems and fish stocks, the prevailing values and principles of the CFP operate to undermine environmental innovation, including the IMP and MSFD (Wakefield 2010).

In order to overcome the five structural failings of the CFP (i.e. fleet overcapacity; imprecise policy objectives; short-term focus in decision making; a framework that does not give sufficient responsibility to the industry; and poor compliance by the industry and lack of political will to ensure compliance) identified by the European Commission (2009g: 8), it has been recognised at both international and European level that fisheries cannot be treated as a discrete sector (Wakefield 2010: 323). Efforts have been made through the MSFD to place the resource within its ecological setting and through the IMP to place fisheries in their wider context so that environmental and other interests are taken into account in maritime policy making. However, despite the reforms, rather than integrating the CFP with other maritime-specific policies, in accordance with the raison d'être of the IMP, fishing remains a discrete regime regulated by the CFP.

4.6 Maritime macro-regional approach

The geographical focus of this thesis is on the EU's transnational Atlantic Arc or Atlantic Area territory: a maritime macro-region encompassing Western Europe's Atlantic seaboard and adjacent North-East Atlantic Ocean space. In this thesis, the term 'macro-region' is used to distinguish the transnational regional (including large sea region or sea basin) level from the subnational regional level on geographic (spatial, social organisation, demographic) and jurisdictional (political authority, administration) scales.

EU macro-regions and macro-regional strategies

There is no definitive definition of what constitutes a transnational macro-region in the EU political context (see Dubois *et al.* 2009: 17-20). However, in EU cohesion and regional policy,[81] the ongoing debate about development of a macro-regional approach is often guided by the definition developed by the European Commission's Directorate-General for Regional and Urban Policy (DG REGIO) during preparation of the EU Strategy for the Baltic Sea Region: a macro-region is

[81] EU cohesion policy aims at strengthening economic, social and territorial cohesion by reducing disparities between the levels of development of the different regions and countries of the European Union. In this way the policy contributes positively to the overall economic performance of the EU. Source: DG REGIO, http://ec.europa.eu/regional_policy/en/policy/what/investment-policy/ [accessed 23/11/2015].

‘an area covering a number of administrative regions but with sufficient issues in common to justify a single strategic approach’ (European Commission 2009d: 5). An alternative definition can be found in a discussion paper by Paweł Samecki, the then European Commissioner responsible for regional policy, which lays out DG REGIO’s understanding of the macro-regional concept: a macro-region is ‘an area including territory from a number of different countries or regions associated with one or more common features or challenges’ (Samecki 2009: 1, original in bold).

Neither of the above definitions is explicit about the spatial scale of a macro-region nor where boundaries should be placed. However, the Samecki paper does add the qualification that: ‘in an EU context a macro-region will involve several regions in several countries but the number of Member States should be significantly fewer than in the Union as a whole’ (Samecki 2009: 1). Regarding boundaries, the Samecki paper states:

> ‘The regions should be defined so as to maximise the efficacy of the strategy. This may well mean flexible, even vague, definitions of the boundaries. However, the limits of the region should be less important than the advantages of participating in the strategy’ (p. 8).

The Samecki paper also notes that it is not essential that a macro-region’s boundaries be precisely defined. Instead, it is the commonality of features or challenges and the specific functions for which a macro-regional strategy is (to be) developed that count most. In other words, from the perspective of a place-based or territorial approach to policy making – as advocated by the Barca (2009) report concerning EU cohesion policy reform – the spatial extent of an EU macro-region depends on the functional scope of the strategy; clearly a case where ‘form follows function’ (Sullivan 1918 [1896]). The INTERACT Programme (2014) states that the functional idea behind EU macro-regional strategies

> ‘is to add value to interventions, whether by the EU, national or regional authorities or the third or private sectors, in a way that significantly strengthens the functioning of the macro-region. Moreover, by resolving

> issues in a relatively small group of countries and regions the way may be cleared for better cohesion at the level of the European Union.'

The macro-region concept is intimately linked with the notion of transnational territorial cohesion and cooperation. In this regard, Schymik (2011) provides a succinct definition: a macro-region is 'a greater region within the EU defined in terms of territory and function, in which a group of member states co-operate to achieve specific strategic goals' (p. 5). In a process largely driven by demand from regional actors and articulated through transnational actor networks, the macro-regional strategy has emerged as a promising approach for strengthening synergies between different EU policy areas and initiatives (European Commission 2009d).[82] Overall, the macro-regional approach aims to contribute to EU ambitions towards deeper political and economic integration and especially the EU's Europe 2020 strategy for the recovery and growth of the European economy (European Commission 2010a, 2010b). More specifically, the different macro-regional strategies aim to promote and facilitate closer territorial cooperation, improved coordination of policy actions, and an integrated approach towards achieving sustainable economic growth and a more balanced and harmonious development of the European territory. The objectives of individual macro-regional strategies vary according to the common challenges, opportunities and geographical specificities of each macro-region (European Commission 2010b, 2011a).

From the beginning, EU policy has been to develop macro-regional strategies based on the 'three no's' principle: no new EU financial resources should be mobilised, no new EU legislation should be adopted, and no new formal structures should be created at EU level (Samecki 2009; Council of the European Union 2011). Instead of creating new institutions for the governance and implementation of a macro-regional strategy, actors are expected to cooperate through existing

[82] The current definition of a macro-regional strategy adopted by DG REGIO is 'an integrated framework endorsed by the European Council, which may be supported by the European Structural and Investment Funds among others, to address common challenges faced by a defined geographical area relating to Member States and third countries located in the same geographical area which thereby benefit from strengthened cooperation contributing to achievement of economic, social and territorial cohesion.' Source: http://ec.europa.eu/regional_policy/en/policy/cooperation/macro-regional-strategies/ [accessed 23/11/2015].

structures within a framework of improved multilevel coordination of policies, instruments, priorities and actions, and closer synergies between existing authorities at all levels (European Commission 2010a).

To date, the EU (via the European Council) has endorsed territorial cooperation and development strategies for the Baltic Sea macro-region (European Commission 2009e), Danube macro-region (European Commission 2010e) and Adriatic and Ionian macro-region (European Commission 2014b). At the time of writing, another future EU macro-regional strategy is being developed for the Alpine macro-region (European Council 2013).[83] These four EU macro-regional strategies are being developed under the aegis of DG REGIO. Meanwhile, DG MARE is responsible for coordinating the development of transnational sea basin strategies for the Adriatic and Ionian Seas, Atlantic Ocean, Arctic Ocean, Black Sea, Mediterranean Sea, North Sea and seas around Europe's Outermost Regions.[84] It should be noted, however, that the Maritime Strategy for the Adriatic and Ionian Seas (European Commission 2012a) developed by DG MARE has been incorporated or subsumed into the EU Strategy for the Adriatic and Ionian Region (European Commission 2014b) developed by DG REGIO.

Regardless of whether they are predominantly terrestrial or maritime in their function, each of the above EU macro-regional strategies is focused on a geographically distinct macro-region that can be represented as a unique social–ecological system.

An evolving EU 'maritime' macro-regional approach

The importance of adopting a regional approach to Europe's maritime and coastal affairs was recognised by regional actors as long ago as the 1950s. Since 1973, the Conference of Peripheral Maritime Regions of Europe (CPMR) transnational actor network has been at the forefront in calling for the introduction of Europe-wide policies that promote and support equitable regional development (Wise 2000a, 2000b; Farthing and Carrière 2007). The CPMR and its various geographical commissions, including the Atlantic Arc Commission (AAC), have

[83] See http://ec.europa.eu/regional_policy/en/policy/cooperation/macro-regional-strategies/
[84] See http://ec.europa.eu/maritimeaffairs/policy/sea_basins/index_en.htm

been instrumental in advocating to EU institutions (1) the need for an overarching EU maritime policy to foster balanced, sustainable and cohesive social, economic and territorial (spatial) development of Europe's 'peripheral maritime regions'; and (2) that the structure of such an overarching policy, its governance arrangements and implementation actions should reflect the particular circumstances of each of Europe's major sea basins.

Arising from lobbying efforts by and consultations with key stakeholders such as the CPMR regarding the development of a European Marine Strategy, the European Commission began to incorporate a regional approach into the EU's institutional framework for sustainable development of the marine environment (EU Presidency 2002a, 2002b; European Commission 2004). The Thematic Strategy on the Protection and Conservation of the Marine Environment (European Commission 2005c) established a dual EU/regional approach as one of its key elements. In this approach, common strategies among EU member states and third countries bordering marine regions would be agreed at EU level. However, planning and implementation of measures would be left to the regional level; this would allow for taking into account the diversity of conditions, problems and needs of marine regions which require tailor-made solutions (European Commission 2005d: 5). Thus, the dual EU/regional approach towards developing and implementing strategies for the protection of the marine environment at the level of marine regions and subregions became central to the MSFD (EU 2008), which gave legislative effect to the Thematic Strategy (European Commission 2005d).

In their joint Communication charting the path towards the IMP, Barroso and Borg stipulated, *inter alia*, that concerning good governance in maritime policy, consideration must be given to the regional specificities of Europe's seas, and to the existing distribution (levels) of decision-making competences between the EU institutions, member states, regions and local authorities (European Commission 2005c). The Green Paper on EU maritime policy (European Commission 2006a) emphasised the need to take into account the geographical realties of Europe's major sea basins and their regional specificities in the development of a governance framework for EU maritime affairs (while respecting the principle of subsidiarity). The Green Paper reiterated the dual EU/regional approach already adopted for the environmental pillar of the IMP (i.e. the Marine Strategy). Notably, the Green Paper embedded the notion that member states should (1) establish regional scale maritime spatial planning (MSP) processes based on and tailored to individual marine regions and regional marine ecosystems (ecoregions); and (2) use, where appropriate, existing regional seas conventions[85] as well as regional and international fisheries organisations for this purpose. The Green Paper states:

> 'The EU's role in such a planning process would be to lay down parameters, define the geographic extent of the regions involved (as has already been done in the Thematic Strategy), and the elements of planning which are in the common interest' (European Commission 2006a: 39).

In the Green Paper, the European Commission also suggested that EU maritime governance should make use of the experience already gained from regional policy (e.g. concerning sectoral policy coordination, cooperation, exchange of best practice and stakeholder partnership). Surprisingly, perhaps, the Commission's 2007 proposal for the IMP (Blue Book) barely touched upon a strategic regional sea basin approach (European Commission 2007a). This despite reporting that stakeholders had, during the IMP consultation process, pointed to the need for cooperation between coastal regions and neighbouring member states and countries in working towards MSP and management solutions specific to each marine ecoregion (European Commission 2007b).[86]

The European Commission's guidelines for integrated maritime governance (European Commission 2008a) reflect a growing recognition within EU institutions[87] of developments concerning EU macro-regional approaches and

[85] That is, HELCOM for the Baltic, OSPAR for the North-East Atlantic, and Mediterranean Action Plan to the Barcelona Convention for the Mediterranean.
[86] In the Blue Book, a regional approach is implicit only in relation to implementing transboundary MSP and promoting socio-economic development in coastal regions, taking into account their diversity and specificities (European Commission 2007c).
[87] That is, the European Commission, European Parliament, European Council, Committee of the Regions, and European Economic and Social Committee.

strategies for Europe's sea basins. The guidelines include explicit reference to the advantages, even necessity of addressing many aspects of the IMP at regional sea basin level (European Commission 2008a, section 4.5). Among these, entry into force of the MSFD and its marine region/subregion-based approach makes it necessary for member states and the Commission to cooperate at regional sea basin level (as well as make best use of the added value provided by multilateral regional seas conventions such as HELCOM and OSPAR). The integrated maritime governance guidelines also refer to the 2008 restructuring of DG MARE to include three new geographical Directorates with responsibility for addressing the specific policy challenges of different European sea basins.[88] In the following paragraphs, I elaborate on the EU 'maritime' macro-regional strategy for Atlantic Europe.

Atlantic Strategy

In 2013, the European Commission published an Action Plan for a Maritime Strategy in the Atlantic area (European Commission 2013b). The Action Plan follows from the 'Atlantic Strategy' adopted in 2011 (European Commission 2011b). In contrast to the Baltic Sea Strategy (BSS),[89] development of the Atlantic Strategy was the responsibility of DG MARE. Unlike the BSS, which was developed against the political background of EU enlargement, the Atlantic Strategy emerged in the context of the 2007-2008 financial and economic crises. Therefore, the strategic aims and priority actions of this EU sea basin strategy are dominated by the objectives of the Europe 2020 strategy (European Commission 2010b). Consequently, the emphasis is on how the Atlantic Strategy can contribute to the EU's Blue Growth strategy. The Action Plan sets out priorities for investment, skills and research to drive the European maritime economy

[88] In 2008, the European Commission reorganised the Directorate-General (DG) for Fisheries and Maritime Affairs (DG FISH) towards the function of coordinating the EU's internal and external maritime affairs. The DG was renamed the DG for Maritime Affairs and Fisheries (DG MARE), signalling the de facto primacy of maritime affairs. The new organisational structure of DG MARE is based on a regional approach to implementing the IMP at the level of different European sea basins. It does this through geographical Directorates for (1) the Atlantic, Outermost Regions and Arctic, (2) Mediterranean and Black Sea, and (3) Baltic Sea, North Sea and landlocked Member States (European Commission 2008a).

[89] The EU Strategy for the Baltic Sea Region (Council of the EU 2009b; European Commission 2009e, 2009f) or 'Baltic Sea Strategy' was the first macro-regional strategy. It was developed under the direction of DG REGIO rather than DG MARE.

forwards and contribute to sustainable regional economic development in the Atlantic area (European Commission 2013b).

The Atlantic Strategy went some way towards addressing stakeholder involvement by establishing an Atlantic Forum. This process allowed stakeholders (member states, regional authorities, civil society and representatives of existing and emerging industries) to contribute to developing the Action Plan through a series of workshops in 2012 and 2013.[90] A further series of stakeholder workshops was held in 2014 with a focus on implementing the Action Plan.[91]

The European Commission recognises that successful implementation of the Atlantic Action Plan requires an appropriate implementation mechanism 'with the means to engage with national and regional actors and monitor progress' (European Commission 2015a). Therefore, the Commission (DG MARE) established an Atlantic Strategy Group and an Atlantic Stakeholder Platform.[92] The Commission monitors implementation actions, reports on progress, facilitates communication between key actors and formulates proposals regarding the Action Plan. The Atlantic Strategy Group comprises representatives of the governments of the five Atlantic member states (France, Ireland, Portugal, Spain and the United Kingdom), European Parliament, European Commission, Committee of the Regions, and Economic and Social Committee. The Group 'provides guidance and stewardship for the implementation and monitoring of the Action Plan, and the necessary political impetus vis-à-vis relevant actors' (European Commission 2015a). The Atlantic Stakeholder Platform is a forum for stakeholder participation, interaction and dialogue regarding the implementation and further development of the Action Plan. The Platform is open to all interested Atlantic stakeholders (individuals, public authorities, NGOs, organisations and networks).

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[90] See http://ec.europa.eu/maritimeaffairs/policy/sea_basins/atlantic_ocean/atlanticforum/events/index_en.htm

[91] See http://ec.europa.eu/maritimeaffairs/policy/sea_basins/atlantic_ocean/atlanticforum/events-2014/index_en.htm

[92] In addition, there is a Support Team for the Atlantic Action Plan (http://www.atlanticstrategy.eu/), established in August 2014 and operating until (at least) the end of 2015.

Regarding governance, however, neither the Atlantic Strategy nor the Action Plan mention the establishment of a formal multilevel governance arrangement for the Atlantic Europe macro-region; and this despite repeated calls from the AAC and other Atlantic Arc/Area actor networks for such a governance arrangement that would include representation of macro-regional level actors as well as those of national, regional and local level (AAC 2009a, 2009b, 2010, 2012, 2013; Atlantic Networks 2013).

4.7 Summary and inferences

This chapter contextualised the research problem. It described the general background in terms of the social–ecological sustainability context. After outlining governance for sustainability, the chapter examined key elements of governance architecture (i.e. context based, visionary, integrative, function oriented and experimentalist). It took into consideration that the existing governance landscape is already complex and that there are no universal solutions to the design of governance architecture. It also presented the interactive governance framework as a starting point for building a conceptual architecture for sustainability governance. The chapter then looked at the European maritime dimension in general. This included the EU IMP and a new European approach to maritime governance. After that, the chapter described the maritime macro-regional approach that is emerging in the EU. Next, I make a number of inferences.

Through the IMP, the EU seeks to facilitate sea-based economic growth, job creation and competitiveness without impairing the marine and coastal ecosystems on which sustainable economic and social development, and human well-being depend. In other words, the IMP is a policy framework for achieving ecologically sustainable development of Europe's maritime spaces and coastal regions. The EU also seeks to bolster a European vision of maritime identity based on social, political and cultural values as well as territorial factors and geographical realities. The objectives of the IMP are closely aligned with those of other EU policy areas, particularly the EU cohesion and regional policy objectives of improving the transnational spatial development and economic, social and territorial cohesion (unity and harmony) of Europe's maritime regions. In accordance with the subsidiarity principle and dual EU/regional approach, the IMP implementation process requires (1) nested action at EU, marine region and subregion, national and local levels, with different roles for the institutions and stakeholders at each level; and (2) solutions tailored to the diversity of conditions, problems and needs of Europe's maritime regions. However, there are numerous obstacles to achieving full and effective implementation of the IMP and key components, including the MSFD.

Among the central issues to be addressed in implementing the IMP is the need for an integrated governance framework for maritime affairs. That is, a framework for coordinating actions between different sectoral policies, decision-making levels and territorial levels. This requires a hierarchical structure through which inclusive governance processes, institutional rules and arrangements, and policy actions can be coordinated at and between multiple levels of organisation (i.e. local, mesoregional/subnational, national, macro-regional/transnational, pan-European/supranational and global/international levels). This governance architecture must also integrate different types of knowledge and sectoral interests into the various planning, policy and management interventions, while allowing for the different roles, rights and responsibilities of actors and institutions at each level (European Commission 2007c). The resulting system of multilevel maritime governance has to function across different, often mismatched social and ecological scales. It also has to facilitate interventions tailored to the diverse conditions, problems and needs of specific regions, ecosystems and EU macro-regions, including Atlantic Europe.

From conceptualisation to implementation, developing a new maritime governance system is fraught with difficulties. Not least of these is the paucity of case studies concerning maritime macro-regions with which to inform design. Underlying this is a lack of theoretical insight into maritime macro-regions and their governance. However, the lens of complex adaptive SES theory provides a way of understanding and conceptualising sustainability governance in relation to the macro-regional and other hierarchical levels. For maritime governance to effectively achieve sustainability and sustainable development, actors at every level need to understand the dynamics of CAS; they need to work with rather than against the fundamental characteristics of CAS described in Chapter 2. I believe that many of the difficulties facing maritime governance result from a failure to understand and deal with CAS characteristics.

There is a knowledge gap between what is known about governance for sustainability in Europe's maritime macro-regions in general and the Atlantic Europe macro-region in particular, and what is known about CAS theory regarding SES. In other words, there is an apparent disconnect between the EU's emerging maritime macro-regional sustainable development policies, including the Atlantic Strategy, and a sound theoretical basis for them. The research for this thesis goes some way to filling the gap by conceptualising and studying the European Atlantic social–ecological system (EASES). EASES is both an analytical construct representing the Atlantic Europe maritime macro-region and the unit of analysis for understanding multilevel governance architecture for maritime regional sustainability in Atlantic Europe. The conceptualisation of EASES provides a way of looking at maritime governance architecture by applying the theory of complex adaptive SES.

Chapter 5
Research framework

This chapter describes the framework for addressing the research problem and questions identified in Chapter 1.

5.1 Introduction

The normative concepts of sustainable development and sustainability raise fundamental questions about how science and technology (S&T) can best serve society in helping to maintain and improve human well-being (Lubchenco 1998; Raven 2002; Holdren 2008). The popularity, ambiguity and contestation of the two concepts have resulted in a wide variety of interpretations (Martens 2006; Kemp and Martens 2007). Most perspectives assume, often implicitly, that the broad social goals of sustainable development and sustainability are desirable, achievable and necessary (White 1995: 237); and that they involve some form of balance and integration between three (environmental/ecological, social and economic) interdependent dimensions or pillars.[93] Following the landmark Brundtland Commission report on sustainable development (WCED 1987a), there has been widespread agreement regarding the need to mobilise and engage the S&T community in the quest for a global transition towards sustainability. It is a view shared by many members of the S&T community itself. Consequently, science, technology, education and other systems of knowledge and innovation are called upon to reorient towards sustainability and the socially-determined goals of sustainable development (NRC 1999a: 16; Clark *et al.* 2002: 7, 2004; ICSU 2003: 9-12, 2005, 2010; UNESCO 2007; Holdren 2008: 433; Jäger *et al.* 2012: 6-7).

[93] The three-pillar approach to sustainable development has become an established principle of the international environment and development agenda (UNCED 1992; UN 2002; UNGA 2012). Elsewhere, other dimensions beyond the tridimensional model are recognised, including the cultural and institutional dimensions, among others (see Pawłowski 2007).

There is a growing recognition among researchers that the pursuit of sustainability requires new and more effective approaches to generating and applying science, technology and learning to solving complex, persistent problems of unsustainability (Jäger 2006: 22-24, 2011: 190-196; Cornell *et al.* 2013; Tàbara and Chabay 2013). It also requires different kinds of knowledge and ways of understanding to be brought to bear. To develop a science of sustainability, it is necessary to collaboratively construct shared knowledge and common, yet context-sensitive, understandings of sustainability (Miller 2013: 289-290). Of course, the role of knowledge is not restricted to problem solving; knowledge is essential for effective decision making.

The remainder of this chapter is organised as follows. Section 5.2 describes my (the researcher's) philosophical stance and the broad, theoretically informed approach to research in this thesis. This orientation underlies the research design and methodology, explained in section 5.3, used to address the research questions. Section 5.4 describes the methods used in the research. A summary is provided in section 5.5.

5.2 Research approach

In this thesis, I use the term 'research' broadly to refer to the critical enquiries, systematic studies, and changing philosophies and practices of different research cultures and communities (Jamison 2011; Trowler *et al.* 2012). In this sense, the concept of research encompasses the five main cultures of intellectual enquiry: the arts and humanities, social sciences,[94] natural sciences, formal sciences, and the professions and applied sciences. Each grouping spans a diversity of research communities based on different disciplinary identities and mixes of academic, practitioner and entrepreneurial values (Felt 2009). I take the term 'research approach' to mean the theoretically informed way of dealing with the research in this thesis.

[94] Perhaps the term 'human sciences' would be more appropriate than 'social sciences'. I use the term 'social sciences' to encompass the broad spectrum of sciences and disciplines that deal with the biological, social, cultural and environmental aspects of humans.

This section explains my (the researcher's) philosophical stance and locates the research approach in the broader academic landscape. It describes a hybrid frame of reference composed of social ecology, sustainability science, a social–ecological systems approach and resilience thinking. Together, these guide the approach and overall framework used to address the research questions posed in Chapter 1 (section 1.2).

5.2.1 Social ecology

Society–nature relations and interactions are the core issue of sustainability and sustainable development. It is clear that the boundaries between nature and society have become blurred. In the current Anthropocene era society and nature have become increasingly tightly coupled (Jahn 2012: 2). As sociologist Ulrich Beck states in *Risk Society: Towards a New Modernity* (1992), we have reached the end of the philosophical antithesis between nature and society: 'That means that nature can no longer be understood *outside* of society, or society *outside* of nature' (p. 80, emphases in original).

Since 1989, the 'new' Frankfurt school of social ecology based at the Institute for Social-Ecological Research (ISOE)[95] in Frankfurt am Main, Germany has developed Beck's notion – that it is impossible to understand nature without society, and society without nature – into the concept of *Gesellschaftliche Naturverhältnisse* or 'societal relations to nature' (Becker and Jahn 2005; Becker *et al.* 2011).

The research approach of this thesis is based on social ecology or 'the science that studies societal relations to nature' as proposed by the Frankfurt school (ISOE 2015).[96] Social ecology provides a way of theorising about society–nature relations and human–environment interactions. It emerges at the interface between the epistemic cultures of the natural and social sciences (Becker and Jahn 2003). Social ecology developed in the mid-1980s from earlier scientific discourses and

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95 http://www.isoe.de

96 Becker and Jahn (2006: 18) originally defined 'social ecology' (*Soziale Ökologie*) in German as *Wissenschaft der gesellschaftlichen Naturverhältnisse*, which translates as 'science of societal relations to nature'.

interdisciplinary studies on environment and development; for example, from environmental sociology, ecological economics, environmental policy research, systems ecology and hybrid ecologies under such names as human, cultural, social or political ecology (Glaeser 2010 [1995]; Bruckmeier 2013).[97]

The fields of social ecology and human ecology are closely related, particularly in the German-speaking countries. The origins of both can be traced back to the Chicago School of sociology in the 1920s. In continental Europe, the development of human or social ecology was influenced by the neo-Marxist, neo-Weberian political-intellectual milieu (Becker and Jahn 2005). In the human ecology perspective, nature is constructed following historical and cultural patterns determined by subjective human realities; human ecology analyses 'not "pristine nature" – but nature as "cultured" by people' (Glaser *et al.* 2008: 77). The new Frankfurt social ecology is an interdisciplinary/transdisciplinary, integrative, problem-oriented approach to science. Becker and Jahn (2001) summarise it as follows:

> 'Social ecology is the science that studies the relationships between people and their natural and social environment. Social-ecological research probes the existing forms of these relationships, and the possibility of transforming them, by means of a perspective that is not bound to any one discipline. The goal of this research is to generate knowledge that can serve as a resource for social actors, increasing their capacity to guarantee the reproduction and development of their society and the natural conditions of their lives' (p. 73).

The basic premise of the social ecology approach is that contemporary society–nature relations and interactions are strongly influenced by the rapidly changing relationship between humanity and the rest of nature (Castree 2001; Glaeser 2002; Costanza *et al.* 2007a; Glaser *et al.* 2008, 2012a; Steffen *et al.* 2011a, 2011b; Bruckmeier 2013). The social ecology perspective recognises three important

[97] Cultural ecology differs from human and social ecology in seeking to explain the origin of particular cultural features and patterns which characterize different areas rather than to derive general principles applicable to any cultural-environmental situation (Steward 1972 [1955]: 36).

considerations. First, the difference and growing interdependence between society and nature. Second, that human and ecological processes interact over space and time while being influenced by anthropogenic processes. Third, that social and ecological systems and processes are so intertwined that their theoretical separation is artificial and arbitrary (Berkes and Folke 1998a: 4). Consequently, social ecology develops a kind of knowledge that is holistic and integrative; it does not seek to understand the world by (overly) fragmenting or reducing it.[98]

Social ecology deals with hybrid society–nature constructions (epistemic objects) such as SES, which are the fundamental objects of curiosity and research (see Becker 2012). Social–ecological research investigates organised clusters of social–ecological problems in a holistic and systemic way. It analyses the complex and dynamic patterns of relationships among people, society and the rest of nature, as well as the possibility of their transformation (Becker and Jahn 2001). It addresses continually changing social–ecological realities, which are often contradictory due to the plurality of perspectives involved. Social–ecological research is also normatively concerned with producing useful knowledge; that is, knowledge for solving complex social problems and informing decision making regarding sustainability and sustainable development.

The Frankfurt school point out that social–ecological research is situated in the space between theory and practice: 'As applied scientific research, it seeks solutions to practical, societal problems of everyday life. As a theoretical science, it seeks to systematically order the knowledge produced by its research' (ISOE 2015). Social ecology's transdisciplinary approach to research helps maintain the productive tension created in the space between these two poles. The Frankfurt school espouses an open-ended theoretical approach to studying societal relations to nature. 'Thus, social ecology is itself open to development and adaptation, and not an entrenched and immutable theoretical edifice' (ISOE 2015).

However, the ISOE's concept of societal relations to nature is only one of several different but similar integrative conceptual frameworks for social–ecological

[98] For a comprehensive review of the development of the science of social ecology, see Bruckmeier (2013).

research (see Table 5.1 for a summary). First, there is the very similar approach situated in the framework of political ecology (Goldman and Schurman 2000; Peterson 2000; Heynen *et al.* 2006; Brand and Görg 2013; Brand and Wissen 2013). A second alternative framework that places society–nature relations at the centre is the concept of social metabolism proposed by the Vienna school of social ecology based at the Institute of Social Ecology in Austria (Fischer-Kowalski and Haberl 1993, 1997, 1998; Haberl *et al.* 2004, 2006, 2011; Weisz and Clark 2011). Social metabolism refers to the relations between material and energy flows and social organisation in co-evolving social and natural systems in the context of sustainable development. A third alternative is the social–ecological systems analysis framework emerging from the German Society for Human Ecology (Glaser *et al.* 2008, 2012a; Glaeser *et al.* 2009; Glaeser and Glaser 2010; Bruckmeier 2013).

Table 5.1 Integrated frameworks for social–ecological research.

Framework		**Key references**
Human dimensions of global environmental change or *human–environment interaction* framework*		Stern *et al.* 1992; NRC 1999b; Wasson and Underdal 2002; Moran and Ostrom 2005; Newell *et al.* 2005; Moran 2006, 2010; IHDP 2007; Moran and Brondízio 2013
Social–ecological frameworks from the perspective of human, social and political ecology, including the:		
	Concepts of *social metabolism* and *colonisation of natural systems* proposed by the Vienna school of social ecology (Institute of Social Ecology, Alpen-Adria University, Vienna, Austria, http://www.uni-klu.ac.at/socec)	Fischer-Kowalski and Haberl 1993, 1997, 1998; Haberl *et al.* 2004, 2006, 2011; Weisz and Clark 2011
	Concept of *societal relations to nature* proposed by the 'new' Frankfurt school of social ecology (Institute for Social-Ecological Research (ISOE), Frankfurt am Main, Germany (http://www.isoe.de)	Becker *et al.* 1997, 2011; Becker and Jahn 2005; Hummel *et al.* 2008; Becker 2012; Bruckmeier 2013
	Political ecology approach to *societal nature relations***	Goldman and Schurman 2000; Peterson 2000; Heynen *et al.*

		2006; Brand and Görg 2013; Brand and Wissen 2013
	Social–ecological systems analysis framework emerging from the German Society for Human Ecology (Deutsche Gesellschaft für Humanökologie, http://www.dg-humanoekologie.de/)	Glaser *et al.* 2008, 2012a; Glaeser *et al.* 2009; Glaeser and Glaser 2010; Bruckmeier 2013
Various integrated *social–ecological systems**** frameworks, generally originating in ecology, including those developed by scholars and practitioners associated with the Resilience Alliance (http://www.resalliance.org) and the International Network of Research on Coupled Human and Natural Systems (CHANS-Net, http://chans-net.org)		Berkes and Folke 1998a; Westley *et al.* 2002; Berkes *et al.* 2003b; Davidson-Hunt and Berkes 2003; Anderies *et al.* 2004; Chapin *et al.* 2006; Walker and Salt 2006; Ostrom 2007, 2008, 2009; Ostrom and Cox 2010
Emerging *long-term socio-ecological research* (LTSER) framework		Redman *et al.* 2004; Haberl *et al.* 2006, 2009; Ohl *et al.* 2010; Metzger *et al.* 2010; Mirtl, 2010; Ohl and Swinton 2010; Collins *et al.* 2011; Robertson *et al.* 2012; Singh *et al.* 2013
Landscape frameworks, including the		
	Convergence of different trajectories of landscape research towards integrated *social–ecological landscapes* frameworks, or	Brunckhorst 2002; Zaccarelli *et al.* 2008; Zurlini *et al.* 2008; Cumming 2011; van Paassen *et al.* 2011; Zurlini *et al.* 2013; Cumming *et al.* 2013
	Synthesis towards a *transdisciplinary landscape science*	Tress *et al.* 2001; Brunckhorst 2005; Haber 2004; Wu 2012; Naveh 2007; Wu and Hobbs 2007; Musacchio 2011
Integrated history and future of people on Earth (IHOPE project, http://ihopenet.org/) framework for research on coupled human–Earth system dynamics over the past millennia		Costanza *et al.* 2005, 2007a, 2012b; IGBP 2010
Frameworks in which social–ecological systems are modelled as *social–ecological networks*		Janssen *et al.* 2006; Cumming *et al.* 2010: 420; Becker 2012; Bodin and Tengö 2012; Gonzalès and Parrott 2012

* The International Human Dimensions Programme on Global Environmental Change (IHDP, http://www.ihdp.unu.edu) is the leading international science programme for interdisciplinary research to better understand the interactions of humans with the natural environment in the context of global environmental change.
** In German: *Gesellschaftliche Naturverhältnisse* (see Brand and Görg 2013: 111, footnote 1 and Brand and Wissen 2013: 3).
*** Also known as socio–ecological systems (Gallopín *et al.* 1989; Young *et al.* 2006b), coupled human and natural systems (Liu *et al.* 2007a, 2007b; Alberti *et al.* 2011), coupled human–environment systems (Turner *et al.* 2003a, 2003b), and ecological–economic systems (Costanza *et al.* 1993; Costanza 1996; Derissen *et al.* 2011).

5.2.2 Sustainability science

In a nutshell, sustainability science is

> 'an emerging field of research dealing with the interactions between natural and social systems, and with how those interactions affect the challenge of sustainability: meeting the needs of present and future generations while substantially reducing poverty and conserving the planet's life support systems' (PNAS 2015).

Sustainability science focuses on solving real world sustainability problems stemming from complex society–nature relations and interactions. It is a multidimensional interdisciplinary and transdisciplinary approach that starts from the perspective that the co-evolving systems of human society and nature are integrated at certain structural levels of organisation (as in social–ecological systems). The origins of sustainability science lie in natural resource management, particularly in efforts by fisheries and forestry scientists to maximise sustainable yields of fish and timber.

Sustainability science is closely linked to the concept of sustainable development, which is explained in numerous definitions and models (e.g. Keiner 2004, 2006; Robinson 2004; Hjorth and Bagheri 2006).[99]

Characteristics of sustainability science

According to Andersson *et al.* (2008: 2), the need for a science of sustainability is demonstrated by the lack of broad consensus on the best way to meet the challenge of sustainable development. A strategy to achieve the seemingly conflicting goals of sustainability and development must be grounded in a better understanding of the relationships between humans and nature in coupled social–

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[99] The World Commission on Environment and Development (WCED) report *Our Common Future* originally defined sustainable development as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED 1987a: chapter 2). Sustainable development strategy broadly aims to promote harmony among human brings and between humanity and nature.

ecological systems. The central purpose of sustainability science is to use rigorous scientific methods to better understand these relationships, but with the underlying normative (value-rich) purpose of promoting a sustainable future. To accomplish this goal, sustainability science must borrow theoretical concepts and methodologies from a wide range of established fields. Despite this, sustainability science is more than the sum of its disciplinary parts. But if sustainability science is not merely a collection of established research programmes related to human–environment interactions, then what is it? What are its defining characteristics? I suggest that the emerging field of sustainability science is characterised by an approach that is:

- Problem driven
- Sustainability focused and use inspired
- Place based
- Integrative
- Systems oriented and social–ecological systems focused
- Transdisciplinary
- Knowledge integrative
- Normative orientation
- A bridge between qualitative and quantitative
- Participatory

I will briefly elaborate on each of these characteristics below.

Sustainability science is 'defined by the problems it addresses rather than by the disciplines it employs' (Clark 2007: 1737). Sustainability research contributes to solving real-world practical problems concerning co-evolving, interacting and linked systems of humans and nature (social–ecological systems) with the goal of creating and applying knowledge in support of decision making for sustainable development (Clark and Dickson 2003).

Policy concerning sustainable development generally recognises that rather than addressing single sectoral issues, solutions must be found to the multiple, interconnected and interacting problems of unprecedented complexity that challenge sustainability and stand in the way of balanced and sustainable development, including of the maritime dimension (European Commission 2007a; EU 2008). Schmandt (2006: 2352) refers to 'complex problem clusters' that arise from multiple, cumulative and interactive natural and social stresses caused by demographic and economic growth that impact, directly or indirectly, natural systems.[100] In the maritime dimension, problems such as overfishing, biodiversity loss, coastal urbanisation, eutrophication, shipping hazards, energy security, ageing populations, rural decline, vulnerability to climate change effects and so forth, must be responded to simultaneously and in an integrated way.

> 'Sustainability science is called for to untangle these problem clusters and thereby provide the knowledge base that decision makers need as they attempt to deal with problems of unprecedented complexity' (Schmandt 2006: 2352).

The role of sustainability science is to untangle the intrinsic complexity of the dynamic interactions between co-evolving human societies and their environment across a range of scales (of time, space, function and structure); thereby, it provides a knowledge base for use in the design, implementation and evaluation of practical interventions that promote sustainability in particular places and contexts (Kates *et al.* 2001; Martens 2006). Accordingly, this thesis investigates the theoretical concepts of resilience and sustainability (in a specific context) in order to generate knowledge that is useful for social action (i.e. decision making and governance). It is essentially use-inspired basic research.

Sustainability science is place based (Lebel 2002). That is, it is located in the context of geographical space and place, as well as in contemporary time. Practical sustainability solutions require consideration of social–ecological systems, conditions and problem clusters at different spatial scales (local,

[100] According to Schmandt (2006), sustainability science 'studies the causes, pathways and impacts of complex development problems that result from the interaction of natural and social forces' (p. 2350).

regional, national, transnational, international and global) and in different geographic situations (e.g. river basins, coasts, sea basins, urban and rural areas).

Sustainability science is more than just a framework for integrated analytical research and the application of knowledge about complex natural and social systems (Martens 2006). It is characterised by long-term perspectives, social learning, persistent uncertainty and systems-oriented approaches that attempt to understand the Earth System (Schellnhuber 1999), social–ecological systems and ecosystems holistically, in a manner useful to cross-sectoral decision making (Clark and Dickson 2003). Alrøe and Kristensen (2002) describe sustainability science as a 'wholeness-oriented' science (p. 13).

Sustainability research adopts an integrative, systematic and adaptive, that is, systems-oriented approach to the discovery and interpretation of new knowledge, and to the development of useful applications of this knowledge. This approach is mainly based in systems theory concerning CAS (Levin 1998; Holling 2001).

An important feature of sustainability science and the research approaches that emerge is the integrative perception that human society and ecological systems are deeply interconnected and co-evolving across spatial and temporal scales (Folke 2006). This recognises that humankind is part of the biosphere and societies are an integral part of ecological systems (Vitousek *et al.* 1997). Berkes and Folke (1998b) introduced the term 'social–ecological system' to stress that the delineation between social and ecological systems is artificial and arbitrary. Sustainability science seeks to understand the (1) behaviour of complex self-organising society–nature systems; (2) fundamental dynamic character of the interactions between the social and ecological domains; and (3) responses of these coupled systems to multiple, cumulative and interacting stresses (Kates *et al.* 2001).

In many cases, a sufficient understanding of the whole SES cannot be arrived at by simply synthesising separate analyses of single social or ecological components. In other words, SES are irreducible and their essential complexity must be investigated as a whole (Clark and Dickson 2003; Gallopín 2006).

Gallopín *et al.* (2001) consider the whole SES to be the basic analytical unit for sustainability-focused research. In sustainability science, resilience is a key concept for understanding the dynamics of SES. A resilience perspective is increasingly used as an approach in sustainability research (Folke 2006).

Clark (2007: 1737) states that research relevant to sustainable development goals has long been pursued from diverse bases such as geography and geochemistry, ecology and economics, physics and political science. However, the central research questions for sustainability science transcend the concerns of its foundational disciplines. Although traditional discipline-based reductionist research – the science of parts – contributes essential insights into the complex interactions between human/social and environmental/ecological systems, sustainability science is what Walters and Holling (1990: 2067) term a 'science of the integration of parts'. The necessity of achieving an urgent transition of human social and economic development towards a trajectory that is sustainable places tough new demands on sustainability science (Newell *et al.* 2005). The processes of enquiry, learning about and understanding the key interactions between humans, our societies and technologies, and the environment cannot be approached successfully from the limited confines of single or even multiple scientific disciplines. Instead, cross-disciplinary or transdisciplinary collaboration is necessary to bridge the divides between the social and natural sciences and other non-scientific sources of knowledge.

The different concepts, models, methods and research findings of relevant scientific disciplines, as well as the different styles of knowledge from multiple non-scientific stakeholders and research participants, all need to be integrated into a holistic body of knowledge (Schmandt 2006). This need arises from the discrepancy between the whole SES as unit of analysis and the compartmentalised character of traditional academic disciplines as units of understanding (Gallopin and Modvar 2005).

In the discourses on sustainability and sustainable development, it is widely accepted that the processes of transdisciplinary knowledge creation, integration and implementation ('knowledge into action') have an explicitly normative dimension. This is inevitable because the concepts of sustainability and sustainable development are fundamentally shaped by social/cultural preferences and uncertainties, inherently subjective and ambiguous, and ultimately about values and equity (Robinson 2004; Kemp and Martens 2007; Luks and Siebenhüner 2007). Furthermore, sustainability science is embedded in broader social and cultural processes of learning, understanding and applying knowledge (Blackstock *et al.* 2007). It is also systemic in that it is a science that influences its own subject area (Alrøe and Kristensen 2002). For the sake of both scientific credibility and communication, it is important to acknowledge the intrinsic normativity of sustainability research, and to be explicit about the normative statements and choices that will be made.

Another aspect of knowledge integration in sustainability research concerns the quantitative and qualitative research traditions and the perception that there is a divide between them (Bryman 1988: 93, 2012: 35-37; Corbetta 2003: 30; Denzin and Lincoln 2005b; Onwuegbuzie and Leech 2005; Mertens 2010: 6). (This is further discussed in section 5.3 under 'Qualitative research strategy'.) Fields of science such as sustainability science have come to view qualitative and quantitative research approaches as complementary (e.g. Luthe and Wyss 2014); likewise for the field of cultural tourism research (Melkert and Vos 2010). They select qualitative and/or quantitative methods according to specific research needs. It is not unusual, particularly within the social sciences, to adopt an approach that bridges the qualitative and quantitative traditions: the use of quantitative methods within a qualitative framework, or the use of qualitative methods to interpret the meaning of quantitative data. For example, from a governance point of view, Luthe and Wyss (2015) analyse tourism supply chain networks in the Swiss Alps using a quantitative social network analysis method; interpretations of the quantitative results (network metrics) are validated in relation to an in-depth understanding of the underlying social processes in the region derived from qualitative interviews and workshop data.

In another example, Blackman (2013) argues that conventional quantitative and qualitative research methods have largely failed to provide policy practitioners with the knowledge they need for decision making. Blackman states: 'These methods often have difficulty handling real-world complexity, especially complex causality' (p. 333). Complexity theory bridges the quantitative and qualitative, especially given its focus on qualitative states and the thresholds at which systems transition between states that are regarded on objective or normative grounds to be qualitatively different (p. 337). Blackman, therefore, suggests that a better approach is to use a hybrid qualitative/quantitative method (qualitative comparative analysis) that enables logical reasoning about actual cases, their conditions and how outcomes emerge from combinations of these conditions.

> 'Taken together, these comprise a system, and the method works well with a whole-system view, avoiding reductionism to individual behaviours by accounting for determinants that operate at levels beyond individuals' (Blackman 2013: 333).

Pragmatism is a paradigm that is neither positivist (typically, quantitative and experimental methods are used) nor interpretivist (typically, qualitative and naturalistic methods are used) yet can accommodate elements of both (Onwuegbuzie and Leech 2005). It focuses on the practical nature of knowledge or what works as the truth regarding the things under investigation. As Tashakkori and Teddlie (2003) state:

> 'Pragmatism rejects the either/or choices associated with the paradigm wars, advocates for the use of mixed methods in research, and acknowledges that the values of the researcher play a large role in interpretation of results' (p. 713).

As a framework, pragmatism considers that solutions to research problems justify the use of integrated 'mixed' qualitative and quantitative approaches, regardless of their philosophical basis. Researchers select methods and techniques appropriate to their needs and circumstances (Onwuegbuzie and Leech 2005).

According to Bryman (2012: 628), 'mixed methods research' is a term widely used to refer to research that combines methods associated with both the quantitative and qualitative research strategies within a single project, rather than just using them in tandem; in other words, the quantitative and the qualitative data deriving from mixed methods approaches should be mutually illuminating. The following paragraphs provide some examples of mixed methods approaches in the literature that address sustainability and social–ecological problems.

Poteete *et al.* (2010: 248-249) look at the opportunities and challenges associated with research related to collective action and the commons that combines multiple (i.e. mixed) methods (and disciplines). They argue for innovative research that draws upon multiple methods to solve the theoretical puzzles presented by SES. The authors illustrate the advantages of research involving multiple methods with several examples (including fieldwork methods such as case study and meta-analysis, experimental methods such as laboratory experiments, and modelling methods such as agent-based modelling). In doing so, they also acknowledge the many practical challenges that constrain methodological choices.

Ayers and Kittinger (2014) used a mixed methods approach to examine the emergence of co-management arrangements in a case study from coral reef fisheries in the Hawaiian Islands. They used a content analysis (employing NVivo qualitative data analysis software) of archival data sources to supplement and confirm data gathered from a series of in-depth, semi-structured interviews. The authors note that although counts and percentages of key respondents identifying major categories are presented to give a general idea of convergence within key interview respondents, they do not represent archetypal results of a quantitative survey approach nor are they generalisable in any way (p. 253). They relate their findings to broader theories on emergence of governance arrangements for SES.

Nuno *et al.* (2014) investigated the role of implementation uncertainties affecting natural resource management and species conservation decisions. They used a mixed methods approach with individual study participants, in private, combining qualitative scenario building, and semi-quantitative institutional analysis and social network analysis exercises with qualitative semi-structured interviews conducted to promote further discussion around the conceptual framework and its components. In order to explore the long-term impacts of regional water governance regimes, Withycombe Keeler *et al.* (2015) used a participatory mixed methods approach, including stakeholder survey, qualitative scenario analysis and system dynamics modelling, to construct normative governance scenarios of Phoenix, Arizona.

Communication is essential to resilience, as interactions among humans influence how SES respond to change. McGreavy *et al.* (2015) undertook research to understand how communication within sustainability science teams influences outcomes related to learning and progress towards goals; and how system properties promote SES resilience. The authors employed a four-phase mixed methods research design involving (1) qualitative participant observations and (2) interviews; (3) a quantitative online survey; and (4) qualitative interviews with key informants to member check[101] the researchers' interpretations. 'The mixed methods approach allowed for rich qualitative insights about individual experiences and subsequent analysis of how these experiences generalized' (McGreavy *et al.* 2015: 3).

Blount *et al.* (2015) employed a mixed methods design in developing social indicators of well-being in nine fishing communities on the Gulf Coast, Texas. This used (1) quantitative analyses of large secondary data sets to rank coastal communities based on socioeconomic measures; and (2) qualitative approaches (an informed expert description of the communities, and cognitive-based interviews in the same communities) to independently provide rankings of the communities. The different types of analyses yielded similar results indicating that cognitive ethnography can be a valuable tool in the description of community resilience, vulnerability and well-being.

In the last example, Bull *et al.* (2016) used a mixed methods research strategy (online surveys and face-to-face discussion groups) to elicit perceptions from an interdisciplinary group of ecosystem services researchers and practitioners regarding the strengths, weaknesses, opportunities and threats of the ecosystem services framework. 'Applying a mixed methods approach allowed researchers to

[101] Also known as informant feedback or respondent validation.

better capture the richness and complexities of the phenomena under study than by using a singularly qualitative or quantitative approach' (p. 101).

Many uncertainties, system behaviours and responses cannot be quantified (Hopkins *et al.* 2011). For example, Spangenberg (2007: 343) states that there is a broad consensus among expert scholars that the rapid loss of biodiversity continues, although the number of species lost (let alone the loss of ecosystem and genetic diversity) cannot be quantified. In another example, regarding future scenarios of energy-related CO2 emissions in Ireland, O'Mahony *et al.* (2013) state that although they may be critical in determining future emissions, governance, society and culture cannot be quantified and may only be known qualitatively. To address uncertainty in key factors that cannot be explored quantitatively, they develop integrated or 'hybrid' qualitative and quantitative emission scenarios. Therefore it is often necessary to apply qualitative reasoning – one of the defining characteristics of sustainability science (Petschel-Held 2005). For example, Eisenack *et al.* (2006) consider qualitative reasoning to be appropriate whenever we are dealing with imprecise knowledge (p. 2631). This is their basis for using qualitative simulation modelling to investigate the dynamical behaviour of a complex bioeconomic fishery system without reference to quantitative values.[102]

Inclusiveness is a key principle of sustainability research. Integrated assessment approaches emphasise the inclusion of stakeholders in the participatory research process leading to the transdisciplinary discovery and integration of knowledge (Hisschemöller *et al.* 2001). Participatory sustainability science has been defined by Blackstock *et al.* (2007) as 'the co-generation of knowledge about socio-ecological systems drawing on multiple understandings in an ongoing collective dialogue in order to transform practice, where academics and stakeholders are all co-researchers' (p. 729).

[102] de Vos *et al.* (2013: 104) state that qualitative reasoning and qualitative simulation provide means and tools for formally representing and reasoning with incomplete and uncertain knowledge that is difficult to quantify. Qualitative simulation uses 'common-sense' system-dynamical insight and expertise in combination with consistent reasoning as a suitable tool for this purpose.

5.2.3 Social–ecological systems approach

This thesis adopts a SES approach to sustainability research. It is an approach based on social ecology and sustainability science that uses the concepts of SES and resilience to investigate society–nature relations. The theory of complex adaptive SES is described in Chapter 2 and the concept of resilience is described in Chapter 3. This subsection briefly looks at the role a SES approach has in sustainability research and some related issues.

Integrated systems perspective

Sustainability problems (the global social–ecological crisis) require scientific analysis of society–nature relations and interactions. Sustainability science focuses on solving sustainability problems. Central to this approach is an integrated systems perspective or 'lens' through which to interpret and understand the complex dynamics that arise from interactions between human/social and environmental/ecological systems (Clark 2007: 1737). Understanding the social–ecological dynamics of SES is vital to the success of society's efforts to promote conditions for a transition towards sustainability (Levin and Clark 2010). Put another way, society's sustainable development depends on our knowledge of coupled SES rather than of human and natural systems as separate entities (Berkes and Folke 1998b; Berkes *et al.* 2003a).

Central to this integrated perspective is the understanding that SES are a type of CAS. The world we perceive and construct can be represented as a set of nested, overlapping and adjacent complex adaptive SES. These vary in scale across space, time and levels of organization from local to the Earth system as a whole (Liu *et al.* 2007a, 2007b; Levin *et al.* 2013). According to Liu *et al.* (2007a), integrated studies of coupled human and natural systems 'reveal new and complex patterns and processes not evident when studied by social or natural scientists separately' (p. 1513). In addition to cross-scale linkages, the six cases studied by Liu *et al.* (2007a) also exhibit reciprocal effects and feedback loops, nonlinear dynamics with thresholds, surprises, legacy effects and time lags, resilience and heterogeneity: properties of CAS. The authors highlight the importance of considering the whole SES as the unit of analysis in sustainability research (Berkes 2011b: 469).

The SES concept provides a particular type of mental model of society–nature relations and the problems thereof. Glaser (2006) uses the term 'mind map' to refer to this type of mental model. A mind map encompasses both an intuitive 'pre-analytic vision' of science (Costanza 2001), which results from differences in paradigmatic world views, and the more analytical 'high-generality conceptual model' (Costanza *et al.* 1993), which is used to simplify relationships and address basic questions. In social–ecological research and sustainability science, the SES has become the epistemic object of research (Jahn *et al.* 2009; Becker 2012). But I have not yet adequately explained why a systems approach is needed.

Analysis of systemic properties

Glaser *et al.* (2008) provide a succinct rationale for the approach: 'To achieve sustainability, systemic capacities for self-organization need to be understood' (p. 77). Moreover, there are manifold systemic interdependencies among human societies and globally interconnected economies, both dependent on ecosystems services (Jahn *et al.* 2009: 2). Indeed, as Glaser *et al.* (2008) observe, the complexity of society–nature relations precludes a reductionist approach and in this regard the tools of holistic systems analysis appear to have potential. This notion of systems analysis has been taken up by the fields of human ecology, social ecology and cultural ecology. For example, the 2008 annual conference of the German Society for Human Ecology in Sommerhausen, Germany[103] focused on bringing together different strands of SES analysis from across the natural and social sciences and multiple academic disciplines. The Sommerhausen conference proposed a conceptual framework for SES analysis that includes the following concepts from systems theory: complex systems, emergence, resilience, vulnerability, adaptive capacity and transformability (Glaser et al 2008; Glaser *et al.* 2012b). The lessons learned from the Sommerhausen conference about a problem-driven, sustainability-oriented approach to the analysis of society–nature

[103] 'Human/Nature Interaction in the Anthropocene: Potential of Social-Ecological Systems Analysis', Annual Conference of the German Society for Human Ecology, 29-31 May 2008 in Sommerhausen am Main, Germany (http://www.dgh2008.org/ [accessed 23/11/2015]).

relations are described in the book *Human-Nature Interactions in the Anthropocene: Potentials of Social-Ecological Systems Analysis* by Glaser *et al.* (2012a).

Constructing SES

Complex systems are inherently difficult to conceptualise and describe. Describing society–nature relations in terms of integrated social–ecological systems is an ontological and epistemological challenge. Furthermore, the analysis of SES is a paradox because the construction of such an integrated unit of analysis begins with an essential distinction between human society/culture and nature. 'Without such a distinction, the interaction between them is unthinkable' (Becker 2012: 46).

We can conceptualise SES in different ways (Becker 2012). First, as boundary objects: things that exist and mediate interactions between intersecting social worlds such as individual research fields, disciplines or epistemic communities[104] (Star and Griesemer 1989; Star 2010). Second, as epistemic objects: things that humans can and want to know about (Becker and Breckling 2011: 390), which are the fundamental objects of research. Third, as real objects: concrete things and social–ecological phenomena that exist in the real world in space and time. Fourth, as abstract objects: things that exist in an ideal world such as information, conceptual representations of knowledge, and models of social–ecological 'networks' and 'systems' constructed for dealing with real-world social–ecological phenomena and problems (Becker 2012).

Becker (2012: 49) cites Glaeser *et al.*'s (2009) working definition of the concept of SES as an example of a realist ontological position:

> 'A *social-ecological system* consists of a bio-geo-physical unit and its associated social actors and institutions. Social-ecological systems are complex, adaptive and delimited by spatial or functional boundaries

[104] Haas (1992) defines an 'epistemic community' as 'a network of professionals with recognized expertise and competence in a particular domain and an authoritative claim to policy-relevant knowledge within that domain or issue-area' (p. 3).

> surrounding particular ecosystems and their problem context' (p. 190, emphasis in original).

Such a realist perspective does not take into account the constructivist argument that SES are scientific constructions. As an alternative to strong positivist/realist and interpretivist/constructivist standpoints, Becker (2012) advocates a constructivist realism approach that 'combines a realistic ontology with a constructivist epistemology' (p. 50). From this perspective, SES can be viewed as abstract objects (models of knowledge) that represent real objects (social–ecological phenomena) in the real world. The SES is constructed as a unit of analysis first by identifying real objects (i.e. three distinct sets of natural, social and hybrid entities) and the relationships between them within the boundaries of a particular problem context. Next, it is necessary to abstract from empirical observations of real world entities and relationships, and their context.

> 'Finally, in a move back towards concretization, an interpretation of the abstract system in empirical terms leads to the construction of a model for the unit in consideration. Elements and relations referring to real world phenomena have to be identified, spatial or functional boundaries at different levels must be defined, and variables that indicate system properties have to be found' (Becker 2012: 52).

The notion of hybrid entities is important here. Becker *et al.* (2011) and Becker (2012) place the societal relations to nature concept in the context of philosopher-anthropologist Bruno Latour's analysis of modernity. Latour (1993: 10-12) argues that, since the late 17th century Western intellectual movement known as the Enlightenment, modernity has been shaped by two sets of practices. The first set, 'purification', creates two distinct ontological zones: human beings and nonhumans; essentially a partition between the natural world and society. This dichotomy is maintained by modern science, which understands nature and society as totally separate domains. The second set, 'translation', creates entirely new types of beings: hybrids of nature and culture. Thus, modernity is defined by a separate consideration of purification and hybridisation processes, whereas the nonmodern or ecological worldview is characterised by a simultaneous interpretation (Latour 1999, 2004).

In Latour's view, a hybrid[105] is something that successfully intermixes or forms a network[106] among human society or culture including science (human assemblies) and nonhuman nature (assemblies of things). Latour argues that despite the constraints of purification imposed by modern science, there has been a proliferation of hybrids: a co-construction of associations between human and nonhuman actors or assemblies, which mix society, politics, science, technology and nature (Latour 2004). Consequently, concepts such as natural resources, ecosystem services, SES or sociotechnical systems, knowledge–action systems, institutions and values conform to the notion of Latourian hybrids. The use of hybrid entities circumvents the unrealistic dualism of nature and society without losing the necessary semantic and analytical distinction between human society/culture and nature.

The hybrid perspective allows us to conceptualise society–nature relations in terms of constructing abstract SES. A SES can be defined qualitatively and represented in terms of either a network or intersecting sets. The social–ecological network consists of natural, social and hybrid elements (parts or components) and their relationships. The intersecting sets model is composed of two sets of elements: one natural, the other social. The hybrid domain is represented by the intersection of the two sets (Becker 2012). The advantage of the network model is that it represents the relationships between elements, whereas the intersecting sets model does not. The advantage of the latter is that it better represents spatial or functional boundaries. In practice, the intersecting sets model is useful for identifying key system components, and the network model is then used to identify important relationships and interactions between components.

[105] Latour also equates the notion of 'hybrid' with the notion of 'quasi-object' (1993: 51) or 'matters of concern' (2004: 24).
[106] Latour (1993: 3) states his preference for the notion of 'network' over the notion of 'system'.

5.2.4 Resilience thinking

The multifaceted concept of resilience (described in Chapter 3) provides the kernel of the SES approach to sustainability research and practice. Resilience provides a transdisciplinary theoretical framework and analytical lens for examining the complex relationships and dynamic interactions between humans, our societies and economies, and the rest of nature. A 'resilience perspective' (Folke 2006) or 'resilience thinking' (Walker and Salt 2006) embodies an integrative 'humans-in-nature' worldview (Berkes and Folke 1998b; Folke *et al.* 2002; Berkes *et al.* 2003a; Folke *et al.* 2010).

As a primarily qualitative approach to social–ecological research,[107] resilience and related concepts provide an organising framework for understanding the complex adaptive dynamics of SES. Resilience thinking addresses the apparently contradictory but nevertheless vital interplays between persistence and change, and disturbance and reorganisation, between the co-evolving social and ecological domains across temporal and spatial scales. Such nonlinear dynamics are essential for maintaining the key functions, structures, feedbacks and therefore identity of whole SES (Walker *et al.* 2004: 6, 2006: 2). Resilience thinking deals with complex adaptive systems properties, which are described in Chapter 2. It takes into account the complex interactions, interdependencies and feedbacks between ecosystem development and social dynamics (Gunderson and Folke 2005: 1). Resilience thinking seeks to understand the qualities of SES that must be managed – deliberately maintained and enhanced or diminished and lost – to achieve sustainability and sustainable development.

5.3 Research design and strategy

Research requires an underlying scheme: a purposeful, systematic arrangement of research process components that promotes their efficient and successful

[107] Gordon *et al.* (2014) caution against losing sight of resilience thinking in the pursuit of agreed upon metrics to quantify and operationalise resilience. The framework's strength is more as a mindset or an approach to understanding the problem and the system that goes beyond measuring a property of a system. They argue that engaging with resilience thinking should be the objective, while measures, indicators and principles are merely tools for doing so.

functioning. It also requires a strategy for achieving the overall aim of the research. In other words, research needs careful design and a plan of action. This section describes the methodology (systematic approach) used for acquiring knowledge; it explains the methodological perspective and key choices concerning the procedure used in the study of EASES.

Methodological perspective

The research approach and design are located in the interpretivist, social constructivist paradigm of enquiry. My (the researcher's) worldview encompasses relativist ontology in which multiple realities are socially constructed; and a subjectivist epistemology in which knowledge is constructed in the individual's mind and co-constructed in the interaction between researcher and participants during the research process. It is assumed that data, information, interpretations and outcomes exist in people and contexts rather than in the researcher's imagination. Data/information can be tracked to their sources, and the logic used to assemble interpretations can be made explicit in the narrative (Mertens 2010: 19). Emphasis is placed on credibility, transferability, dependability and confirmability rather than on objectivity (Denzin and Lincoln 2005b). Furthermore, the research is influenced by the system of values held by the researcher and other participants in the research. The research process is embedded in a normative context that has interacting and interdependent social, cultural, political, economic, technological, historical, ecological and other dimensions. Hence, a qualitative research strategy and methods are best suited to studying complex issues, situations, problems and systems involving human–environment interactions and society–nature relations. Together, this is the methodological basis for the study design and systematic procedure for acquiring knowledge.

Qualitative research strategy

A research strategy is the overall plan of action the researcher uses for conducting a research project and achieving its aims (Denscombe 2010: 3-4). Lähdesmäki *et al.* (2014) consider a strategy to be the rules directing a research project, which guide the researcher in making essential methodological choices. In effect, a research strategy is the method or set of different methods selected and used, according to particular rules, to perform specific functions at different stages in the research process.

Commonly, a polar distinction is made between quantitative and qualitative strategies in terms of contrasting characteristics. On the one hand, quantitative strategies use measurement as the main approach to collecting and analysing data, and a deductive approach to test theories; are epistemologically based on a positivist approach inherent in the natural sciences; and are ontologically objectivist in that social reality is regarded as objective fact. On the other hand, qualitative strategies use description and an inductive approach to generate theories; rely on individual interpretation of social reality; and are constructionist in that social reality is seen as a constantly shifting product of perception (Walliman 2006: 36-37). However, many authors consider such a rigid distinction between quantitative and qualitative strategies unwarranted (e.g. Sechrest and Sidani 1995). Indeed, Onwuegbuzie and Leech (2005) consider that relying on only one type of data (i.e. numbers or words) is extremely limiting; they go as far as to state that 'mono-method research is the biggest threat to the advancement of the social sciences' (p. 384). A more useful approach that minimises the distinction involves the careful selection of quantitative and qualitative techniques according to their suitability in addressing particular research questions (Bryman 1988, 2012; Creswell 2009; Mertens 2010; see also the *Handbook of Emergent Methods* by Hesse-Biber and Leavy 2008). Then there is mixed methods research: an emerging strategy for combining multiple quantitative and qualitative methods for collecting and analysing data (Plano Clark *et al.* 2008; Hesse-Biber 2010; Bryman 2012: Chapter 27).

Denscombe (2010) considers 'mixed methods' a term that refers to a research strategy that crosses the boundaries of conventional research paradigms by deliberately combining methods drawn from different traditions with different underlying assumptions: 'At its simplest, a mixed methods strategy is one that uses both qualitative and quantitative methods' (p. 137). According to Creswell (2012: 22), the core argument for a mixed methods design is that the combination of both forms of data provides a better understanding of a research problem than either quantitative or qualitative data by itself. Some researchers choose to combine them in order to minimise the weaknesses of each method and to maximise its strengths, which can also improve the validity of the research (Melkert and Vos 2010: 36). Mixed methods designs are procedures in which the researcher decides on the emphasis (priority) to be given to each form of data, which form of data to collect first (i.e. concurrently or sequentially), how to integrate or connect the data, and whether to use theory to guide the study (Creswell 2012). However, mixed methods practice is not without some concerns, particularly regarding the problem of commensurability and the problem of continuing specialisation, including methodological specialisation (Small 2011: 77-79; see also the critiques of mixed methods research by Teddlie and Tashakkori 2011: 294-296).

For this research, I adopted a qualitative research strategy.[108] The key difference between a qualitative and a quantitative approach relates to the means or method of data collection and analysis. There are, of course, various methods that can potentially be used in qualitative research. (Methods are described in section 5.4.) There is no standard definition of qualitative research. However, I adopt the view of Melkert and Vos (2010) for whom qualitative research is

> 'research that aims to obtain in-depth insight into the social reality on the basis of a relatively small number of respondents or observations. The methodology does not usually rely on sampling or employing statistical analysis. Qualitative research is suited for situations where little is known about the subject matter to be analysed' (p. 34).

From an interpretivist, social constructivist perspective, a qualitative research strategy is generally suited to studies that seek to understand and interpret contexts, qualities, characteristics and meanings of the construct or constructs being studied.

[108] There is no standard definition of 'qualitative research'. Denzin and Lincoln (2005b) define it as 'a situated activity that locates the observer in the world. It consists of a set of material practices that make the world visible. These practices transform the world. They turn the world into a series of representations [...] At this level, qualitative research involves an interpretive, naturalistic approach to the world. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them' (p. 3).

Designing the study

The research began with the idea to conceptualise EASES as both an analytical construct representing the Atlantic Europe maritime macro-region and the unit of analysis for understanding governance architecture for maritime regional sustainability in Atlantic Europe. The envisaged study would involve both deductive reasoning proceeding from general principles to understand a specific instance (EASES) and inductive reasoning that derives broader generalisations about maritime SES from observations about EASES. The study would develop and use a conceptual framework consisting of key concepts such as resilience and other components of complex adaptive SES theory to guide the analysis of EASES (see Chapter 2 and Chapter 3). The study would gather information about EASES based on expert opinion (for the reasons described later in this section).

A brief review of the literature regarding participatory and collaborative research methods and techniques used in the social and natural sciences was undertaken to determine suitable candidate methods and techniques for eliciting and reporting (aggregated or individual) expert opinions. The following were considered: brainstorming, mind, cognitive and concept mapping, individual interviews, questionnaire survey, expert panel, focus group, nominal group, RAND appropriateness method, the Delphi approach and case study. For reasons of space, I elaborate on the alternative methods and techniques considered, and their pros and cons, in Appendix A.

In order to understand the complexity of EASES (a single case study) it was apparent that an in-depth case study approach (Yin 2003) was appropriate and, therefore, was selected. Nevertheless, two other nonexperimental qualitative methodologies were considered before deciding on this approach: survey research and grounded theory.

Survey research is an approach for collecting information from a sample of a population in their real-life context with the aim of generalising from instance to class. Usually, surveyed information in a standardised format provides a quantitative means of identifying and describing patterns (trends, attitudes, opinions or behaviours) across large groups of people or organisations (Maxwell

2005; Ryan 2006; Given 2008; Creswell 2009; Denscombe 2010). This approach was rejected on the basis that a standardised questionnaire would constrain the information collection. (However, elements of survey research were incorporated into the workbook method adopted.)

Grounded theory (Glaser and Strauss 1967) is an approach dedicated to generating theories rather than testing theories or providing descriptive accounts of the subject matter (Denscombe 2010). Designs involve systematic, qualitative procedures used to generate theory that explains a process, action or interaction about a substantive topic at a broad conceptual level (Creswell 2012: 621). Grounded theory 'is an approach that emphasizes the importance of empirical fieldwork and the need to link any explanations very closely to what happens in practical situations in 'the real world'' (Denscombe 2010: 107). A grounded theory approach was rejected because the EASES study would be based on a strong theoretical foundation and conceptual framework in the first place. Therefore, a case study approach was selected; this research is based on a single case study of a conceptual SES.

Case study is an approach in which the researcher explores and develops detailed, intensive knowledge about a single instance (the 'case')[109] or small number of instances based on extensive data/information collection (Creswell 2007: 73). The aim is to provide an in-depth account of actors, relationships, events, experiences or processes occurring in that particular instance (Denscombe 2010: 52). Context and relationality are extremely important. In order to produce useful knowledge, the case study would involve a detailed definition and description of EASES, followed by analysis of the information collected about EASES regarding specific thematic issues including resilience and governance. I explain and justify the selection of a case study approach in Appendix A (section 10).

[109] A 'case' is an instance of an object of study (Dul and Hak 2008: 278). Gerring (2007) defines 'case' as a 'spatially and temporally delimited phenomenon observed at a single point in time or over some period of time – for example, a political or social group, institution, or event. A case lies at the same level of analysis as the principal inference. Thus, if an inference pertains to the behavior of nation-states, cases in that study will be comprised of nation-states. An individual case may also be broken down into one or more observations, sometimes referred to as within-case observations' (p. 211).

Unit of analysis

The unit of analysis is the most basic element of a research project: the major entity (the who or what) of the study about which an analyst may generalise. It is the unit the researcher uses to gather the data (Creswell 2012: 630). In the social sciences, the case study approach can use a wide range of social phenomena (e.g. community, state, region, institution, policy or social system) as the unit of analysis (Denscombe 2010: 55). The macro-region object of this research and concomitant macro-regional level of analysis determined the unit of analysis (i.e. EASES). The selection of this unit of analysis (rather than, say, a subnational regional or statistical NUTS region) influenced the research methodology. By this I mean it influenced conceptual and methodological decisions, for instance, about the type of information to be collected and the subsequent treatment of that information. Another consideration when selecting the unit of analysis was the envisaged end users of the knowledge generated: policymakers and other actors with interests in governance issues concerning the Atlantic Europe maritime macro-region.

Overview of information needed

All research depends on information.[110] Therefore, the research design and strategy began with a series of questions: What do I already know (or assume) about the research topic? What do I need to find out about the topic in general and the research object in particular? What information is required by or will be useful to potential end users? What type of information do I need to perform my analysis? And what type of source or resource is most likely to provide this information? Of course, answers to these questions depend on the context, purpose and scope of the research, and the main aim, problem addressed and research questions. I elaborate on these questions in the following paragraphs, which leads to a justification of my selection of expert opinion as the source of information.

[110] Note on terminology: I generally prefer to use the term 'information' rather than 'data' on the basis that 'information' is a broader concept than 'data'. Data consists of observations, measurements, facts, statistics and other pieces of information; whereas information encompasses interpreted data to which a quality has been attributed, such as a description or opinion. Information is a rationalised sequence or arrangement of data that is learned, represented and conveyed.

First of all, the 2006 proposal for this research summarised my knowledge and assumptions regarding building resilience for social-ecological sustainability in Atlantic Europe. The proposal itself was grounded in my accumulated experience of relevant issues, including human activities in the marine environment (especially offshore oil and gas), marine biodiversity and ecosystem-based management, integrated maritime policy, governance and transnational actor networks at different levels (national, transnational/ macroregional and international). The common thread linking these issues was the North-East Atlantic. This was experience acquired from (at the time) 19 years of professional work connected directly or indirectly with the North-East Atlantic marine environment and Atlantic Europe's coastal peripheries. As an individual, I have acquired a unique stock of knowledge. As a researcher, this translated not only into a research idea, but also a set of assumptions that would, arguably, impact on the validity of the results.

Second, what I needed to investigate was arrived at through an iterative and reflexive process of reviewing the literature and developing and refining the research questions. This included the five initial research questions formulated to guide the research process in general and the study of resilience in EASES in particular (section 1.2); and the specific questions and sub-questions that were asked as part of the expert consultation during the study. For reasons of space, I will not repeat them here. Quite simply, the information sought is reflected in the questions asked.

Third, what information is required by or will be useful to potential end users? I judged such information based on (1) my past experience of NGO policy work regarding North-East Atlantic environmental issues; and (2) informal discussions with (former) colleagues and acquaintances.

Fourth, what type of information do I (the researcher) need to perform my analysis? This question refers to the basic form of the information: observable facts, written material, graphical representations, opinions, historical and contemporary perspectives and so forth. Such forms of information provide the basis on which analysis is performed. I decided that the richness and complexity of the things to be studied required description rather than measurement; things could be meaningfully described as qualities rather than quantities in the first instance. I decided that adequate qualities of information could be obtained from the opinions of individuals.

This leads to the fifth question of what type of source or resource is most likely to provide this information? There are, of course, numerous people with knowledge concerning the Atlantic Europe macro-region. Indeed, one can say that every person living in, visiting or otherwise connected with the macro-region has knowledge of it. However, this research is focused on a single case and bounded unit of analysis (EASES). Therefore, the most appropriate sources of information (opinions) were people with identifiable expertise, that is, experts with relevant knowledge. Such experts could be scientists or practitioners, academics or non-academics, or a mixture. In short, expert opinion would be the primary source of information. Information for the study also came from secondary sources, including refereed journal articles (e.g. Wise 2000a, 2000b; Farthing and Carrière 2007), non-refereed publications of relevant actors (e.g. CPMR 2005), statistical information (e.g. Eurostat data for NUTS regions), biogeographic classifications (e.g. Dinter 2001) and maps (e.g. Sea Around Us Project 2015).

5.3.1 Expert opinion

Knowledge is socially constructed; people interpret the significance, validity and usefulness of new information in the context of their particular worldviews (Hoverman *et al.* 2011). Kueffer *et al.* (2012) argue that those involved in producing knowledge to solve societal problems face three particular challenges: the complexity of real-world sustainability problems, maintaining impartiality when expert knowledge is used in decision making, and ensuring the salience of scientific knowledge for decision makers. Expert knowledge is used widely in, for example, the science and practice of conservation because of the complexity of problems, relative lack of data, and the imminent nature of many decisions (Martin *et al.* 2012). Experts may have valuable knowledge about models and parameters for problems in their specific field of interest. However, this knowledge is not certain, ‘but is entertained with an implicit level of subjective confidence, or degree of belief’ (Cooke and Goossens 2004: 643-644).

Increasingly, expert judgement is recognised as just another type of scientific data and information for decision making and management. But expert knowledge is only one type of knowledge generation that is available. Historically, experts have been distinguished from laypersons; this distinction has become more nuanced, primarily by positioning so-called ‘local’ knowledge as a necessary means to contextualise and often challenge scientific knowledge (Krueger et al 2012: 6). Examples of local expert groups include fishermen, farmers, environmental managers and groups of environmental stakeholders who hold knowledge and experience grounded in everyday management practices that is only partly accessible through scientific observation (Krueger *et al.* 2012: 6). As Gray *et al.* (2015) point out, the notion of citizens or non-scientific stakeholders participating as data collectors and decision makers is not new. However, because modern science is often seen as an expert-driven endeavour, lay individuals and more traditional knowledge forms can be marginalised (p. 10). Collaborative approaches to learning and decision making emphasise that everyone has valuable knowledge to contribute, and are especially critical if expert knowledge is used to eclipse the contributions of others (Arnold *et al.* 2012). Hoverman *et al.* (2011) provide an example of one study in which both expert and community knowledge is elicited to create a SES understanding regarding integrated water resources management.

With democratisation ‘expertise spreads throughout society and becomes socially distributed expertise’ (Nowotny 2003: 155). This leads to an expansion and re-evaluation of the concepts of expert and expertise, and necessitates negotiations about which expertise is to be recognised and taken as the basis for action (Lenhard *et al.* 2006: 348). What, therefore, is expertise? What is an expert? According to Krueger *et al.* (2012), the literature on expert elicitation uses the term ‘expert’ pragmatically to describe anybody whose opinion might be of interest; an expert can be anyone with relevant and extensive or in-depth experience in relation to a topic of interest. Likewise, both Cornelissen *et al.* (2003: 4) and Azadi *et al.* (2007: 238) define an expert as a person whose knowledge in a specific domain is obtained gradually through a period of learning and experience. Regarding experts from different disciplines with working knowledge of issues surrounding climate change, Lowe and Lorenzoni (2007) consider an expert as someone who has thought deeply on a particular subject or has status of authority in a subject by reason of special training or knowledge. 'We can infer from this that the expert has the ability to proffer a coherent and well-judged opinion of what may be, based upon a vast wealth of experience and knowledge' (p. 133). Therefore, experts are usually selected on criteria that reflect such definitions. Usefulness is another factor. Lele and Allen (2006) define a useful expert as one whose opinion adds information over and above what is provided by the observed data.

According to Laws *et al.* (2004: 51), an expert is an individual who has expertise and can report on it. In their understanding, expertise must involve experiential and context-bound knowledge that differentiates it both from sophistication and from a specialist. Krueger *et al.* (2012: 5) use a broad definition of expertise centred on experience, under which experts are distinguished from non-experts by the relevance and extent or depth of their experience in relation to a topic of interest. In this view, expertise includes professionals such as scientists and managers as well as experienced members of the public. Martin *et al.* (2012) identify three types of expertise: substantive, which reflects knowledge of a domain; normative, which is the ability to accurately and clearly communicate judgments in a particular format (e.g. probabilities); and adaptive, which describes the degree to which one is able to extrapolate or adapt to new circumstances.

Krueger *et al.* (2012) note that in the environmental modelling literature, the terms 'expert knowledge', 'expert judgement' and 'expert opinion' seem to be used interchangeably. They prefer to use the term 'opinion' to describe a preliminary state of knowledge of an individual (subjective opinion) or community (intersubjective opinion) when 'claims are not fully justified or are justified with an inadequate reliability level' (Ayyub 2010: 418). For Martin *et al.* (2012: 30), expert knowledge is substantive information on a particular topic that is not widely known by others. An expert is someone who holds this knowledge and who is often deferred to in its interpretation. When experts use their knowledge to predict what may happen in a particular context, Martin *et al.* refer to these predictions as expert judgments.

The complexity of sustainability problems, which usually span broad spatial and temporal scales, mean they cannot be investigated by the usual methods and approaches of disciplinary research (Kueffer *et al.* 2012). Sustainability problems require new approaches for investigating complex SES, for acquiring and integrating different types of data and information, and for determining the validity of results and dealing with uncertainty. Expert opinion can provide substantial information about complex adaptive systems for which information is sparse and data are limited (Bergseth *et al.* 2015: 248). Expert opinion can bridge incomplete process understanding and a lack of experimental data (van Putten *et al.* 2013: 1316). Leal *et al.* (2007) consider expert (subjective) opinion a legitimate source of information for decision-analytic modelling where required data obtained from observed evidence are unavailable. In situations where empirical information is scarce, expert knowledge provides an inexpensive and quick alternative to data acquisition; expert knowledge is an important, and often the only, source of information used in the decision-making process by environmental managers (Drolet *et al.* 20015: 441 & 447).[111] Jones *et al.* (2013) state that when confronted with an incomplete systematic evidence base, alternative methods of evidence rationalisation are required:

> 'This frequently involves the provision of recommendations to policy makers based upon best available data, whilst acknowledging any evidence uncertainties. Eliciting expert opinion and evaluating consensus between experts is one such approach that has been shown to lead to balanced informed decisions' (p. 47).

Expert opinions or judgements may be the only or most credible source of information available for making management decisions (Martin *et al.* 2012). For some clearly defined problems, it may be obvious from the beginning that a particular type of expertise is required; thus, the proposed solution would be

[111] Drolet *et al.* (2015) cite examples in which experts can help assess the severity of anthropogenic impacts, develop species distribution models and make plans for land use.

widely legitimised. ‘However, most sustainability problems are too complex, and the required solution is not at first evident’ (Kueffer *et al.* 2012: 4). The type of expertise and selection of experts is one aspect of the challenges involved in using expert knowledge. Issues of concern include that expert judgments may be biased, poorly calibrated or self-serving and thus lead to poor inference and decision making (Martin *et al.* 2012: 31).

Selection of experts

In order to elicit appropriate expert opinion, that is, guarantee the quality of expert knowledge, it is necessary to identify and select a group of experts capable of expressing opinions regarding the problem or issue. Criteria are applied to the selection. For example, Cooke and Goossens (2004) recommend that experts are selected on the basis of their reputation, including experience and publications in the area of interest, backgrounds and perspectives. For the purpose of eliciting expert perceptions for managing climate change, Lowe and Lorenzoni (2007) consider experts to be those individuals who, having specialised in their particular area of work or research, have extensive knowledge of wider climate change issues demonstrated through involvement in climate change-related projects and international publications. Climate-related experts were identified according to a specific set of criteria (pp. 133-134). Selection recognised that the study on climate change, due to the high degree of uncertainty and complexity of the issue, requires a wide range of disciplinary input.

> ‘This has enabled individuals with no previous background or experience in climate change science (but with a specialisation in a subject area related to climate change impacts or responses) to participate in research and debate on climate change’ (Lowe and Lorenzoni 2007: 134).

As part of a study regarding climate change and tropical island communities, McLeod *et al.* (2015a, 2015b) selected vulnerability and adaptation experts to participate in surveys using the Delphi and focus group methods. The criteria for the selection of experts included: (1) knowledge/expertise concerning climate vulnerability and adaptation as evidenced by climate vulnerability or adaptation publications in peer-reviewed journals; (2) research conducted on climate change and/or adaptation; (3) development or application of tools to assess the impacts of climate change and the development of adaptation strategies; and (4) expertise in tropical island environments and developing countries. Other considerations for expert selection included geographic representation, gender balance, and sufficient capacity and willingness to participate in three rounds of the Delphi process. Based on these criteria, 15 experts were invited to participate and 12 agreed to participate in the Delphi process (McLeod *et al.* 2015a: 371).

Cornelissen *et al.* (2003) base criteria to identify experts on: (1) a person's period of learning and experience in a specific domain of knowledge, which influences his or her judgmental and analytical behaviour; and (2) the specific circumstances in which experience is gained, for example, in theoretical or practical circumstances. The authors state that although there is no definite list of criteria, and even if criteria at best are formulated qualitatively, 'the important contribution is that the basis on which experts are to be selected is transparent and public' (p. 4). Furthermore, Cornelissen *et al.* consider it important to distinguish between the role of experts and the role of stakeholders; a person who qualifies as a stakeholder does not necessarily qualify as an expert, as stakeholders and experts are selected on the basis of different criteria.

Elicitation

Ayyub (2001) defines expert elicitation as a formal heuristic process of gathering information and data or answering questions on issues or problems of concern (p. 235); the expression of an opinion can be defined as putting into words or numbers, or representing the opinion in language, a picture or a figure (p. 126). According to Slottje *et al.* (2008: 7), expert elicitation is a systematic approach to synthesising subjective judgments of experts on a subject where there is uncertainty due to insufficient data, when such data is unattainable because of physical constraints or lack of resources.

> 'It seeks to make explicit and utilizable the unpublished knowledge and wisdom in the heads of experts, based on their accumulated experience and expertise, including their insight in the limitations, strengths and

weaknesses of the published knowledge and available data' (Slottje *et al.* 2008: 7).

Various methods and techniques exist to elicit such views, although the limitations of these approaches, and therefore any decision making which may rely on them, need to be explicitly recognised (Lowe and Lorenzoni 2007: 133). Different methods of elicitation can lead to different results. Furthermore, the sensitivity of results to the second order expert opinion of the researcher-analyst makes the need for explicit justification and documentation of the chosen method(s) even more important; design and documentation can overcome, or at least make explicit, most of the existing limitations (Krueger *et al.* 2012: 11). Ayyub (2001) advises that expert elicitation ought to be: reproducible (documented so as to enable peer review); accountable (anonymity, in contrast, might degrade outcomes); empirically controllable (cross-checked against other information/experts); neutral (in relation to the conduct of the elicitation process); and fair (equal treatment of experts) (Krueger *et al.* 2012: 12).

Krueger *et al.* (2012: 11) consider the type of information sought (quantitative, qualitative or conceptual) to be fundamentally important in designing an elicitation procedure, as this largely dictates either direct or indirect elicitation and limits the choice of appropriate techniques. The next important design choice is that between individual or group elicitation. There are benefits associated with both. Individual interviews may allow for more targeted questioning, explanation and feedback, but might be compromised by preconceived ideas of the interviewer. Group discussions may make disciplinary biases more explicit and discount redundant information through sharing of knowledge, but might be dominated by single individuals and might overemphasise consensus. Individual elicitation may be carried out remotely using questionnaires or software tools, with the benefits of lower cost, standardisation and freedom for the interviewees to respond in their own time, but with the drawbacks of an often low response rate and resulting bias. Furthermore, Krueger *et al.* (2012: 12) state that briefing experts prior to elicitation is an important step that establishes relevance and thus increases experts' attention and sincerity levels.

Martin *et al.* (2012) outline a structured expert knowledge elicitation approach that consists of five steps: deciding how information will be used, determining what to elicit, designing the process of eliciting judgments, performing the elicitation and translating (encoding) the elicited information into quantitative statements that can be used in a model or to inform a conservation decision directly. Typically, an expert elicitation team includes the problem owner (person who specifies the problem), facilitator, analyst and one or more experts; one person can have several roles. In general, definition of the problem and selection of experts is the domain of the problem owner; the facilitator manages the interactions among experts and oversees the judgment-elicitation process; and the analyst handles calibration, elicitation procedures, processing of responses and analysis of elicited information (p. 31).

Martin *et al.* (2012: 32) state that during the design phase the steps in the elicitation process are delineated, how to manage bias is established, and the elicitation format (e.g. email survey, telephone interview, face-to-face interview, group meeting) is determined. In addition, experts are identified; background materials are compiled (e.g. reports, journal articles, data sets); questions are tested and finalised; scenarios to help the experts understand the questions are developed; logistics of acquisition of and interactions with experts are determined; methods of analysis of the expert data, including methods to address uncertainty, are determined; and roles of the elicitation team are identified.

In cases where the elicitation process involves multiple experts, either a group opinion can be sought or information can be elicited independently and then combined. Common group approaches include expert panels and Delphi methods. Selection of elicitation formats and techniques depends on the number and types of experts, accuracy required, and time and resources available to conduct the elicitation. In addition, there is a trade-off between the number of judgments that can be elicited with accuracy and the need to retain experts' attention throughout the process and complete the elicitation efficiently (Martin *et al.* 2012).

Hagerman *et al.* (2010) consider a key strength of expert elicitation (regarding the implications of climate change for conservation policy) is that it does not seek to identify consensus within a group. ‘Rather, it highlights the current diversity (and locus) of agreement and disagreement within an expert community that may not be voiced in more public fora (p. 194).

Dealing with bias and securing validity

Humans are susceptible to a range of subjective and psychological biases, often unknowingly (Martin *et al.* 2012: 33). Expert knowledge is influenced by individual perspectives and goals. Therefore, complete impartiality of expert knowledge is difficult to achieve (Cornelissen *et al.* 2003: 4). Localised knowledge may be biased by experience and values. The fact that experts may carry with them a bias based on their context is a criticism of using expert information (Martin *et al.* 2005). This presents a challenge to the design of expert elicitation procedures.

There are different types of bias. Martin *et al.* (2012: 34) identify the following:

- Motivational biases arise from the context of an expert’s personal beliefs and from the personal stake he or she might have in a decision.
- Accessibility biases arise when information that comes more easily to the mind of an expert exerts a disproportionate influence on an expert’s judgments.
- Anchoring and adjustment biases occur when an expert uses (relies too heavily on) an initial piece of information or familiar reference point (the ‘anchor’) to make subsequent judgments and is unable to adjust their view from this anchor.
- Overconfidence bias arises when the confidence of an expert in his or her judgments is higher than is warranted by the accuracy of their estimates.

As Martin *et al.* (2012: 34) point out, despite the potential for bias, not all experts in all elicitation processes will be biased. Furthermore, bias can be mitigated by careful management, including providing unambiguous feedback and phrasing questions in such a way that they are aligned with an expert’s knowledge. However, some biases, such as overconfidence, are more resistant to mitigation.

Lombard *et al.* (2010) believe that by encompassing a wide coverage of areas of expertise and institutional interests, most of the possible biases can be mitigated. Of course, not only the expert biases but also the bias of the interviewer, facilitator or analyst (in my case, the single researcher; this is discussed in Chapter 8, section 8.3) can bias group processes (Krueger *et al.* 2012).

There is a deep suspicion within positivist science cultures of the validity of expert judgment (Arnell *et al.* 2005: 1428). Bray and von Storch (1999: 439, cited in Lowe and Lorenzoni 2007: 133) conclude that experts, especially under conditions of high uncertainty, express views beyond their area of expertise, which affects the validity of such perspectives. The reliability of, for example, expert judgement depends on its consistency in quality across time and/or situations. The validity of expert judgement depends on whether it addresses that which it was elicited to address. Reliability is necessary, but not sufficient, for validity (Jacobs *et al.* 2015: 25). According to Dorussen *et al.* (2005: 327), even when experts are chosen with great care, researchers may question the validity of (some of) the responses provided. Confidence in an expert may be based on the standing or reputation of the expert, or simply on his or her behaviour during the elicitation procedure. In other words, the validity of the information collected crucially depends on the quality of the experts (p. 333). In order to secure validity, Martin *et al.* (2012) suggest that, because expert knowledge is only a snapshot of the expert's judgments in time, expert assumptions and reasoning 'should be documented in such a way that they can be updated as new empirical knowledge accrues' (p. 33). Dorussen *et al.* (2005: 317) conclude that there are good reasons for consulting multiple experts to increase the validity of the data.

In relation to quality and validation, Low-Choy *et al.* (2011, cited in Martin *et al.* 2012: 35) devised a checklist of attributes for assessing the comprehensiveness and effectiveness of an expert elicitation process. It involves four criteria: (1) Study context and justification (including study location and topic) and singularity of expert knowledge (e.g. is the expert knowledge supplemented, complemented or sole source of information). (2) Elicitation design (e.g. number of experts invited/participated; and expert category; elicitation process piloted with test subjects). (3) Elicitation method (e.g. knowledge elicited individually or in groups; knowledge elicited in person or remotely; and elicited information was qualitative, quantitative or both). (4) Elicitation output (e.g. representation of uncertainty in final output; and validation of the experts' knowledge).

5.3.2 Elicitation strategy

The most appropriate sources of information are experts with relevant knowledge. Therefore, the study was designed to elicit expert opinion about the things being studied. This required a procedure (see subsection 5.4.1) for identifying and selecting individuals capable of providing valid and valuable information. Following careful selection of potential candidates, individual experts were invited to participate in a panel for the study. The panellists were geographically dispersed, residing and working at different locations in Europe. For practical reasons, the researcher (myself) would interact and exchange information with panellists without physically assembling and meeting them. For methodological reasons, panellists would remain anonymous to each other during the study (and their responses would remain anonymised afterwards).

It is important to be explicit about the location of power in the research process, which remained with the researcher. The mode of participation was limited to consultative. That is, the panellists would be consulted and asked for their opinions rather than involved in working together collaboratively (Cornwall and Jewkes 1995: 1669). Therefore, the study design should properly be called a 'participative form of enquiry', not 'participatory research', due to the absence of democracy (Bergold and Thomas 2012: 5).

Anonymity

The issue of anonymity between panellists is significant. Various social processes that occur naturally in decision-making groups are considered detrimental to the quality of decisions, making group decision making inferior to individual decision making (Postmes and Lea 2000). By avoiding direct confrontation between panellists in face-to-face group meetings and reducing the negative influence of some undesirable psychological peer pressure and biasing effects arising from dominant personalities and seniority status of panellists (Gupta and Clarke 1996: 186; Powell 2003: 377; Landeta 2006: 469), controlled methods of group interaction can provide a level playing field for participation and the communication and documentation of facts and opinions.

In controlled methods such as the Delphi technique, an individual's views and comments can be presented to the group in a way that (fully or partially) suppresses individual identification. Disassociating a panellist's identity from their contributions (to all but the researcher) may mean that the panellist is more disposed to share ideas, views and opinions with the group. In other words, the cloak of anonymity reduces or eliminates concerns regarding status and judgement by one's peers (Rowe and Wright 1999: 354). Anonymity may enable individuals to more freely change their mind and adopt modified or new positions in the face of new knowledge and understanding instead of sticking with their earlier position. In general, anonymity reduces or moderates the influence of individual personalities on group behaviour and judgements. Nevertheless, anonymity has methodological weaknesses. Sackman (1974: 62-63) suggests that anonymity may lead to abandonment of accountability for views expressed and even inadvertent reinforcement of elitist vested interests.

The degree and timing of anonymity can be controlled by the researcher. Anonymity may be appropriate for some steps in the research process but not for others. Panellists may be unwilling to become involved in the first place if they are not due to receive open acknowledgement of their contributions; or if they do not know the identities of the peers with whom they will collaborate. Furthermore, among a panel selected from a small and specialised community of practice, anonymity might be artificial. This is because individuals could recognise or guess the identity of contributors, whom they know or know of, from the character and style of their contributions. While panellists may know by design who else is participating, it is the responsibility of the researcher, as facilitator, to ensure that panellists are unable to identify and connect contributions with another panellist's identity (HERO 2001: 2).

Communication

Interpersonal communication is a vital component of the study design. Implicit in the process of expert elicitation is the need to establish a setting in which geographically dispersed panellists can interact with the researcher and the research process; but, in this case, not with each other. This structured interaction would take place via electronic media and Internet-based online interactions. Online communication can significantly reduce costs, particularly when panellists are geographically dispersed.

Panel size

There is no consensus regarding the ideal number of individuals for studies involving expert panels (Powell 2003: 378; Coleman *et al.* 2013: 97). For example, a global scale Delphi study concerning aquaculture development conducted by the Hishamunda *et al.* (2009: 4) involved 305 experts. Plummer and Armitage (2007) administered a Delphi study on adaptive co-management with an expert panel of 30 individuals. Gordon (2009: 7) notes that most Delphi studies use panels of 15 to 35 people. For Garrod (2003) an expert panel comprising 15 members was considered appropriate for a Delphi study concerning marine ecotourism

> 'as this would make the panel large enough for differing views to emerge among the panel members, while keeping it small enough to enable the research team to administer the project and turn the questionnaires around in a timely manner' (p. 22).

What then is the ideal size expert panel for this study? Guidance suggests that numbers of panellists will vary according to the scope of the problem and resources available (Powell 2003: 378). Garrod (2003) argues that the size of the panel is not considered to be a critical issue; 'what is more important is that the Delphi panel needs to be suitably balanced in terms of the background, interests and expertise of its members' (p. 19).

Invitation list, dropout and substitution

Forming an expert panel requires candidates, once they have been selected, to be contacted and invited to participate. According to Gordon (2009: 7), the length of the invitation list should anticipate an acceptance rate of between 35 and 75 percent. The issue of how many experts should be contacted depends on (1) the method chosen to elicit opinion from the panel, and (2) the need for redundancy to account for dropout. For example, Franklin and Hart (2007: 242) found that in a study using the policy Delphi method, 22 panellists began the process, but only 17 panellists continued to the end of the study.[112]

Consideration should also be given to the possibility that although some contacted candidates are not themselves willing or able to participate, they may nominate another expert or experts who may agree to act as substitutes. Given this possibility, should the initial contact explicitly refer to substitution and, if necessary, request the candidate to nominate a substitute if they decline the invitation? Can the act of nomination be considered a valid peer recommendation and an affirmation of the nominee's expertise? Or, particularly if the nominee did not appear on the shortlist, should the nominee be subjected to the same selection criteria? I decided that peer recommendation was justified. Therefore, in the invitation to participate, I included the request that in the event the candidate was unable or unwilling to participate in the study, would they please recommend a colleague who I may contact instead? In the end, no one availed of this opportunity; all replies were either straightforward acceptances or declines.

5.4 Methods

According to the Oxford Dictionary (2015), a method is a 'particular procedure for accomplishing or approaching something, especially a systematic or

[112] As well as dropout, panellists may become less willing to participate over the period of the study. Franklin and Hart (2007) state: 'The best strategy to improve retention and ensure willingness to participate to the bitter end is the selection of a valid group of experts who have an interest in the topic. Outside of that selection, another strategy is to design a process whereby researchers stay in contact with all panelists [sic] during the data collection and analysis phases. This includes staying in contact with panelists [sic] in between each round of questionnaires. Additionally, for most experts participating in higher education there is an ebb and flow of work during the academic year. In planning when to begin and end a policy Delphi study, researchers should attempt to initiate the study based on the work timeline of panellists' (p. 244).

established one'. The European Commission's Joint Research Centre considers a method to be a systematically arranged series of steps taken to complete a certain task or to reach a certain objective (JRC-IPTS 2013). Therefore, methods are the rules and practices used by the researcher at both theoretical and practical level to answer the research questions and achieve the research objectives. The remainder of this section describes the methods and tools used in this research, including the expert panel selection (subsection 5.4.1), workbook method used for data collection during the study (subsection 5.4.2), data analysis method (subsection 5.4.3) and other or rather non methods (subsection 5.4.4). For reasons of space, various details are consigned to appendices.

5.4.1 Expert panel

In the study, I am interested in the idea of producing transdisciplinary knowledge by obtaining information from a carefully selected group of experts. That is, by drawing on knowledge from different disciplines – spanning distinctions between the natural and human/social sciences – and integrating it into a coherent whole. Given the type (opinion) and source (experts) of information to be collected, it was necessary to form a panel of experts for consultation during the study. (For further details, and an explanation of the selection of academic rather than policy experts, see Appendix B on the procedure for identifying and selecting candidates for the expert panel for further details and justification.) However, as Lowe and Lorenzoni (2007) point out, 'there is no agreed definition of what constitutes an 'expert' in the expert knowledge elicitation literature' (p. 133). According to Cornelissen *et al.* (2003: 4) and Azadi *et al.* (2007: 238), an expert is a person whose knowledge in a specific domain is obtained gradually through a period of learning and experience. Such a definition bypasses the issues of status, authority and reputation. It also obviates the need to specify an individual as a scientist, academic, specialist, policymaker, manager, professional, lay person and so forth. A loose definition circumvents either/or considerations: whether an individual is either an insider or outsider (in terms of community of practice), with experience gained either in theoretical or practical circumstances, who is either directly or indirectly involved with the system being studied (Cornelissen *et al.* 2003: 4; Azadi *et al.* 2007: 238).

The procedure for selecting suitable individuals with appropriate expertise to form the panel involved identifying potential panellists before making a selection according to certain criteria in order to address selection bias (see Appendix B). In short, the procedure consisted of undertaking structured Web searches for relevant scholarly literature using querying based on the researcher's (my) reasoning (Zins 2000) with subsequent information retrieval. The search engine Google Scholar[113] was used; during pilot runs it captured a more focused and therefore manageable field of results specific to the study topic than did, for example, Scirus (since retired). A series of search strings using different combinations of words and phrases was created to reflect as precisely as possible the subject matter, for example:

> european maritime OR marine OR ocean OR coast OR coastal atlantic sustainability OR "sustainable development" governance "maritime policy"

The search strategy allowed for modifying the strings to improve or refine the results. The results were then browsed and the names, email addresses and affiliations of all relevant individuals were sought (using the main Google search engine) and recorded. Limitations and exclusions were introduced to filter the list to produce a shortlist of 98 candidates. The intention was not to generate a definitive list of all possible individuals suitable for an expert panel, but rather a valid and manageable list of candidates that could be invited to participate.

The selected candidates were contacted by email with an invitation to participate in the study. This included a statement of the study objectives, requirements of panellists and consent form.[114] Two weeks later, a reminder was emailed to candidates who had not yet responded. Copies of the invitation, consent form and follow-up communications are presented in Appendix C. The majority of

[113] http://scholar.google.com/

[114] Each panellist completed and returned a participant consent form (Appendix C) agreeing to the conditions of the study and allowing their name and that of their affiliated organisation to be disclosed at the end of study.

candidates, despite expressing interest in the study, declined due to unavailability, existing commitments, concerns about potential workload and/or duration of the study. Nineteen experts agreed to participate in round one of the study; seven of them continued to participate in round two. The study took place between November 2009 and December 2011. The list of panellists in rounds one and two are presented in Appendix D.

5.4.2 Workbook method for data collection

Initially, three different methods for obtaining expert opinion were considered: the Delphi, questionnaire and interview methods. However, all three were rejected for different reasons, as follows. Despite its reliance on anonymity and inherent use of feedback and opportunity to revise earlier responses, the multi-round Delphi method was rejected because of its emphasis on achieving a panel consensus. This was considered counterproductive to obtaining a diversity of opinion. The use of a questionnaire was considered unsuitable for capturing the depth of opinion concerning a complex subject matter such as EASES. The prospect of conducting interviews remotely was also rejected; this followed discussion with a pilot sample of three experts (who did not participate in the study) which concluded that demands on a panellist's availability and the potential duration of an interview were effective deterrents to participation in the study.

Consequently, I decided to develop a qualitative workbook method specifically for the study. It would employ a set of tools including workbook documents for data collection. The idea was inspired by the resilience assessment workbooks developed by the Resilience Alliance (2007a, 2010). However, these documents did not provide an out-of-the-box solution. They would have required significant modification and tailoring to achieve usability for the study. Therefore, I decided to develop workbook tools from scratch.

The EASES study encompasses a large number of issues concerning society–nature relations in a European maritime macro-region. Practical considerations determine that such a large and complex subject matter be subdivided into appropriately sized packets for the researcher (myself) and panellists to deal with them effectively. In this design, it was the researcher's task to identify these packets and decide on their priority and arrangement. The workbook method is essentially a procedure for asking panellists specific open-ended questions about packets of the subject matter of the research.[115] A workbook is a structured tool for asking those questions, drawing out meaningful responses and recording the information for subsequent analysis. Workbooks are generally a one-off exercise. However, the method was developed to be an interactive and iterative process between researcher and expert over two rounds of consultation. This was achieved by incorporating design characteristics of the Delphi method, including structured information flow, controlled feedback, iteration, anonymity and asynchronous communication. A different workbook was developed for each round.

Rounds one and two

A workbook document was prepared, containing a number of objectives accompanied by some background information, the researcher's suggestions and 49 open-ended questions (Appendix E) with space to enter a response.[116] At the start of round one, each panellist received instructions and a copy of the workbook by email. They were asked to respond to as many questions as they could and submit the workbook back to the researcher. For their information, panellists were supplied with two supporting documents: one describing the researcher's initial conceptualisation of EASES, the other providing background information on the maritime context and resilience concepts. Panellists' responses were analysed and synthesised to produce a report for their information in round two. The results and analysis of round one are presented in Chapter 6.

Taking into consideration the panel's responses, a round two workbook was prepared containing 12 questions (Appendix E). Two additional supporting documents were also prepared: one describing the resilience-related dynamics of

[115] Open-ended questions are designed to encourage a respondent to give full, meaningful and unstructured responses, of indeterminate length and detail, using the respondent's own knowledge and experience. This is in contrast to closed-ended questions, which are designed to encourage (or lead to) limited, short and structured responses intended for quantitative (statistical) analysis.

[116] The development of the round one workbook benefited greatly from the advice and assistance of colleagues at the Coastal and Marine Research Centre (CMRC), University College Cork. Five of these colleagues participated in piloting the workbook. Their comments and suggestions were incorporated into the final version of the workbook.

SES; the other describing the concept of social–ecological resilience.[117] During round two, panellists were given the opportunity to review the panel's round one responses and submit any feedback.[118] The results and analysis of round two are presented in Chapter 6.

Each round had a different focus. The purpose of round one was to define key components and characteristics of EASES as well as identify key disturbances and other drivers of change affecting EASES. The purpose of round two was to identify characteristics of EASES (now a shared representation that emerged from round one) that are crucial to its general resilience, both in terms of resilience dynamics and resilience capacity. In other words, identifying SES properties that require resilience management in the context of multilevel governance.

The workbook method is only one of the methods used in this research. The other main qualitative method is the one used for data analysis.

5.4.3 Data analysis method

The answers to the research questions depend on explanations of the things being studied, which in turn depend on detailed examination of the information collected from the expert panel using the workbook method. Of course, there is no single approach to the analysis of qualitative information. The choice of method of data analysis depends on the particular type and source of information and the purpose of information relative to the initial propositions, research problem and study aims. The choice also depends on the researcher's philosophical (ontological, epistemological and methodological) stance, starting assumptions, theoretical foundation and conceptual framework. For some research designs there may be a definite choice between more or less off-the-shelf analysis methods. For

[117] Due to time and other constraints, piloting of the round two workbook involved just two colleagues at CMRC, both of whom were familiar with the concept of resilience. Their feedback focused on the contents of the supporting documents rather than the workbook. Their comments and suggestions were taken into consideration in the final version.
[118] Panellists were invited to respond to the report and/or summary with any additions or revisions they wished to make; and to freely comment on views expressed by the panel as well as the researcher's analysis and interpretation.

others, including this research, the choice is much more ambiguous, which presents a challenge to validity. But there are some pointers in the literature.

Denscombe (2010: 272), for example, suggests three general principles of qualitative data analysis. First, analysis is an iterative, evolving process in which data collection and analysis occur in parallel. Second, analysis is an inductive process that proceeds from the detailed study of localised data to arrive at more abstract and generalised statements. Third, analysis is researcher centred, that is, the researcher's self-identity, values and experiences are seen as factors influencing the analysis. Creswell (2007: 148) considers qualitative data analysis to consist of preparing and organising the data for analysis, then reducing the data into themes and finally representing the data in figures, tables or a discussion. But what about case-based data analysis in particular? The analysis of case study information is especially difficult because the strategies and methods are generally not well defined (Yin 2003: 109). Case study research produces vast amounts of data, which 'implies that qualitative data analysis of case studies is complex and requires flexibility, experience, and skill' (Evers and van Staa 2010: 749).

Analytical strategy

For case studies, Yin (2009: 130-136) suggests four general analytical strategies: The first, 'relying on theoretical propositions', involves following the propositions underlying the case study. The second strategy, 'developing a case description', is to develop a descriptive framework for organising the case study. This is more useful when lots of information have been collected without having first settled on an initial set of research questions or propositions. 'Studies started this way inevitably encounter challenges at their analytic phase' (Yin 2009: 131). The third strategy is to 'use both qualitative (statistical) and quantitative data'. A fourth general analytical strategy, 'examining rival explanations', involves setting up a framework to define and test rival explanations. This generally works with all of the previous three strategies if, for example, the initial propositions have included rival hypotheses; or if the contrasting perspectives of participants have produced rival descriptive frameworks.

Bearing in mind the difficulties of qualitative case study analysis, I decided to follow a variant of Yin's (2009: 130) 'relying on theoretical propositions' analytical strategy. This involves following the propositions that led to the case study. This is logical where research objectives and questions are based on such propositions. Propositions shape the data collection strategy and therefore give priorities to the relevant analytical strategies. This research was guided by an initial set of propositions and related set of research questions (presented in Chapter 1, section 1.2). As Yin (2009: 13) points out, propositions help to focus attention on certain information and to ignore other information. That is, they help to define the analytical focus and scope of the study. The initial set of propositions provided a foundation for developing the conceptualisation of EASES in Chapter 6. The analysis stems from the propositions and underpins the discussion of findings. Although more prominent following data collection, analysis is an activity that occurs throughout much of the research process.

In this research, data analysis is a reflexive and iterative process involving both inductive and deductive inference. Application of an analytical method to make sense of information gathered in the workbooks is essential to the development and refinement of the conceptual framework (described Chapters 2 and 3). In turn, refinements to the conceptual framework modify the analysis. In this way, a satisfactory level of analysis can be achieved. Essentially, this interdependent process takes place in my (the researcher's) mind. It is also shaped, to some degree, by my interaction with the panellists in terms of their responses. As Daly (2007: 210) points out, it is important to recognise that participants are also analytic; the panellists' responses to my open-ended questions depend on their own particular analytical and interpretive frameworks applied to the study information presented. However, this analytical interplay is unequal; the panellists did not construct the final analysis and interpretation, which remain the purview of the researcher.

Analysis is the process of fragmenting the data, separating the thing(s) being studied into components, identifying patterns and relationships, grouping them thematically, highlighting key elements and arranging them; interpretation is the process of assigning meaning to elements, abstraction, attaching significance and theory construction. Hence, when examining the information gathered, the researcher is 'engaged in a recursive process of analysis and interpretation whereby we go back and forth between trying to see the component parts and the meanings that these have for understanding the broader phenomenon' (Daly 2007: 215). This recursive process is represented in Figure 5.1.

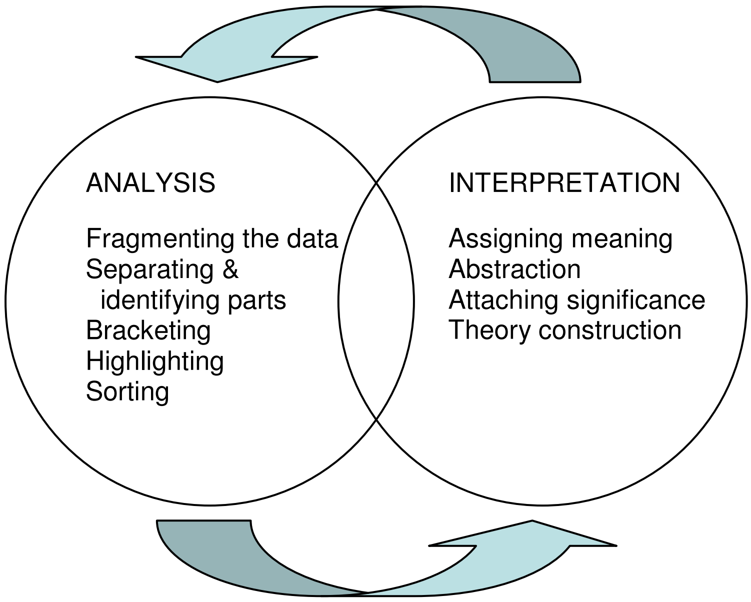

Figure 5.1 Recursive interplay between analysis and interpretation. (Based on Daly 2007: 215, Fig. 9.1).

Qualitative research is an inherently interpretive process in which the researcher steps back and forms some larger meaning about the things being studied. Interpretations are based on personal views and cannot be separated from the researcher's own background, history, context and prior understandings (Creswell 2007: 248, 2009: 176, 2012: 257). The interpretivist paradigm recognises the researcher's role in interpreting the information gathered and in constructing meaning from it. It also recognises that the researcher's interpretation will differ from interpretations made by others.

Method of data analysis

A procedure for the analysis of empirical material emerged during the research process. By 'empirical material' I mean the total set of workbooks containing responses returned by panellists (19 workbooks in round one, seven in round two). The method consists of five interdependent stages: preparing data, conducting data analysis, representing, interpreting and verifying data. There was significant overlap and interplay between the stages rather than a strict sequence. In the following paragraphs, I describe the five stages.

1. Preparing data. Data preparation involves checking the empirical material (e.g. for completeness), entering the responses into the computer database, and organising data to facilitate retrieval and analysis. Both Stake (1995) and Yin (2009) recognise the importance of organising data effectively. The data sets used in qualitative data analysis tend to be large and cumbersome, even though samples may be small. They require intensive examination, understanding and, therefore, organisation.

Organisation can be achieved manually or with the assistance of software. There are several computer assisted qualitative data analysis software (CAQDAS) tools available (e.g. ATLAS.ti and NVivo) that can be used to help organise qualitative data systematically. CAQDAS use the coding method to structure, organise and sort through data. In qualitative research, coding means to attach a label or tag to a selected data segment, usually by assigning a word or phrase that summarises a section of language-based data (e.g. paragraph of text) or visual data (e.g. part of an image or video). Coding can help catalogue key concepts and themes while preserving the context in which these occur. However, CAQDAS do not 'analyse' data (that is the task of the researcher), they simply aid data management and make handling qualitative data sets easier (Burnard *et al.* 2008: 430). Thorne (2000) states that none of the CAQDAS 'are capable of the intellectual and conceptualising processes required to transform data into meaningful findings' (p. 68). In order to preserve the uniqueness and nuances of panellists' responses, the coding method was not employed. Instead, the empirical material was annotated with thematic notes (de facto tags and labels) – in other words, written memos – using the comment function of the Microsoft Office Word 2003 word processor program. To assist with this, I also used the IHMC CmapTools v4/v5 concept mapping software program[119] for organising the information.

Memoing is recognised as an effective research tool and component of a qualitative data analysis strategy (Birks *et al.* 2008). Memo writing is a process of recording the reflective thoughts and ideas of the researcher. Memoing enables the researcher to immerse themselves in and explore the data, and extract the meanings it holds in the context of the things being studied; it helps the researcher in making conceptual leaps from the data to achieve abstractions (e.g. regarding concepts and their relationships) while remaining true to the data.

> 'While guidelines exist to aid in the production and use of memos, memoing remains a flexible strategy wherein the process of construction and nature of content is determined by the preferences and abilities of the researcher and the aims and focus of the specific research study' (Birks *et al.* 2008: 68).

Often in qualitative research, the collected data need to be condensed for the sake of manageability and reconfigured so they can be made meaningful in relation to the issues being addressed. Miles and Huberman (1994: 10) describe data reduction as the process of selecting, focusing, simplifying, abstracting and transforming the data. According to Frechtling and Sharp (1997), data reduction often forces choices about which aspects of the assembled data should be emphasised, minimised or set aside completely for the purposes of the study. Data reduction was employed to produce a report for the panellists' information in round two.

The panellists' responses were already well categorised and organised according to the workbook (data collection) structure. However, it was helpful to copy and paste all responses to a particular question into the appropriate box in one master copy of each workbook. This facilitated

[119] Developed by Institute for Human and Machine Cognition (IHMC, http://cmap.ihmc.us/).

information retrieval. It also facilitated convergence, that is, analytic comparison of linked material without treating each data source (expert panellist) independently during the analysis stage (Baxter and Jack 2008). To enable tracking of responses to their original source (individual workbooks), the 19 panellists who participated in round one were each labelled from A to S. With data organised in a master copy, I then performed an initial exploration of the responses: developing a general sense of the information, making notes and highlighting emerging themes.

2. Conducting data analysis. This is the iterative and reflexive process of examining the responses and unlocking information by hand and mind rather than using software. The analysis was guided by the conceptual framework concerning SES and resilience theory (presented in Chapters 2 and 3 respectively). The aim was to develop a qualitative understanding of key characteristics of EASES and identify those that are crucial to resilience. The analytical process can be described as moving deeper and deeper into understanding the information (Creswell 2009: 183). This was achieved by reading and rereading the prepared empirical material, looking for key points, concepts, themes, patterns and relationships – a process assisted by the techniques of memoing and concept mapping.

I considered using the QSR International NVivo 8 CAQDAS program.[120] But I decided against it on the basis that NVivo is designed for interrogating unstructured data sets, coding and automated searches for patterns. The empirical material was already well structured (due to the structured workbook approach adopted for data collection); and annotation could easily be applied to master copies using the Microsoft Office Word 2003 word processor insert comment function. More importantly, I judged that NVivo would not adequately account for nuances involved in the responses, including in terms of an individual panellist's phraseology. Overall, I did not want to rely on any form of automated relationship identification function (NVivo 8 included a 'relationships tool').

[120] http://www.qsrinternational.com/

Instead of using NVivo or another CAQDAS, I used CmapTools to assist with understanding the things being studied (e.g. system properties) within their context (i.e. the empirical material), uncovering links and relationships within and between concepts, developing themes, representing emerging knowledge in graphical form and documenting the analysis (Bradley *et al.* 2007). Vasconcellos (2014) describes CmapTools as a tool that facilitates visual data organisation that in turn helps cognitive interpretation without the need for prior elaboration of concepts. 'On the contrary, concepts emerge during the cognitive process of data interpretation' (p. 480). The emphasis is on cognitive interpretation rather than simply software techniques.

In addition to its strong concept map visualisation features and sound theoretical basis (Cañas *et al.* 2003, 2004; Novak and Cañas 2008), my decision to use CmapTools was based on my prior familiarity with using the program for concept mapping SES relationships for the Cork Harbour case study (SSA08) as part of the FP6 SPICOSA project 2007-2011.[121] Furthermore, unlike CmapTools, which is free to use, NVivo is an expensive commercial product, which was a consideration.

The process of qualitative data analysis involved the researcher (myself) remaining open to a combination of deductive and inductive analysis (Frechtling and Sharp 1997). That is, open to both deductive reasoning proceeding from general principles to understand a specific instance (EASES) and inductive reasoning that derives broader generalisations about maritime SES from observations about EASES. In summary, the aim was to make sense of the data collected by identifying important themes and meaningful patterns. From this, in an iterative and fluid process, the researcher moved forwards – guided by the research questions – to some form of interpretation of the things being studied and their meanings regarding the conceptualisation of EASES (Chapter 6).

[121] See http://www.spicosa.eu/cork_harbour/index.htm [accessed 4/7/2016].

3. Representing data. In qualitative analysis, the analyst (myself) decides which data are to be selected, both to address specific research questions, and to represent and understand the big picture. The information (results) arising from the analysis need to be represented and reported. This takes the form of descriptive accounts of the data (descriptions) accompanied by tables and figures where appropriate.

4. Interpreting data. As mentioned above, there is a recursive relationship between analysis (identifying points, concepts, themes, patterns and relationships) and interpretation (attaching meaning and significance to them). For Creswell (2012), 'interpretation' is explaining the larger meaning of the results. It is the process of explaining what has been found, of making sense and reflecting on the results and how they relate to the research questions. This includes taking uncertainty into consideration and addressing why results either agree or disagree with my assumptions, theoretical expectations and the conceptual framework.

My interpretations take what I consider to be the important results and link them to the larger theoretical and conceptual issues (presented in the conceptual framework in Chapters 2 and 3) and the context (described in Chapter 4). The data were interpreted through an interpretivist, social constructivist lens. The aim was to transform the empirical material into a coherent representation of the things being studied. My interpretations are found in the various discussions and conclusions throughout this thesis, but particularly in the synthesis and discussion in Chapter 7.

5. Verifying data. Proving reliability and trustworthiness is a challenge in qualitative data analysis. Confirming the correctness, truthfulness or accuracy of data depends on the researcher's justification of the methods applied to collection and analysis. Repetition of data gathering is not feasible. Analysis and interpretation are based on one-off responses to questions provided by multiple panellists. To some extent, the round one responses were verified by feedback from panellists participating in round two. More broadly, a multiple perspectives approach involving an expert panel was built into the methodological framework to address quality, validity and credibility (see Chapter 8, section 8.3).

5.4.4 Non-methods

Data synthesis

No specific method for qualitative data synthesis was applied (for a critical review of synthesis methods see Barnett-Page and Thomas 2009). I consider the process of qualitative synthesis (combining information) to be an intrinsic part of interpretation stages of the research process. Synthesis is implicit in the study of systems; the search for wholeness or forming a whole is essentially the aim of systems analysis and interpretation.

Literature review

In this thesis, I do not consider a literature review to be a method of data collection or analysis, or stand-alone statement. It is a *sine qua non* for research. Reading and reviewing literature (both academic and grey) concerning the object of research, theoretical background, methodology and other aspects of research is an ongoing process of acquiring and updating knowledge. It began prior to the research proposal, continued throughout the research process and melds into subsequent studies. Simply put, continual literature review informed this research; and all this research is embedded in literature review.

5.5 Summary

This chapter charted the researcher's (my) philosophical stance and methodological perspective. Instead of maintaining a static position adopted at the start, the research framework evolved as the investigation progressed. This framework underlies the research approach, design and methodology used to address the research questions. The chapter began by examining the fundamental rationale for this research, which is the production of usable and effective knowledge for sustainability against a background of uncertainty. The chapter then explained the research approach for addressing contemporary society–nature relations and interactions. It located the study in a hybrid frame of reference for sustainability research consisting of social ecology, sustainability science, a SES approach and resilience thinking. Turning to the methodological aspects of this research, the chapter provided justification for a single case study involving a macro-regional unit of analysis (EASES). It then explained the rationale behind the qualitative research strategy adopted for the study of EASES. Finally, the chapter described the methods used for selecting the panel of experts, gathering their opinions and analysing the data. This involved innovation of a workbook method specifically for this study.

Chapter 6

Conceptualising the European Atlantic social–ecological system (EASES)

This chapter describes the conceptualisation of the European Atlantic social–ecological system (EASES) as the unit of analysis for understanding the Atlantic Europe maritime macro-region.

6.1 Introduction

In this thesis, I argue that the theory of complex adaptive social–ecological systems (SES) has important implications for the design of integrated ocean and coastal governance. My premise is that SES-based governance architecture is necessary for European maritime governance to successfully meet the challenges of global social–ecological change and sustainable development. This research asks whether it is possible to use a maritime SES as a conceptual framework and analytical tool to relate multilevel adaptive governance architecture to sustainability and development. This is in the context of Europe's maritime macro-regions and sea basins in general, and the Atlantic Europe maritime macro-region in particular. To address this central question, a study was conducted to conceptualise EASES as an analytical construct to represent the Atlantic Europe maritime-macro-region as both a SES and a unit of analysis. The conceptualisation of EASES provides a basis for relating governance architecture to maritime regional sustainability using the lenses of complex adaptive SES theory (Chapter 2) and resilience thinking (Chapter 3).

The remainder of this chapter is organised as follows. Section 6.2 considers the SES as the unit of analysis. Section 6.3 gives an overview of the study of the selected unit of analysis (EASES) that underpins this thesis. This is followed by sections describing the results and analysis. Section 6.4 outlines the geographical and ecological characteristics of EASES, while section 6.5 concerns the sociopolitical and socioeconomic characteristics. Section 6.6 defines system boundaries and describes their conditions. Section 6.7 identifies key system structures, processes and functions of EASES, including in terms of critical capital. Section 6.8 determines the system hierarchy and cross-scale interactions between the macro-regional level and other levels. Section 6.9 identifies key disturbances and other drivers of change that influence EASES. Section 6.10 concerns key human activities that affect the sustainability of EASES. The chapter ends with a summary (section 6.11).

6.2 Social–ecological system as the unit of analysis

SES are integrated systems of individual people, human society, the built economy and ecosystems (Costanza 1996, 2003, 2011; Costanza *et al.* 2007a, 2012a, 2014). The concept considers social and ecological systems to be deeply and dynamically interconnected through cross-scale interactions and reciprocal feedbacks: equally important, interdependent subsystems that function as a coupled SES across space, time and levels of organisation (Gunderson and Holling 2002; Berkes 2011a: 12).

A SES is an integrative unit of analysis. As a construct, it can be specified at any level of organisation or 'focal level' of interest on a scale, at levels from a local community and its surrounding environment to the entire Earth System (Gallopín 1991). In general, an understanding of the whole system cannot be arrived at by simply synthesising separate analyses of single social and ecological components (Gallopín and Modvar 2005: 7). Nor can the system's behaviour and emergent properties be anticipated without simultaneously taking into account processes in both the social (including cultural, economic, institutional, political and technological aspects) and ecological domains, and their interactions across space and time. In other words, a SES is more than just an aggregate of its parts; it is non-decomposable and must be investigated as a whole (Gallopín 2006: 294). Indeed, the fundamental qualities of unity (wholeness) and continuity are linked to the identity of the system (Cumming and Collier 2005). Therefore, SES can be considered the basic unit of analysis for sustainability and sustainable development research (Gallopín *et al.* 2001: 224; Gallopín and Modvar 2005).

SES are open systems that continually interact with their environment. Their boundaries are generally permeable to variable transboundary flows and exchanges of energy, nutrients, materials, information, organisms, human migrants, social cooperation, trust, finance, trade, political influence, cultural influence and so forth. For research to be meaningful and useful, a unit of analysis cannot be amorphous and ill-defined; a SES must be bounded, even if its boundaries are generally indistinct ('fuzzy') and dynamic. Here, the issue of scale is important. Social–ecological patterns and processes can occur at and across a number of different scales and levels. Clearly there is a relationship between the focal level at which the structures and processes of interest are considered and the scale (extent) of the SES selected, and subsequently defined, as the unit of analysis. For the study underpinning this research, the researcher (myself) selected a unit of analysis (EASES) commensurate in scale with the Atlantic Europe macro-region of interest.

6.3 Overview of the study of EASES

This research is sustainability focused, use inspired and place based (see Chapter 5, subsection 5.2.2). It aims to contribute to solving real world sustainability problems in a specific geographical context, this being the Atlantic Europe macro-region. The basis for this research is a study that sought to examine the proposition that a multilevel governance framework can be focused on building SES resilience in order to help achieve sustainability in the Atlantic Europe macro-region (see Chapter 1, section 1.2). This is in the context of the then emerging Integrated Maritime Policy (IMP) framework for integrating Europe's maritime affairs (see Chapter 4, section 4.5).[122] In order to relate governance to sustainability and sustainable development, the study used a complex adaptive SES as a conceptual framework. The study involved two rounds of consultation with an invited panel of experts (see Chapter 5, section 5.4). Nineteen experts participated in round one and seven of them went on to participate in round two. A workbook method was developed and used in each round to elicit and gather

[122] The IMP is the EU political framework for supporting cross-sector and cross-scale sustainable development policy and governance concerning ocean and coastal activities, economic growth, European territorial cohesion and environmental sustainability.

information from panellists. Panellists' responses (and feedback concerning round one) were taken into consideration when preparing the conceptualisation of EASES.

The study began with an initial conceptualisation of EASES: a single construct produced by the researcher. It identified key geographic, ecological, social, political and socioeconomic characteristics of the Atlantic Europe macro-region. The initial conceptualisation was used during round one to position EASES in relation to marine biogeographic subdivisions, notions of Atlantic Europe space and identity, spatial development and governance in the macro-region. This provided a starting point for the panel's work.

Study aims and objectives

The aims of the study were to:

1. Define the boundaries and establish the essential identity of EASES in relation to existing structures and processes considered critical to the functioning of the system.
2. Identify and better understand the key system components (agents and processes) and properties (structures, behaviours and functions) that determine resilience in EASES.
3. Consider how a resilience perspective can help multilevel maritime governance focus on developing sustainable pathways at the macro-regional level of Atlantic Europe.

The focus of round one was on defining key components and characteristics of EASES as well as identifying key disturbances and other drivers of change affecting EASES. The objectives of round one were to:

1. Establish and clarify the spatial and temporal boundaries of EASES.
2. Describe conditions that characterise these boundaries.
3. Identify key structure, processes and functions of EASES, including in terms of different forms of critical capital.

4. Determine key structural relationships and cross-scale interactions between macro-regional and other levels.
5. Identify key disturbances and other drivers of change that influence EASES.
6. Identify key changes taking place in the social and ecological domains.

The focus of round two was on identifying properties of EASES that require active resilience management in the context of multilevel governance. The objectives of round two were to:

1. Identify critical resilience dynamics of EASES using two related models of nonlinear change: the adaptive cycle (Holling 1986) of system development and renewal, and the panarchy (Gunderson and Holling 2002) of cross-scale interactions between adaptive cycles at different levels of organisation.
2. Explore key sources of the resilience capacity of EASES.
3. Identify key strategies that could be applied to enhance and build capacity for social–ecological resilience in EASES.

Analysis of the panellists' responses enabled the researcher to develop a revised conceptualisation of EASES using expert opinion. Thus, the conceptualisation of EASES presented here is the conceptual model that emerged from the study.

6.4 Geographical and ecological characteristics

The most immediately apparent characteristics of EASES are spatial. EASES possesses qualities such as space and place, spatial scale and connectivity, and proximity and distance. These are relational qualities, that is, they depend on the relationality of perspectives and worldviews of multiple actors. The physical geography of EASES is characterised by its Atlantic Europe location, spatial extent and the heterogeneous pattern of landmass, coastal interface, offshore islands, continental shelf seas, continental margins and deep ocean basin, as depicted in Figure 6.1.

Figure 6.1 Map of the North-East Atlantic showing bathymetry and location of Atlantic Europe. (Source: Google Earth).

EASES is located in the North-East Atlantic region at the western periphery of the European continent. Its area encompasses Europe's Atlantic seaboard and adjacent ocean space. The coastal regional component is commensurate with the transnational cooperation territory known in EU parlance as the 'Atlantic Area' or 'Atlantic Arc' of Western Europe (European Commission 1991; Wise 2000a, 2000b; CPMR 2005; Farthing and Carrière 2007). This European macro-region, which extends approximately 2,500 km from the north of Scotland southwards to the Strait of Gibraltar, comprises the Atlantic coastal regions and islands of France, Portugal, Spain and the United Kingdom, and the entire territory of Ireland. The lateral extent of EASES, both offshore and inland, is more difficult to determine (see section 6.6).

An estimate of the overall geographic area of EASES can be obtained by considering the combined land/sea surface area. The Atlantic coastal regions included in the 'Atlantic Area 2007-2013' transnational cooperation operational programme funded under EU cohesion policy (CCDR-N 2007: 11) cover approximately 594,000 km². The adjacent Celtic-Biscay Shelf large marine ecosystem (LME) and Iberian Coastal LME have a combined sea surface area of about 1,067,000 km² (Sea Around Us Project 2015). This gives a total land/sea area of approximately 1,663,000 km². This encompasses approximately 46,300 km of coastline and a total catchment area of around 830,000 km² (EEA 2006: 20).

Ecological regionalisation

The ecological domain of EASES is characterised by complexity, interconnectivity and variability across spatial, temporal and organisational scales (OSPAR 2000, 2010; EEA 2006; Langmead *et al.* 2007). Ecological boundaries, patterns and processes are dynamic properties; they may change in strength and direction over time in response to internal and external influences. There is a strong relationship between the organisation of ecological phenomena into functional entities (ecosystems) and geographic place as well as biogeochemical and physical environment.

Instead of defining ecosystems solely on the basis of the main environment, species, community or habitat type, multifaceted biogeographical subdivisions such as 'ecoregions' may be established. These spatial units are based on key assemblages of interconnected biological, physical and chemical attributes in an area. In the context of oceans, coasts and river basins, the natural limits of biogeographical regions are determined by a high degree of interconnectedness and commonality between ecological structures, processes and functions. Nevertheless, identification of the spatial and temporal dimensions, boundaries and patterns of ecosystems is subject to perceptual bias imposed by the observer (Levin 1992). Therefore, the subdivision of the Earth's surface into spatial biogeographical units for purposes of governance, ecosystem-based management, conservation and protection is an art as well as a science.[123] By encompassing entire ecosystems within biogeographical management units, ecosystem approaches seek to balance the maintenance of ecosystem productivity and functionality (i.e. ecosystem goods and services, and the flow of these benefits to

[123] Biogeographical classification systems generally evolve via expert opinion and group consensus, particularly when concerning the delineation of ecosystems at larger, higher levels in the systems hierarchy. Moreover, there is no universally agreed method for biogeographic classification (ICES 2004).

people) with sustainable yields of commercially important species and other uses of natural resources.

EASES is spatially consistent with a number of marine biogeographical subdivisions. Of these, the LME classification pioneered by the US National Oceanic and Atmospheric Administration Fisheries Service is prevalent (Sherman and Hempel 2009; NOAA 2015).[124]

LME are defined as relatively large (typically 200,000 km² or greater) natural regions of ocean space encompassing coastal waters from river basins and estuaries to the seaward boundaries of continental shelves and the outer margins of major current systems (Sherman 1995; Sherman *et al.* 2004). The natural boundaries of LME are based on four ecologically rational criteria: characteristic bathymetry (bottom topography), hydrography (water masses and currents), ecosystem productivity, and multispecies trophodynamic population dependencies. The last criterion distinguishes LME from other marine biogeographic classification systems such as the Longhurst and Dinter schemes (ICES 2004). The LME modular approach uses suites of indicators for monitoring and assessing alternative stable LME states and LME-wide large-scale changes (in productivity, fish and fisheries, pollution and ecosystem health, socioeconomics, and governance) in support of actions for the recovery, long-term sustainability and adaptive management of human interactions with living marine resources and their habitats (Sherman *et al.* 2004).[125]

[124] The LME concept provides the basis for other classifications in which the Celtic-Biscay Shelf LME and the Iberian Coastal LME are more or less replicated: as subregions in the Global International Waters Assessment (GIWA, http://www.unep.org/dewa/giwa/) project and as ecoregions in both the Marine Ecoregions of the World (MEOW) system (Spalding *et al.* 2007) and the International Council for the Exploration of the Sea (ICES) advice to the European Commission concerning marine spatial divisions for the implementation of an ecosystem approach (ICES 2004). Though loosely defined at present, the marine region and subregion management units established within the Marine Strategy Framework Directive (MSFD) (EU 2008) are based on the ICES ecoregions. In both the MEOW and ICES/MSFD classifications, the Celtic-Biscay Shelf LME is named the ‘Celtic Seas’ ecoregion or subregion and the Iberian Coastal LME the ‘South European Atlantic Shelf’ ecoregion or subregion.

[125] To date, 64 LME have been identified worldwide, effectively dividing the continental shelf regions of the Global Ocean into biogeographical units for ecosystem-based management of living marine resources (Sherman and Hempel 2009). Since many of these LME regions overlap the territorial jurisdictions of multiple countries, the LME concept is inherently transboundary and predisposed to regional multinational approaches to cooperation in the management of marine resources (UNEP 2006; Murawski 2007).

EASES is associated with two North-East Atlantic LME that span the marine component of the Atlantic Europe macro-region: the Celtic-Biscay Shelf LME and Iberian Coastal LME (see Figures 6.2 and 6.3).

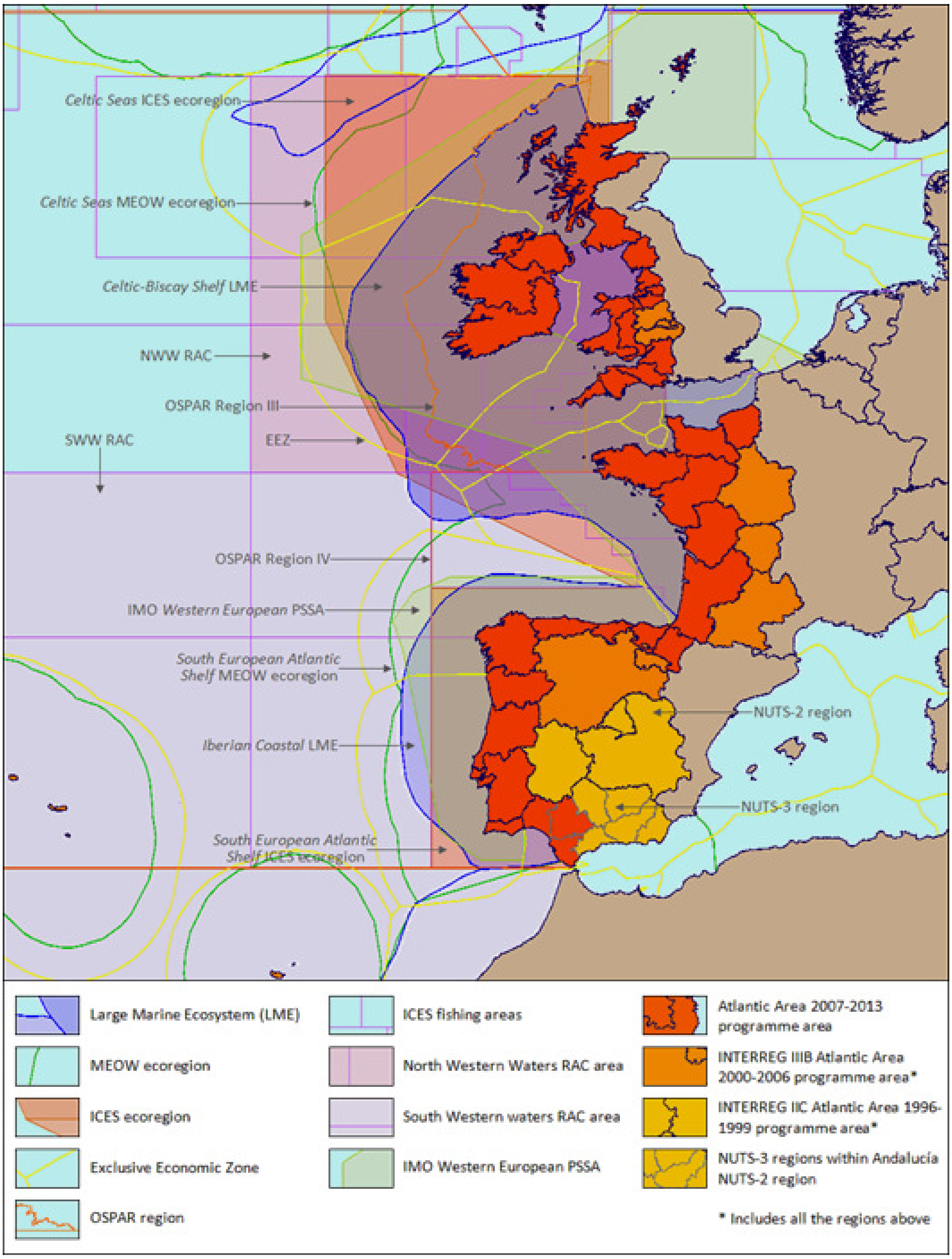

Figure 6.2 Principle spatial units and boundaries relevant to EASES and the Atlantic Europe macro-region.

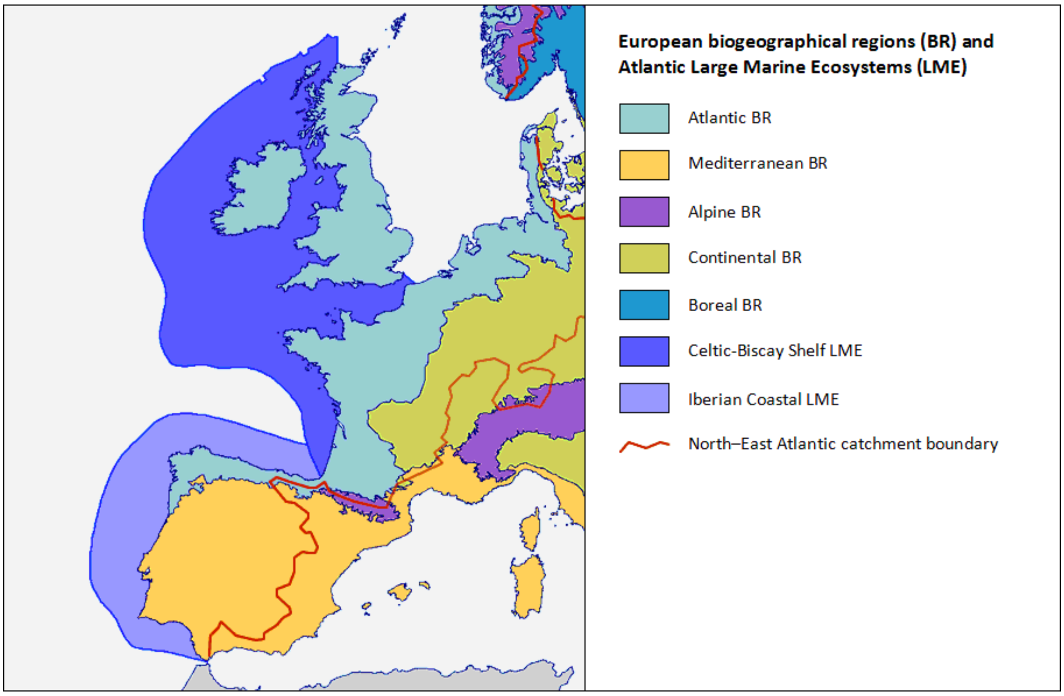

Figure 6.3 European terrestrial biogeographical regions and Atlantic large marine ecosystems (LME).

The principal biogeographical land classification applicable to the macro-regional level is the European biogeographical regions scheme under the EU Habitats Directive (Council Directive 92/43/EEC). EASES encompasses parts of the Atlantic and the Mediterranean biogeographical regions, which are shown in Figure 6.3.

6.5 Sociopolitical and socioeconomic characteristics

Atlantic Europe space and identity

The 1950s saw the advent of the European Communities, followed by the move towards European enlargement and a growing single internal market. With this came the supranational policy objective of assimilating the regions into one cohesive (closer and more equitable) European territory and economic landscape (European Commission 1991). This resulted in the emergence of an influential transnational lobbying network, the Conference of Peripheral Maritime Regions of Europe (CPMR),[126] from among regional councils and allied institutions in the

[126] http://www.crpm.org/

Atlantic Europe macro-region. This bottom-up cooperative effort sought to (1) defend against political and economic marginalisation in an expanding and increasingly centralised Europe and globalised world economy; and (2) promote common interests such as new models of regional development and a more equitable redistribution of Community funds.

In 1989, the CPMR decentralised itself into three distinct geographical commissions: the Atlantic Arc, North Sea, and Mediterranean commissions (Farthing and Carrière 2007: 333). Subsequently, three more emerged: the Balkan and Black Sea Regional, Baltic Sea, and Islands commissions. The CPMR's Atlantic Arc Commission (AAC) is the primary macro-regional level institution, sociopolitical coalition and socioeconomic actor network to have emerged in the Atlantic Europe macro-region.[127]

Underpinning the AAC's strategy is the notion of a distinct Atlantic regional socioeconomic grouping. This is the Atlantic Arc transnational cooperation territory composed of regions sharing a sense of common identity and heritage, united by common maritime characteristics and traditional sectors, and confronted by common problems associated with their peripheral location and disparities in the levels of development, income, employment and productivity between regions (Wise 2000a, 2000b; Farthing and Carrière 2007). Subsequently adopted by the European Commission and other EU institutions (European Commission 1991), the concept of an Atlantic Arc macro-region continued to emerge. This led to a series of EU Atlantic Area interregional (Interreg) European initiatives and transnational cooperation operational programmes co-financed under the European Regional Development Fund (ERDF) and other financial instruments ('structural funds') associated with EU regional and cohesion policy:[128]

- Interreg I 'Atlantis' Atlantic region cooperation pilot project (1993-1995).

[127] Other Atlantic Europe actor networks that function at macro-regional level are the Conference of Atlantic Arc Cities (CAAC, http://www.atlanticcities.eu/), Association of Chambers of Agriculture of the Atlantic Arc (AC3A, http://www.ac3a.fr/AC3A_en.php) and Atlantic Transnational Network (ATN, http://rta-atn.eu/en/).

[128] NB: For the purpose of this analysis, only the programming period from 1996 to 2013 is considered. The Atlantis pilot study is excluded due to the limited amount of information available. The Atlantic Area 2014-2020 programme is excluded because, at the time of the study, it was at a preparatory stage.

- Interreg IIC ‘Atlantic Area’ programme (1996-1999).[129]
- Interreg IIIB ‘Atlantic Area’ programme (2000-2006).[130]
- European Territorial Cooperation ‘Atlantic Area 2007-2013’ transnational programme.[131]
- European Territorial Cooperation ‘Atlantic Area 2014-2020’ transnational programme.[132]

Typically, boundaries in the social domain are indistinct (fuzzy) and variable. However, the boundaries of the Atlantic Area have been delineated spatially (plotted geographically) as lines or hard edges according to politically expedient criteria including pre-existing jurisdictional boundaries. In particular, the various Atlantic Area transnational cooperation programmes have delineated the landward area according to the boundaries of regional government and administrative authority areas. Each Atlantic Area programme encompasses an aggregation of NUTS 2 level[133] maritime regions from the North of Scotland to the Strait of Gibraltar in the five EU member states with Atlantic coastlines (France, Ireland, Portugal, Spain and the United Kingdom).

The total number of NUTS regions (some having no coastline) included in the administrative Atlantic Area has decreased between programmes, from 46 in 1996 to 33 in 2007 (see Figure 6.2). Though still stretching the same length of Atlantic seaboard from Scotland to Andalucía, the geographical surface area and associated population of the administrative Atlantic Area has diminished with each successive programme (see Table 6.1). This is the result of removing programmatic eligibility from several large NUTS 2 regions without coastlines in Spain, France and to a lesser extent England. Consequently, the Atlantic Area

[129] http://www.interreg-atlantique.org/iic/english/index.htm
[130] http://www.interreg-atlantique.org/iiib/eng/
[131] http://www.coop-atlantico.com
[132] http://atlanticarea.ccdr-n.pt/
[133] The NUTS (*Nomenclature des Unités Territoriales Statistiques*) classification system is used by the EU to collate statistics at regional level for the purposes of socioeconomic analyses and framing EU regional policies. All regions in the EU are classified into three nested NUTS levels: NUTS 1 are major socioeconomic regions; NUTS 2 are basic regions for the application of regional policies; and NUTS 3 are small regions for specific diagnoses. Source: Eurostat, http://ec.europa.eu/eurostat/web/main/home [accessed 10/2/2014].

2007-2013 programme was predominantly composed of maritime regions that actually possess an Atlantic coastline.

Taking the 2007-2013 operational programme as a basis, the Atlantic Area (i.e. the potential landward component of EASES) encompasses maritime regions covering a surface area of over 594,000 km² with a population (in 2005) of nearly 58 million people (TCOPAA 2007).

Table 6.1 Geographic surface area and associated population of combined NUTS regions for successive Atlantic Area programmes.

Programme period	1996–1999	2000–2006	2007–2013
Surface area (km²)	904,704	856,530	594,361
Population (million people)	80.8	76.1	57.8 (in 2005)
(Poitou-Charentes 2003; TCOPAA 2007)			

Atlantic Europe spatial development

The intrinsically complex, multiscale, heterogeneous and variable character of the social domain of the Atlantic Europe macro-region (and by extension EASES) is reflected in the Atlantic Spatial Development Perspective (ASDP) (CPMR 2005). Described as 'a unique tool for territorial development' (AAC 2008: 5), the ASDP study provides a snapshot evaluation of the socioeconomic, demographic and environmental trends of the transnational Atlantic macro-region and its constituent regions.[134] The ASDP also presents a strategic macro-regional level vision of a more balanced, polycentric and sustainable territorial development in terms of a framework for achieving improved spatial planning and territorial cohesion across multiple levels.[135]

[134] NB: The 'Atlantic area' of the ASDP does not correspond to the reference area of the Atlantic Area 2007-2013 transnational operational programme.

[135] The aims of the collaborative project that led to publication of the ASDP were to: (1) identify a set of strategic proposals designed to orient regional and EU policies and strategies in order to improve the way the Atlantic seaboard is structured and create greater cohesion within its territories; and (2) identify issues of common interest for project cooperation between the Atlantic

A key feature of the ASDP is the spatial subdivision of the macro-region into subareas according to their functions and relative advantage or disadvantage, regardless of any pre-existing political and administrative boundaries. The ASDP distinguishes between four levels of spatial analysis corresponding to four levels of urban and regional systems. These are metropolitan regions, intermediate cities, medium-sized towns and rural areas (CPMR 2005).

The ASDP analysis highlights the intrinsic heterogeneity of the Atlantic Europe macro-region and identifies internal imbalances and significant disparities between Atlantic subareas. These include variations in development levels, wide differences in competitive advantage, discontinuities in networks, absence of links, and demographic and economic trends. The evaluation goes on to divide the macro-region spatially into 'motor subareas', the most dynamic and relatively advantaged regions, and 'integration subareas', the large and relatively disadvantaged interstitial spaces between the motor subareas.

The AAC considers the ASDP to be supportive of its objective of pursuing an integrated urban, rural, coastal and maritime polycentric development model for the Atlantic Europe macro-region (AAC 2008).

Atlantic Europe governance

As a key institutional actor, the AAC has developed and continues to develop a high level of both political and social capital as a transnational network of sociopolitical and socioeconomic actors. The AAC and other Atlantic Arc actor networks increasingly concern themselves with the need to establish a macro-regional 'tier of competence' to represent a coherent Atlantic Arc area within the EU multilevel governance system (AAC 2009b, 2012; Atlantic Networks 2013). This aspiration is linked with the ongoing debate in Europe concerning territorial cohesion and how best to distribute responsibility or competence, devolve decision making, and structure and coordinate cooperation between all levels of territorial governance (European Commission 2008a; CPMR 2009; EU

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regions and the EU Structural and Cohesion Funds operational programmes for after 2006 (AAC 2009a).

Presidency 2011). It is a debate centred on the gap between the traditional levels of European governance (supranational, national, subnational regional and local) and the non-traditional levels (transnational, interregional and macro-regional).[136]

In 2008, the AAC made it a political priority to position both itself and the Atlantic Arc territory in a future multilevel system of European territorial governance (AAC 2008). It was envisaged that such a new form of governance would entail closer cooperation and increased coordination between the European Commission, member states, regional and local authorities, and the AAC and other actor networks (AAC 2009b). However, at the time of writing, neither the AAC nor other Atlantic Arc actor networks are part of any formal multilevel governance arrangement; political competences for decision making affecting the Atlantic macro-region remain with the EU institutions responsible for legislation (i.e. the European Commission, Council of the European Union, and European Parliament) and the national governments of the relevant member states. Despite this, it is generally understood that the European Commission, in particular DG MARE, values the participation of the CPMR/AAC as a stakeholder in policy-related discussions and consultations.[137]

Atlantic Europe spatial development and MSP

In its proposal for an Atlantic Maritime Strategy, the European Commission (2011b) states:

> 'EU instruments for an integrated maritime policy and territorial cooperation are already supporting pilot projects on spatial planning and coastal zone management in the Atlantic. The European Commission is currently examining options for a more structured approach towards these mechanisms that will allow the Atlantic Member States and stakeholders to implement the ecosystem approach' (p.3)

[136] Apart from the AAC and other Atlantic Europe transnational actor networks (i.e. CAAC, AC3A and ATN), the 'Atlantic political dynamic' (AAC 2008: 5) is manifest at EU institutional level primarily through (1) publicly elected representatives from the regions to the European Parliament; and (2) appointed representatives from individual local and regional authorities to the Committee of the Regions.

[137] See, for example, http://news.crpm.org/cpmr-news/maritime-cpmr/blue-invest-how-the-eu-supports-to-maritime-regions/ [accessed 23/11/2015].

This text links the Integrated Maritime Policy (therefore the Blue Growth strategy), Regional Policy (territorial cohesion, transnational cooperation and, therefore, Atlantic Area spatial development) and maritime spatial planning (therefore the MSP Directive) in terms of implementing the ecosystem approach (therefore the Marine Strategy Framework Directive). However, the subsequent Action Plan for a Maritime Strategy in the Atlantic Area (European Commission 2013b) only mentions maritime spatial planning once in a cursory manner (p. 7). In other words, the EU Atlantic Strategy – the de facto macro-regional strategy – makes no explicit connection between land-based Atlantic Europe spatial development, as envisaged by the AAC in the ASDP, and Atlantic Europe maritime spatial planning (MSP), as required for implementation of the MSP Directive (EU 2014c).

Schuh *et al.* (2015: 112) note that according to the AAC's region members the Action Plan is not sufficiently bottom-up. During the development of the Action Plan, opinions diverged between the AAC and DG MARE regarding its thematic focus. The AAC argued for a more territorial emphasis that addressed territorial cohesion as well as the territorial dimension of sustainable economic 'blue growth' (ESPON 2013b). Furthermore, during discussion at the 20th October 2014 meeting of the EU Atlantic Strategy Group[138] regarding the implementation of the Atlantic Strategy (AAC 2014a, 2014b), it was apparent that two separate visions coexist within the Atlantic Strategy Group, particularly over the scale of proposed projects. Significantly, the topic of an Atlantic MSP project was deemed to be too political by France, Ireland and England (AAC 2014b: 7; Schuh *et al.* 2015: 115).

It is worth noting that in 2009 the AAC expressed its commitment to working with DG MARE on MSP, particularly in relation to developing pilot studies in the Atlantic sea basin (AAC 2009c). In 2013 the CPMR published policy guidelines (CPMR 2013a) concerning the then proposed Directive on MSP and ICZM

[138] The EU Atlantic Strategy Group (ASG) is steered by DG MARE and made up of representatives of the five member states of the Atlantic Europe seaboard (France, Ireland, Portugal, Spain and the UK) alongside the other European institutions and actor networks AAC, CAAC and ATN. The AAC (2014a) states that 'The role of the ASG is still quite unclear, since they cannot directly support projects (this would be discriminatory to other projects and against EU open competition rules)' (p. 2).

(European Commission 2013a). At the time, the CPMR was concerned with promoting the territorial dimension of planning beyond MSP and ICZM. The CPMR asked how can we 'ensure a territorial dimension in the economic, social and environmental aspects of all EU maritime policies?' (CPMR 2013b: 25).

European policy is making increasing reference to Europe's marine environment and marine regions as integral to the evolving EU territorial cohesion and spatial development agenda. For example, the Territorial Agenda of the European Union 2020 (EU Presidency 2011) states:

> 'Maritime activities are essential for territorial cohesion in Europe. Economic activities such as energy production and transport are increasing rapidly in European marine environments. There is a need to solve user conflicts and balance various interests by cooperation in maritime spatial planning. The Marine Strategy Framework Directive and EU Integrated Maritime Policy calls for coordinated actions from Member States on **maritime spatial planning**. Such planning **should be integrated into the existing planning systems to enable harmonious and sustainable development of a land-sea continuum**' (p. 10, emphases added in bold).

Nevertheless, in order to clarify the relationship (or lack of one) between spatial development and MSP in the Atlantic Europe macro-region, we must turn to the European Seas and Territorial Development, Opportunities and Risks (ESaTDOR) project undertaken by the European Observation Network for Territorial Development and Cohesion (ESPON) between 2010 and 2013.[139]

According to ESPON, Europe's regional seas offer significant opportunities for, and potential risks to, territorial development. There has been growing realisation of the complexity of land-sea interactions and recognition of the need for more integrated forms of planning and governance of maritime space, as exemplified by the growth of ICZM and MSP. (The replacement of fragmented approaches with

[139] http://www.espon.eu/main/Menu_Projects/Menu_AppliedResearch/ESaTDOR.html

integrated approaches to spatial planning and territorial development have long been a feature of terrestrial planning.) Despite this, little has so far been done to explore the potentials and challenges of integrated planning for maritime areas, particularly in cross border and transnational contexts, and across the land-sea divide (ESPON 2013a). The ESaTDOR project aimed to explore the territorial development opportunities and risks facing the seas of Europe by distilling key land-sea and transnational interconnections. Annex 3 to the ESaTDOR Scientific Report focuses on the Atlantic Ocean regional sea (ESPON 2013b).

ESaTDOR produced 10 recommendations concerning policy developments that respect the broader policy perspectives of territorial development, the emergence of MSP, and the opportunities offered by blue growth (ESPON 2013a: 7-10). The first five recommendations concern good governance and planning across the land-sea divide/continuum. They are summarised as follows:

> *Recommendation 1*: MSP needs continuing support and promotion at both EU and national level to ensure that states maximise the opportunities presented by Blue Growth in a way that is consistent with the ambitions of the Marine Strategy Framework Directive (MSFD), while contributing to the territorial cohesion objectives of the Territorial Agenda of the European Union 2020. Despite recognition in the EU Territorial Agenda 2020 that MSP should be integrated into existing planning systems, this process is still at an early stage. In all European seas it is evident that integrated management both across national boundaries and the land-sea divide could be strengthened.

> *Recommendation 2*: There should be greater recognition of the importance of marine space within EU activities and greater integration of sectoral policies with maritime dimensions. Opportunities exist, including through close collaboration between European Commission Directorate-Generals, to extend the leading role the EU has already take in promoting MSP and developing macro-regional strategies for sea basins such as the Baltic and Atlantic.

> *Recommendation 3*: There is a need for continuing efforts to support and develop emerging and effective transboundary maritime governance regimes in working towards MSP at different spatial scales. The EU has an important role to play in encouraging and facilitating the development of effective maritime governance both in national and transnational space.
>
> *Recommendation 4*: National governments should develop integrated MSP arrangements that ensure consistent planning across the land-sea continuum in both national and transnational space that takes account of the strength of land-sea interactions. With some exceptions, planning arrangements for the land and sea tend to be distinct with only a very small geographical area of overlap. Efforts will be needed to ensure more effective integration of maritime policies across the land-sea divide.
>
> *Recommendation 5*: The ESaTDOR maritime region typology could be used as a spatial tool for understanding land-sea interactions and informing Integrated Maritime Policy development at a range of different scales. The typology illustrates the strength of land-sea interactions and spatial variations across European maritime space. The five types of maritime regions (from most to least intense land-sea interactions: European core region, regional hubs, transition regions, rural regions and wilderness regions) each have distinct identities which, therefore, may benefit from different types of policy intervention.

The ESaTDOR project considered the AAC as one of its transnational maritime governance case studies (ESPON 2013c). One of the great strengths of the AAC is the holistic approach it takes to planning for the Atlantic Area; it promotes growth and development in a coordinated way across the whole of the territory and does not simply work for the member regions of the AAC. In terms of lessons for MSP,

> 'This inclusive approach is something that should be adopted by other regional sea governance arrangements to ensure that the territorial dimension of maritime activity can be fully realised in a way that builds

on the strengths and opportunities offered by individual regions within a larger sea basin' (ESPON 2013c: 20).

At present, however, the focus of research and pilot projects tends to remain on either land-based or sea-based spatial planning rather than on the integration of both. For example, the recent (December 2012 to May 2014) Transboundary Planning in the European Atlantic (TPEA) pilot project.[140] Co-funded by DG MARE, TPEA aimed to develop a commonly-agreed approach to cross-border MSP in the European Atlantic region. The project brought together different actors from the five member states of the Atlantic seaboard, including the AAC as an expert advisor. TPEA focused on two pilot areas for MSP: one in the south involving Portugal and Spain and the other in the north involving Ireland and Northern Ireland (UK). In another example, the CPMR is involved in the Supporting Implementation of Maritime Spatial Planning in the nascent Northern European Atlantic region (SIMNORAT) project (2016-2018). The project aims to support Atlantic member states in implementing the MSP Directive. The CPMR is tasked, among other things, with organising a workshop on MSP and the land-sea interface, to take place at the end of 2017 (AAC 2016).

In summary, in accordance with ESPON's recommendations, for any future macro-regional maritime strategies, territorial development should consider both land-based and sea-based spatial planning together (ESPON 2013b: 54).[141]

6.6 Defining system boundaries

Round one began with the objectives of establishing and clarifying the spatial and temporal boundaries of EASES, and describing the conditions that characterise these boundaries. Setting boundaries and describing their conditions are necessary to identify what is included in the system and what is not. In round one, 19 panellists were asked five questions regarding spatial boundaries and boundary

[140] http://www.tpeamaritime.eu/

[141] Unfortunately, exploring the linkage between land-based and sea-based spatial planning and territorial development in more detail is beyond the scope of this thesis.

conditions. (Temporal boundaries are addressed in subsection 6.9.1 concerning the historical profile of EASES.)

Spatial boundaries

The workbook objective was *to identify key spatial units and their boundaries relevant to EASES in its present state, while recognising that some boundaries may fluctuate and vary spatially over different time periods*.

In the initial conceptualisation, the spatial boundaries and scope of EASES were established by combining two sets of recognised spatial units and their boundaries. One of these is the Atlantic Area territory, which is definable by the collective boundary of the various political-administrative regions that make up the land area of EU Atlantic Area programmes for transnational cooperation. The other set comprises two contiguous large marine ecosystems: the Celtic-Biscay Shelf LME and the Iberian Coastal LME. Taken together, the Atlantic Area and adjacent ocean space amount to the Atlantic Europe maritime macro-region, as represented by EASES. Therefore, the northern geographical limit of EASES was originally defined by the major bathymetric/oceanographic feature of the Wyville-Thomson Ridge, which separates the Faroe-Shetland Channel to the north from the Rockall Trough to the south. The suggested southern limit of EASES corresponded to the Strait of Gibraltar, which marks the physical, political, economic and social boundary between south-western Europe and north-western Africa, and between the Atlantic Ocean and the Mediterranean Sea.

The westward limit into the Atlantic Ocean was defined as the offshore boundaries of the two adjacent LME, which are based on ecological criteria rather than political, economic or other social criteria. Such a LME-based boundary is fundamentally problematic precisely because it is an amalgamation of two distinct LME. The eastward limit of EASES was delineated on the basis of the collective inland boundary of the peripheral coastal regions included in the Atlantic Area programmes. However, this is complicated by the different number of regions included in consecutive programmes. An alternative basis would have been to use the hydrological/geomorphological boundary of the drainage areas (catchments) that feed into the North Atlantic, Irish Sea, Celtic Sea and English Channel

(Langmead *et al.* 2007: 26; de Jager and Vogt 2010: 665). However, these river basins and groundwater systems encompass large areas of the continental and island interiors. Although relevant to EASES in terms of the land–coast–ocean continuum and biogeochemical cycling (Salomons *et al.* 2005; Talaue-McManus 2010), areas far inland are seldom, if ever, considered to be coastal or maritime, even where the nation state has a strong maritime identity. Sociocultural notions about what identifies a coastal or maritime region and its boundaries are complex and dynamic multidimensional constructs (Smith 1995: 13).

Table 6.2 Spatial units relevant to EASES and the Atlantic Europe macro-region, and the characteristics of their boundaries.

Spatial unit	**Primary characteristics of unit**				**Characteristics of boundary**		
	Biogeographic	Management	Political	Economic	Mapped	Actual	Notes
LME	✓				Fixed line	Fuzzy	Ecological boundary: spatially–temporally diffuse/variable
GIWA subregions	✓	✓			Fixed line	Fuzzy	Ecological boundary: spatially–temporally diffuse/variable
ICES ecoregions	✓	✓			Fixed line	Fuzzy	Ecological boundary: spatially–temporally diffuse/variable
MSFD marine subregions	✓	✓	✓		Undefined	–	Assumes dimensions of ICES ecoregions
MEOW ecoregions	✓				Fixed line	Fuzzy	Ecological boundary: spatially–temporally diffuse/variable
OSPAR regions		✓			Fixed line	Fixed line	Management area boundary defined by agreement
IMO PSSA		✓		✓	Fixed line	Fixed line	Management area boundary defined by agreement
ICES fishing areas		✓		✓	Fixed line	Fixed line	Management area boundary defined by agreement
CFP RAC areas		✓	✓	✓	Fixed line	Fixed line	Management areas defined by political/stakeholder agreement
UNLCOS EEZ & CFP FZ			✓	✓	Fixed line	Fixed line	Jurisdictions (State/EU competences) by political agreement
NEAT catchment area	✓				Fixed line	Fixed line	Ecological boundary: variable over geologic timeframe
EEA terrestrial biogeographical regions	✓				Fixed line	Fuzzy	Ecological boundary: spatially–temporally diffuse/variable
Atlantic Area transnational programmes			✓	✓	Fixed line	Fixed line	Political boundary: variable no. of eligible regions over time
Atlantic Arc Commission network area			✓	✓	Fixed line	Fixed line	Political boundary: variable no. of member regions over time

Coastal regions (NUTS levels 2 & 3)			✓	✓	Fixed line	Fixed line	Political–administrative boundaries
EU member states			✓	✓	Fixed line	Fixed line	Political–administrative boundaries (nation-state jurisdiction)

Key

LME Large Marine Ecosystem (NOAA) www.lme.noaa.gov - Celtic–Biscay Shelf (24), Iberian Coastal (25) LME

GIWA Global International Water Assessment (UNEP, GEF) www.giwa.net - Celtic–Biscay Shelf (19), Iberian Coastal Sea (20) subregions

ICES International Council for the Exploration of the Sea www.ices.dk - Celtic Seas (E), South European Atlantic Shelf (G) ecoregions; VI, VII, VIII, IX fishing areas

MSFD EU Marine Strategy Framework Directive marine subregions ec.europa.eu/environment/index_en.htm - Celtic Seas, Bay of Biscay and Iberian Coast

MEOW Marine Ecosystems of the World (Spalding *et al.*) www.worldwildlife.org/MEOW - Celtic Seas (26), South European Atlantic Shelf (27)

OSPAR 1992 OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic www.ospar.org - Region III Celtic Seas, Region IV Bay of Biscay and Iberian Coast

IMO International Maritime Organization (IMO) Particularly Sensitive Sea Area (PSSA) www.imo.org - Western European PSSA

CFP RAC EU Common Fisheries Policy (CFP) Regional Advisory Councils (RAC) ec.europa.eu/fisheries/index_en.htm - North Western Waters RAC, South Western Waters RAC, Pelagic RAC areas

UNCLOS 1982 United Nations Convention on the Law of the Sea (UNCLOS) www.un.org/Depts/los/index.htm - Exclusive Economic Zone (EEZ) including a fishery zone (FZ)

CFP FZ EU Common Fisheries Policy (CFP) fishery zone (FZ) competence ec.europa.eu/fisheries/cfp_en.htm - 200 nautical mile limit

NEAT North–East Atlantic regional sea - Catchment area (combined river basin and groundwater systems)

EEA European Environment Agency (EEA) European biogeographical regions 2005 www.eea.europa.eu - Atlantic, Mediterranean regions

The panellists were asked (Question 1a): *Are there any spatial units and boundaries that you think should be added or removed from the list suggested in Table 6.2?* Among the 18 panellists who responded, opinion was divided between eight who thought no spatial units and boundaries should be added or removed and eight who suggested various additions or removals. The reasons given for no further additions included because the units and boundaries listed were already numerous, comprehensive, and reflect the true complexity of the macro-region and its issues. As one panellist stated, “Considering the difficulties of connecting/integrating the different types of ecological, managerial, political, economic boundaries nothing should be added to the already complex typology.” Reasons for not removing any units and boundaries included because even the less important ones have relevance. A panellist stated, “They are political constructs, their relevance depends on who uses them and for what purposes.”

Additional spatial units and boundaries were suggested by eight panellists as follows. Concerning the ecological domain of EASES:

- LOICZ definition of the coastal zone (physical area extending from 200 m land elevation to 200 m sea depth).
- Shelf break (physical outer edge of the continental shelf).
- Biogeochemical provinces and ocean currents associated with the North Atlantic gyre.
- Dinter (2001) biogeographic classification used by OSPAR Commission.

Concerning the social domain of EASES:

- Limits of economic exploitation by Atlantic Europe fishing fleets.
- Sea shipping routes.
- Significant intangible and non-spatial boundaries such as social, cultural and knowledge boundaries.
- Institutional boundaries of the Water Framework Directive (EU 2000), particularly the one nautical mile limit of coastal waters, and marine jurisdictional boundaries defined in national legislation.

Four panellists identified significant overlap and duplication of purpose among spatial units, particularly between LME, MEOW ecoregions and OSPAR regions. However, one panellist did consider both LME and MEOW ecoregions to be functionally relevant despite their apparent similarity. Another panellist suggested that some simplification might be possible by removing the LME, OSPAR regions, IMO Western European PSSA, EEA terrestrial biogeographic, and Atlantic Area transnational programme boundaries. Concerning landward territorial units and boundaries, one of the panellists considered the Atlantic Area 2007-2013 transnational programme area to be more logical relative to previous INTERREG programme areas.

Boundary conditions

Here, the workbook objective was *to establish boundary conditions that help clarify*:

1. *What is included in EASES at present*, that is, the key internal structures, processes and functions (identified in section 6.7 below).
2. *What relevant factors lie outside EASES*. That is, the key external conditions or 'exogenous controls' (Chapin *et al.* 2009b: 12) belonging to other generally larger-scale systems of the wider world, which determine or influence the configuration of EASES and determine or drive the system's dynamics.
3. *The main transboundary flows and exchanges*, that is, the key interactions between EASES (the macro-regional focal level system) and other external, either adjacent or higher-level/larger-scale, systems.

It may not always be possible or desirable to assign a position in space and time to the boundaries of a SES, particularly when boundaries are subject to high uncertainty or concern intangible social processes. However, system boundaries may be described by the conditions that characterise them. These boundary conditions represent the influences of the wider world on the focal system (EASES) and vice versa. They also represent transboundary flows and exchanges, and other interactions between the internal structure and processes of the focal system and the external structures and processes of other systems. These exogenous factors are typically associated with neighbouring macro-regional SES and larger-scale systems at 'higher' encompassing levels of organisation. The boundary conditions are dynamic. In other words, they continually change to reflect both internally and externally driven dynamics.

In terms of qualitative modelling, the term 'boundary conditions' refers to the information needed from external or adjacent systems about conditions that affect the function of the system being considered (Gilbert *et al.* 2011). Boundary conditions are often categorised according to the type of provenance or causal domain (e.g. environmental, social, economic or technological). An alternative approach would be to categorise boundary conditions according to type or recipient of the effect produced in the focal system.

As a starting point, panellists were provided with an initial conceptual model of EASES in the round one workbook (see Figure 2.11). The assumption was that the boundaries of EASES are generally open (permeable) to transboundary flows and exchanges of energy, nutrients, materials, information, organisms, migrants, social cooperation, trust, finance, trade, political influence, culture and so forth.

Panellists were asked (Question 2a): *Are there any external conditions influencing EASES they thought should be added or removed from the conceptual model provided?* Of the 15 panellists who responded, five thought that no external conditions should be either added or removed; the reasons given included because the set is comprehensive and because all are important and useful. Additional external conditions, such as the current global economic system, global governance mechanisms, human migration and transboundary pollution were suggested by six panellists.

Panellists were also asked (Question 2b): *What do you consider to be the key flows and exchanges across the boundaries of EASES?* Eleven panellists identified a range of key flows and exchanges across the boundaries of EASES. These are aggregated in Table 6.3.

Table 6.3 Key flows and exchanges across the boundaries of EASES.

• Unspecified external shocks. • External pressures on the ecological domain. • Biogeochemical and physical processes/cycles (2). • Water circulation/hydrological cycle (4) and transport, including the global thermohaline circulation. • Climate or weather (2), including the North Atlantic Oscillation. • Climate change (2), including ocean acidification. • Biodiversity (2), including primary production and migratory species. • Natural resources (matter and energy). • Global/international trade, goods, services and markets (8), including economic globalisation. • Finance (5), including financial globalisation. • Transport/infrastructure connections (2), including marine transport routes and transport of resources. • Waste and waste transport. • Ideas, learning and knowledge (5), including technology and innovation, scientific knowledge and co-operation (specifically OSPAR), and research results. • Rights and symbols (permits and patents). • Governance structures and processes (6), including centralised EU governance, evolving EU policy, the role of institutions, cooperation and conflict mitigation. • Political power, contexts and trends (2). • Social perceptions of culture and language, which dominate external opinions and tourist flow.
Note: Numbers in brackets denote the number of same or near equivalent responses given by different panellists.

One of the panellists considered key flows to be those associated with human consumption of ecosystem goods and services, the provenance of which may be within – but very often outside – the EASES region. Another panellist listed key flows and exchanges across the boundaries of EASES as follows:

- Flows of finance and goods: from the Western European core into the [peripheral] EASES region.
- Trade flows: from East Asia through the Strait of Gibraltar and EASES on into the Western European core, and from the Americas into the Western European core, with sub-flows into the Irish Sea and Bay of Biscay (with a series of feeder networks flowing back out of the core into EASES).

- Political flows: the key driver at the scale above is the EU, and from the scale below are the national governments of UK, Ireland, France, Spain, Portugal and devolved sub-national governments.
- Population migration flow: apparently, from inland to coastal regions within EASES, as well as from EASES to the Western European core. [In response to question 2c].
- Drivers for scientific co-operation: OSPAR.
- Water circulation: the global thermohaline circulation and North Atlantic Oscillation.
- Biodiversity: migratory species, including whales, salmon, mackerel, eels, etc.

A different panellist provided a detailed list of flows, as follows

Material flows:

- The three ecological processes of water circulation/hydrological cycle, biogeochemical processes/cycles, primary production and organisms – all of these are closely linked to or are part of vital ecosystem services, their maintenance over time being an essential condition for sustainable development.
- Natural resource (matter and energy) flows as part of the global trade and transport of resources; important for sustainable development.
- Waste flows (and waste transport) are also important for sustainable development.

Symbolic and information flows:

- Technology and innovation as knowledge related processes.
- Financial and economic capital flows (directing resource use and appropriation across boundaries).
- Rights, permits, patents (directing resource appropriation).
- Governance, cooperation, conflict mitigation (as decisive political power flows).

- Knowledge flows (scientific knowledge, research results, influencing decision making).

In addition, one panellist considered all the flows and exchanges suggested in the conceptual model (Figure 2.11) to be important. Two panellists pointed to the interconnection and interdependence between flows. One panellist commented on the uncertainty regarding where the transboundary effects of anthropogenic climate change, pollution and such like would fit in to the model.

The definition of boundaries and their conditions is considered in Chapter 7 (section 7.4).

6.7 System structures, processes and functions

The third objective of round one was to identify key structures, processes and functions of EASES, including in terms of critical capital. The overall workbook objective of this part of the study was *to define ecological, social and economic components (agents and processes), relationships, structures and functions that are essential to understanding the current configuration of EASES*. In other words, to produce a snapshot of EASES at the present time. However, to construct this snapshot it was necessary to develop an analytical framework for defining EASES in terms of different 'critical' capitals: critical assets and capacities. These are addressed in subsections 6.7.1 to 6.7.3. I then turn to the key social components of EASES in terms of groups, organisations, institutions and governance. These results are discussed in Chapter 7 (section 7.4).

6.7.1 Rationale for a multiple capitals framework

Planetary sustainability, intergenerational equity, resource security, sustainable development, society, community and human well-being all depend on diverse forms of capital. In the classical, neoclassical and Marxist economic traditions, capital is one of the factors of production (principal inputs) that are used to produce goods and services, and create or add utility and value; the other factors being labour or human effort, natural resources including land, and entrepreneurship. In this sense, 'capital' refers to the physical means of production: the existing stock of tangible non-human instruments (tools, machinery, factories and infrastructure) and objects (natural resources, commodities and raw materials) used in production and wealth creation.

In the study, however, the term 'capital' was used in the more functional sense of 'a stock that yields a flow of valuable goods or services into the future' (Costanza and Daly 1992: 38). Stocks are the entities that link current actions to future outcomes (Baumgärtner and Quaas 2010: 2058). A stock, which may be tangible or intangible, is a dynamic and finite accumulation of something with utility and value. The flow yielded by a particular capital stock over a period of time can be continuous or discontinuous, sustainable or unsustainable. In the view of ecological economics, the primary distinction between different types of capital is based on whether the stock is naturally occurring or human made.

Concept of critical capital

Sustainable development is a normative concept and political process that involves contestations, value judgements and trade-offs between ecological, social and economic objectives. It raises fundamental questions and decisions about 'what should be sustained and for whom, for how long, and with what certainty' (Lélé and Norgaard 1996: 362) and about 'what kind of development do we prefer' (Hediger 2000: 482). This is a separate issue to the feasibility of what can be sustained and how.

In its report to the UN concerning sustainable development within ecological limits, the Brundtland Commission was categorical in its assertion that the process of economic development 'must be more soundly based upon the realities of the stock of capital that sustains it' (WCED 1987a: Chapter 2, para. 36). Since the publication of the Brundtland report, the debate on sustainability has drawn attention not only to the different types of capital involved and the extent of substitutability[142] between them, but also to the question: which types and

[142] Substitutability refers to the ability and degree to which different forms of capital and their components (stocks and flows) can replace each other. Neoclassical economists have tended to

components of capital are critical to sustaining ecosystem integrity, economic development, social progress and human well-being (at a particular level of systems organisation)? Of course, given the diversity of views and values in a pluralistic global society, there is no single answer.

In round one of the study of EASES, the 19 panellists were asked to identify key aspects of different capitals that they considered important to the functioning of the Atlantic Europe macro-region. These are addressed in the following subsections.

6.7.2 Natural capital and ecosystem services

Concerning the ecological domain of EASES, the workbook objective was *to identify key natural capital assets and capacities, including ecosystem services, associated with the Atlantic Europe macro-region*. 'Natural capital' refers to stocks of natural assets or resources used by humans and, therefore, are of value to human society and to the capacity of the environment to produce and maintain them. Natural capital comprises: non-renewable natural resources (non-living ecological components, e.g. fossil fuels and topography) derived or extracted from the environment; renewable natural resources or ecosystem goods (both living, e.g. fish stocks, and non-living, e.g. freshwater) produced and maintained by ecosystem functions; and spatial resources. Natural capital is the base that generates, or helps to generate, a flow of benefits for people and other species, benefits that are often called 'ecosystem services'.

Ecosystem services (or environmental services) are the outcomes of ecosystem functions. They are the flows of useful or crucial benefits obtained by humans and

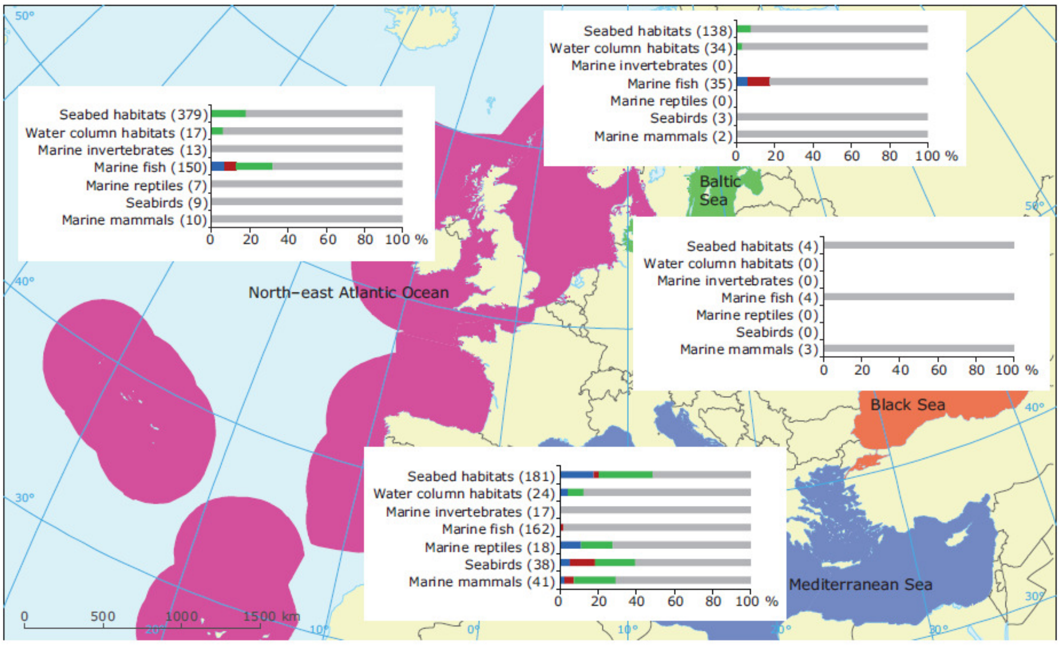
assume that the factors of production (land and natural resources, labour, physical capital and entrepreneurship) are generally fungible. That is, one basic input (e.g. form of energy resource) can be freely interchanged with and replaced by another in the production process (Hussen 2004: 9). The notion of substitution also includes changes in location and spatial dimension (Christensen 2001: 18). In this worldview (which has dominated natural resource, environment and development economics) it is assumed, often implicitly, that the obstacle of natural resource scarcity can be circumvented through factor or resource substitution possibilities, advances in production technology and resource conservation (Hussen 2004: 9-12). The logic of this optimistic worldview is that the substitutability of human-made capital for natural capital is effectively unlimited (Ayres 2007: 115-116).

other species. Ecosystem services contribute to the well-being of human societies (MA 2005). Flows of ecosystem services are likely to be variable rather than steady (Koch *et al.* 2009). Ecosystem services include: provisioning services, which are the products or goods obtained from ecosystems (e.g. supply of food from the sea or timber from forests); regulating services, which are the benefits obtained from regulation of ecosystem processes (e.g. climate regulation and flood mitigation); cultural services, which are the non-material benefits obtained from ecosystems (e.g. amenity and heritage); and supporting services, which are the services necessary for the production of all other ecosystem services (e.g. primary production and nutrient cycling).

The EU Biodiversity Strategy aims to halt the loss of biodiversity and the degradation of ecosystem services in the EU, and restore the EU's natural capital where practicable, by 2020 (European Commission 2011c). Central to this is the full implementation of EU nature legislation to protect, value and restore biodiversity and ecosystems, including in relation to healthy European seas and coasts.

In its 2010 Quality Status Report, the OSPAR Commission concluded that 'On the basis of current evidence, the UN target of reducing the loss of biodiversity by 2010 is far from being achieved in the North-East Atlantic' (OSPAR 2010: Chapter 10).[143] The European Environment Agency (EEA 2014: 10) states that information reported by EU member states under the MSFD indicates that the rate at which the local loss of biodiversity and the related resilience of marine ecosystems occurs could be considerable (Figure 6.4).

[143] In OSPAR Region III (Celtic Seas), 23 species and 11 habitat types are under threat; in OSPAR Region IV (Bay of Biscay and Iberian Coast), 25 species and nine habitat types are under threat (OSPAR 2010).



Note: Blue = good, red = not good, green = other and grey = unknown). The figures in parenthesis are the number of reported features. The associated confidence rating of the information is rarely high.

Source: ETC/ICM, 2014.

Figure 6.4 Status assessment of natural features reported by EU member states under the MSFD. (Source: EEA 2014: 11, Fig. 2.)

Whether looking at marine species, habitats or ecosystems, less then 20% (often much lower) of all biodiversity features are considered to be in Good Environmental Status. This pattern is consistent throughout all the marine regions (except for the Black Sea, where the status of all features are reported as 'unknown') (EEA 2014: 10). Clearly, marine ecosystems, their biodiversity features and related ecosystem services are under pressure in European seas, including the North-East Atlantic Ocean. This assessment is replicated in the coastal dimension. 'Overall, the current pattern of European coastal biodiversity suggests an accelerating fragmentation and loss of habitats, species, and coastal ecosystem services' (EEA 2013: 16).

The state of natural capital and ecosystem services in the Atlantic Europe region can be further illustrated by 1) the state of fisheries and 2) the distribution of marine ecosystem services capacity in the North-East Atlantic.

State of fisheries

According to the FAO (2016), global fish production is approaching its sustainable limit, with 89.5% of the world's stocks assessed in 2013 now fully fished or overfished (p. 38). Global fisheries production is forecast to increase by 17% by 2025 (p. 171). Aquaculture production is forecast to surpass capture fisheries production in 2021 (p. 172). In the North-East Atlantic, marine capture fisheries production averaged 8,969,599 tonnes annually between 2003 and 2012, declining to 8,654,722 tonnes in 2014. Stocks of Atlantic herring (*Clupea harengus*) are fully fished, while stocks of Atlantic cod (*Gadus morhua*) are fully fished to overfished.

Despite the challenges facing the world's marine capture fisheries, progress is being made in reducing fishing rates and restoring overfished stocks and marine ecosystems through effective management actions in some areas. In the North-East Atlantic, for example, up to 70% of assessed stocks had either decreasing fishing rates or increasing stock abundance (Fernandes and Cook 2013). Nevertheless, a significant proportion of assessed fish stocks in the region remain outside 'safe' biological limits, that is, they are overfished, as illustrated in Figure 6.5.

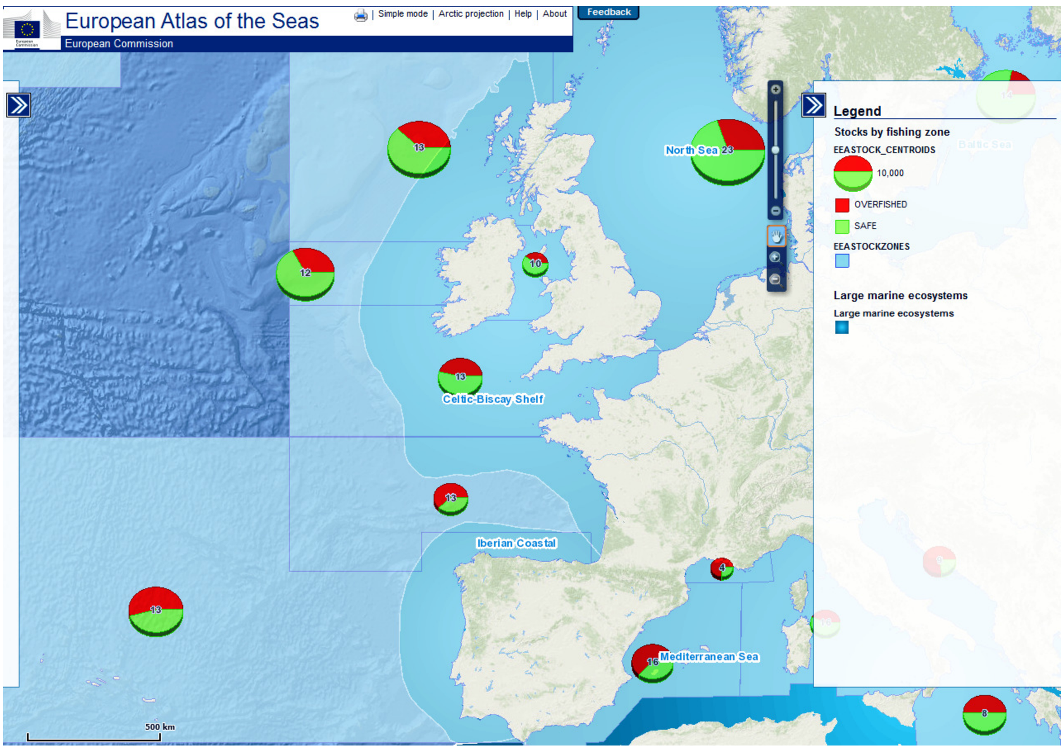


Figure 6.5 Proportion of assessed fish stocks in 2009 that are overfished (red) and those within safe biological limits (green) in the ICES and GFCM fishing areas of Europe. Numbers in the circles indicate the number of stocks assessed within the given region. Size of the circles relates to the size of the catch in that region. (Source: EEA data; European Atlas of the Seas http://ec.europa.eu/maritimeaffairs/atlas/maritime_atlas/ [accessed 13/7/2016].

Marine ecosystem services

To assist the implementation of the EU Biodiversity Strategy to 2020 (European Commission 2011c), decision makers at EU and member state level require spatially-explicit ecosystem services information for MSP and environmental management (Tempera *et al.* 2016). The Mapping and Assessment of Ecosystems and their Services (MAES) initiative is an essential part of the Biodiversity Strategy to 2020. Under MAES, land-cover data has already been used to map the distribution of several ecosystem services provided over the European land surface. However, a similar approach for marine ecosystem services is still emerging for the European seas.

The marine component of MAES has recently been addressed by the Joint Research Centre[144] in a technical report regarding the spatial distribution of marine ecosystem service capacity in the European seas (Tempera *et al.* 2016; see also Galparsoro *et al.* 2014). The report maps the distribution of seabed-associated ecosystem services capacity by using 1) broadscale seabed habitat maps of the EU seafloor area in the North-East Atlantic and adjacent seas, and 2) expert-based assessments of each habitat's capacity to provide ecosystem services. The report relates 33 ecosystem services to 91 seabed habitats, and maps a total of 30 Common International Classification of Ecosystem Services (CICES) ecosystem service categories. From the resulting maps, area-based indicators of ecosystem service capacity (i.e. extent where each service is potentially provided) are

[144] https://ec.europa.eu/jrc/

extracted per MSFD region/subregion, ecoregion, fishing area and an approximation of EU member states' maritime areas.

Overall, continental shelves and oceanic elevations (islands, seamounts and ridges) are highlighted as ecosystem services hotspots where a larger number of services could be potentially held (Tempera *et al.* 2016: 1). When maps are segmented using MSFD region/subregion boundaries, the extended continental shelf areas claimed by the EU member states in the North-East Atlantic, and the Celtic Seas and the Greater North Sea subregions are the regions holding most ecosystem services capacity. Alternatively, an ecoregion-based segmentation of the maps emphasised the Atlantic Deep Sea as the major ecosystem services capacity holder; this is followed by ecoregions containing large continental shelves, including the Boreal-Lusitanean biogeographic region (Dinter 2001) which loosely corresponds to OSPAR Region III (Celtic Seas). Mapped by fishing area, the results highlight the North-East Atlantic, including areas around the British Isles. When an approximation of EU member states' maritime areas was used, member states with larger Exclusive Economic Zones (including Portugal, Spain and the UK) are shown to hold most of the marine ecosystem services capacity. Figure 6.6 depicts a selection of marine ecosystem services maps from the report; it shows one example of each of the three main categories of services provided: provisioning, regulation and maintenance, and cultural services.

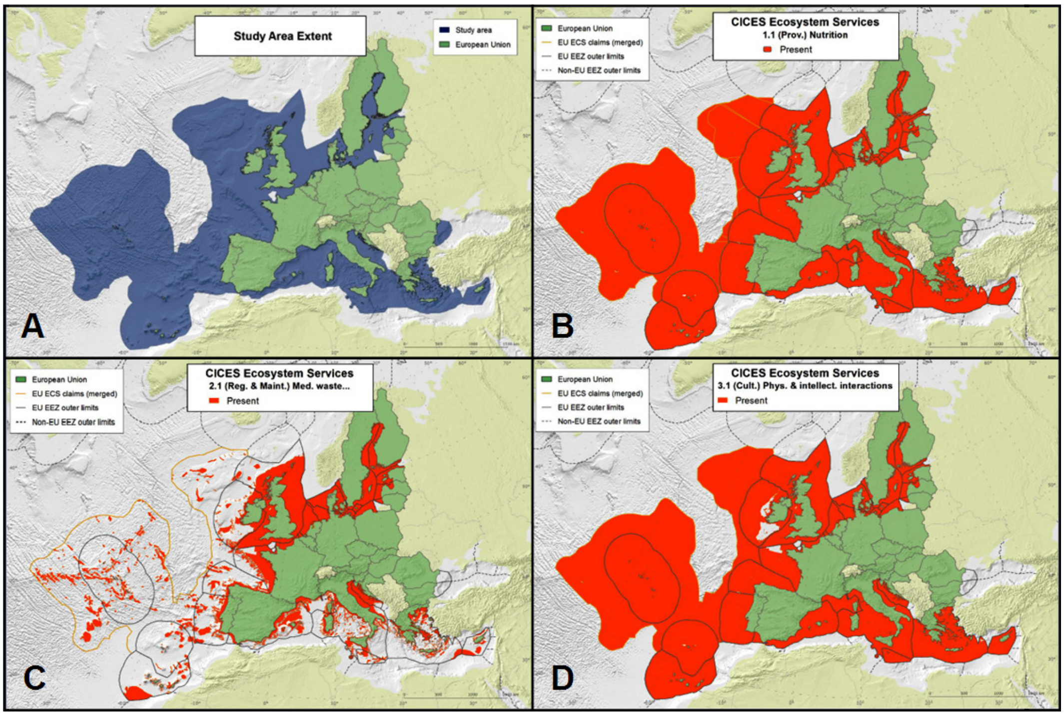


Figure 6.6 Marine seabed-associated (benthic) ecosystem services maps. A) Study area extent. B) Spatial distribution of provisioning ecosystem services in CICES division 'Nutrition'. C) Spatial distribution of regulation and maintenance ecosystem services in CICES division 'Mediation of waste, toxics and other nuisances'. D) Spatial distribution of cultural ecosystem services in CICES division 'Physical and intellectual interactions with biota, ecosystems and land-/seascapes [environmental settings]'. (Source: Tempera *et al.* 2016, Figs. 7, 9, 16 and 29 respectively.)

Panellists were asked (Question 3a): *What do you consider to be the key non-renewable and renewable natural resources that are sourced from within the Atlantic Europe (ocean and coastal) macro-region?* Fifteen panellists responded, identifying a range of key natural resources, including environmental resources and services, sourced from within Atlantic Europe. These are summarised in Table 6.4.

Table 6.4 Key natural resources in Atlantic Europe.

Renewable natural resources: • Fish and shellfish (15) including seafood, fish stocks, capture fisheries,

aquaculture/ mariculture (4), algae and other marine organisms. • Renewable (continuous) resources used in the production of renewable energy (12) including (offshore) wind (12), wave/current (4), tidal (4), water (unspecified) and solar radiation. • Agricultural land and biomass for food production (5) including pastoral, crops and "characteristic regional food and agriculture". • Freshwater and clean air.
Non-renewable natural resources: • Fossil fuels, (offshore) oil and gas (8). • Aggregates (sand, gravel) (7) including marine aggregates. • Minerals (4).
Spatial resources: • High biodiversity areas (2) including fish nursery areas and wildlife (plant and animal) habitats, e.g. kelp/seaweed and cold-water coral habitats. • Environmental sinks for waste (i.e. waste removal/assimilation capacity). • Sites for renewable energy production, living space, shipping routes, military exercise areas, maritime landscape, and beach and coastal territory.
Note: Numbers in brackets denote the number of same or near equivalent responses given by different panellists.

The panellists were also asked (Question 3c): *What do you consider to be the key ecosystem services associated with the Atlantic Europe macroregion (rather than the wider environment in general)?* Fourteen panellists identified a range of key ecosystem services. These are grouped in Table 6.5 according to the four principle types of services used in the Millennium Ecosystem Assessment framework (MA 2005) as suggested by one of the panellists.

Table 6.5 Key ecosystem services associated with Atlantic Europe.

Provisioning services: • Food production and provision (8) including food for humans as this "affects environmental quality and social wellbeing both inside and outside of area"; fisheries and seafood production including key seasonal fish stocks (mackerel, herring, cod) and aquaculture (4). • Forests and farm crops. • Freshwater (2) including "because of its significance for human life and ecosystem functioning". • (Offshore) wind, tides, waves and thermal gradients as potential for energy production (3).
Regulating services: • Regulating services in general, qualified by the panellist on the basis that

they "affect environmental quality and social options". • Temperature control and microclimate regulation (5) including influence of Gulf Stream/North Atlantic Drift and winter warmth. • Extreme weather moderation regarding major storm/weather systems from outside (with relevance to climate change). • Oxygen production through plankton. • Atmospheric carbon absorption through boundary layer. • Organic carbon sequestration in seagrass beds. • Waste sink and absorption (3) including wastes from diffuse and point sources, and contaminant fixing mainly in estuaries. • Water purification (3) including through bivalves, seaweed beds, etc. One panellist emphasised that this service is "significant for ecosystem functioning and human well-being". • Flood regulation (2). • Coastal resistance to storms and protection of inland areas (2).
Cultural services: • Maritime heritage, tourism and marine recreational resources (11) including underwater archaeology (especially for diving), tourism resources (coastal areas, beaches etc.), and marine recreation (especially surfing, sailing, windsurfing, kite-surfing and kayaking) • Employment.
Supporting services: • Nutrient cycling and primary production "because of their significance for human life and ecosystem functioning". • Maintenance of biodiversity (4) including high biodiversity areas, habitat for wildlife and fisheries, and fish and other marine animal nursery areas.
Numbers in brackets denote the number of same or near equivalent responses given by different panellists.

6.7.3 Social assets and capacities ('capitals')

Concerning the social domain, the workbook objective was *to identify the critical assets and capacities ('capitals') associated with human society in the Atlantic Europe macro-region*. In other words, to identify key social components (actors and processes) and their relationships, social structures and collective functions, which together influence the configuration and dynamics of EASES.

The multiple capitals framework developed for round one focused on social, cultural, political, economic and financial capitals. 'Human capital' refers to the capabilities and status accumulated in people that facilitate personal and socioeconomic well-being. Human capital is a property of individuals rather than groups and is treated as an aspect or subset of social capital.

Social capital

Social capital is a property of groups of people rather than individuals. It is the supply of active connections (connectedness) between people within groups as well as between different groups. Social capital includes the trust, mutual understanding, shared values (common good, norms, rules and sanctions), reciprocity and exchange, and other relationships that bind together people, groups, communities, networks and organisations. Social capital includes society's cultural, economic and political arrangements. Such connectedness can be horizontal and vertical (hierarchical), inward looking (bonding) or outward looking (bridging or linking). Social capital is the 'glue' that enables people to act collectively and cohesively, and makes cooperative action and common problem-solving possible.

The intrinsic value of social capital is associated with the strength of its connections. In particular, those connections that engender cohesiveness of people in their communities and those that facilitate collective action, access to resources and support (i.e. information and ideas), informal social learning and learning-by-doing. Social capital is both a cause and consequence of social and economic cohesion. Although deliberate actions are usually required to establish and maintain social capital, it is often self-reinforcing (e.g. when reciprocity and exchange lead to greater trust and shared values). Social capital is built by investing in connectedness and participation. The effectiveness of institutions and agencies is increased through enhancement of social capital.

The Atlantic Arc Commission (AAC), Conference of Atlantic Arc Cities (CAAC) and Atlantic Transnational Network (ATN) actor networks are key examples of social capital at the Atlantic Europe macro-regional level: economic and political arrangements among subnational regional actors for collective and cooperative action at EU level (see section 6.5). Other examples include the stakeholder-led advisory councils[145] established under the CFP reforms of 2002 and 2013 in the context of regionalisation (see subsection 4.5.3). Social capital is critical in partnership cooperation. The AAC, for example, consists of a high-level Political Bureau and a Coordinating Committee to steer the activities of the AAC, which are structured in the form of different working groups on policy areas such as transport, fisheries, tourism and culture, and Atlantic strategy. Thus, the AAC has a strong social capital through its internal governance arrangements.

Individuals and their human capital are not discrete entities that exist separately from social units. Both human capital and social capital contribute to economic capital and the well-being of society. The concept of social capital focuses on the real-world complexity and nonlinear relationships between individual agents/actors, the networks they form and the norms which govern these relationships. The concept of human capital focuses on individual agents/actors and simple linear relationships (e.g. investment–return relationships) and is commonly linked to the economic activity and productive potential of people.

Social capital exists and develops within a particular social, economic, cultural, political and technological context. Therefore social capital at the local or subnational level will have a significantly different character to social capital at macro-regional or global levels.

Panellists were asked (Question 6a): *Which aspects of social capital do you consider key to the functioning of the Atlantic Europe macroregion?* In other words, what are the key relationships connecting which key groups within the macro-region? Key in the sense that they are relationships that must be maintained in the face of disturbances in order to facilitate social functioning – relationships that are important to strengthen and build in order to cope with change and recover from future disturbances. Responses were received from 14 panellists, with many containing multiple points regarding key aspects of social capital. Six panellists considered connections, trust and cooperation critical. In summary, their responses referred to:

[145] http://ec.europa.eu/fisheries/partners/advisory-councils/index_en.htm [accessed 14/7/2016].

- The dominance of bonding social capital within groups and epistemic communities.
- Established mechanisms and trust between governments, NGOs and business. For example, the European Maritime Day annual meeting for Europe's maritime community to network, discuss and forge joint action.[146]
- Personal connections between representatives of user communities and governance bodies. For example, between representatives of the ocean renewable energy industry and of the AAC.
- Cooperation incentivised by economic interests. For example, the shared social, cultural and, in particular, economic interests of the Atlantic seaboard regions have resulted in close cooperation through the AAC.
- Conflict mediation and mitigation, and localised processes such as participatory and community-based resource management, are important to strengthening trust and cooperation between different actors, interest groups and institutions.
- A key relationship is 'transboundary social capital' concerning the multinational and multicultural relationships at macro-regional and international levels (rather than local social capital focused on local social relationships).

I will now elaborate further. Connections, trust and cooperation were considered crucial by several panellists. One panellist stated: "Connectivity and trust is fundamental. Connectivity in terms of 'bonding' or inward looking [social capital] I would say is the dominant paradigm restricted to [Atlantic Europe] 'user groups' or epistemic communities, e.g. scientists, fishermen, government. The trust and links between groups is explicitly weak." Regarding strengthening trust and cooperation between different Atlantic Europe actors, another panellist stated:

> "To (re)build and strengthen trust and willingness to cooperate between researchers, decision makers and resource user groups, especially with regard to fishery and agriculture – this implies to mediate and mitigate

[146] http://ec.europa.eu/maritimeaffairs/maritimeday/en/home

> interest conflicts between different resource user groups, power and knowledge bearers. More specifically: From the general requirement to strengthen cooperation between different actors, interest groups and institutions, one can develop (through sub-regional in-depth analysis) more locally specific processes linked to social capital, especially participatory and community based resource management."

Regarding institutional relationships in Atlantic Europe, one panellist considered "transnational institutions (rules, agreements, policies) rooted in national and transnational (macro-regional) stakeholder associations and regular meetings" to be key. Another panellist stated that "numerous regional and coastal management initiatives and policies have helped to build relationships across institutions and are potentially good social capital builders – but a lot of this seems to remain within institutions." A third panellist stated:

> "Central governance is very important for broad scale social issues, including for example the [European Commission], a regional seas body (OSPAR), a regional fisheries body (NEAFC and DG MARE) and international shipping governance (IMO). Each reaches out to different social sectors and stakeholder groups. Greater coordination is required amongst such groups, however."

Five panellists mentioned or alluded to key multilevel connections between different governance levels. One panellist considered that "Key relationships are those between the state, private sector, voluntary sector and civil society (the public) at all geographical scales, namely, international regional, EU, national, and sub-national/local." Another panellist pointed to "multilevel connections between governance levels, particularly local, national and EU". A third panellist specified "vertical hierarchies – in the sense of rules and regulations filtering down the chain and communication and reaction filtering back up." A fourth panellist considered the relationship between local initiatives versus regional approaches to be crucial. A fifth panellist emphasised the dynamic web of institutional linkages as very important in terms of social capital:

> "In societal terms, the web of institutional linkages among the different levels involved is very important. These are: plenty of belief [trust?], reciprocity, legitimacy, and face-to-face knowledge. Normally, such a web is dynamic and flexible, and extends its sphere of influence to the local communities. There is room to amplify the positive effects of these structures: the inward democracy might be improved, and the good governance principles (social justice and overall environmental sustainability) must be supported and enhanced [throughout] the structure."

The last comment, regarding room to amplify the positive effects of structures, points to a potential feedback loop in the social domain, whereby resilience might be managed.

Regarding the fisheries sector, one panellist stated:

> "Whereas oil & gas, shipping and tourism all do have a clear connection with the marine ecosystem, fisheries is traditionally the activity that defines its [own] existence by [its] use of the marine socio-ecological system. Fishing communities, in the broadest sense, derive a large part of social capital (but in this respect also identity and social structure) from the marine system."

Another panellist considered the fishing sector potentially "a means of building social capital across EASES, as – although it can be a bit tribal – it has a 'brotherhood' aspect and relatively good networks across the region." The same panellist also considered the issue of identity in relation to territory:

> "The future development of the [EU] is of importance [… regarding] tacit acknowledgement within the EASES region as to whether they are a central or diluted part of a European identity. But it is hard to see where this will lead at present."

Also regarding identity, a different panellist pointed out that “national identity can be social ‘glue’ as can sectoral identification.”

The construct of identity, whether community, sectoral or territorial, is closely associated with the concepts of SES and resilience (Walker *et al.* 2004; Cumming and Collier 2005) and widely recognised as fundamental to human well-being and the overall resilience of individuals and communities (Turner *et al.* 2008). Loring (2007) considers identity the counterpart of change in a SES; a qualitative characterisation of what results from the overlap of the social and the ecological domains.

One panellist considered stakeholder participation in environmental decision making a key aspect of social capital, stating:

> “Another key relationship is the role of stakeholder participation in environmental decision-making, for example the role of Regional Advisory Councils in the Common Fisheries Policy, and how this will potentially be expanded in the Marine Strategy Framework Directive and Integrated Maritime Policy. We can see disparity between different regions already and I think this is a key issue that needs to be strengthened. By stakeholders I’m referring to industry, the public and NGO representatives.”

The same panellist also considered the accountability of elected officials and representatives an important aspect of social capital:

> “A key area here is accountability on the part of elected officials, from the viewpoint of the public. This can be expanded to include consumer perspectives on the environmental positions taken by representatives, where this is supported by NGO actors. For example, with respect to marine environmental issues, the whole issue of eco-labelling and the potential strength of consumer preference to have an impact on the market for fish products.”

One panellist considered economic relationships involving fisheries, which appear to evolve and change rapidly across the macro-region, to be important: “For example, movements of fishing boats and final destinations for fish landings. It would seem that – if it made economic sense – any relationships would be formed or broken as expedient.”

The same panellist considered language to be a major aspect of social capital in the Atlantic Europe: “English first-language speakers being particularly clannish; though this can also be observed regarding French and Spanish [speakers].” This panellist also detected a possible “devolution of ‘marine society’ in Scotland, Wales and England, as political devolution brings slightly differing objectives and means of engagement between these groups.”

Other aspects of social capital that panellists considered key to the functioning of the Atlantic Europe macro-region included: family, community and local government; and the need to strengthen the sociopolitical empowerment and participation of women in different spheres to facilitate change, solutions to community problems, and flexible responses to social and environmental crises.

Regarding transboundary social capital, one panellist stated:

> “The complication seems [to be] at the level of ‘transboundary social capital’ creation: social capital is focused on local social relations – but how to deal with the multi-national, multi-ethnic, multi-cultural relations at macro-regional and international levels, and the manifold conflicts included in capacity building at these levels? This would require specific kinds of ‘bridging’ or linking social capital that cross social, cultural and political boundaries. May be transboundary social capital cannot be seen in other ways as local social capital and as local social capital in boundary regions. For all social capital analysis, also in building trans-national networks of cooperation, it seems necessary to disaggregate levels of action and focus on subregional and local levels to catch the specific preconditions given for that.”

Panellists were also asked (Question 6b): *Are there any trends in Atlantic Europe concerning key aspects of social capital (capacity) that you are aware of and consider to be important?* For example, significant improvements or declines in social and economic cohesiveness, social learning, social cooperation, collective action, levels of participation, effectiveness of institutions and agencies, and so forth. The 11 panellists who responded identified the following trends:

- Very slow improvements in collective action, participation and cooperation, including in ICZM and fisheries management.
- Gradually increasing institutional and stakeholder cooperation despite some uncooperative stakeholders in certain sectors (e.g. fisheries and oil and gas).
- Declining social cohesion.
- Growth of regional identities at subnational levels related to devolved government and increasing community participation.
- Devolution of regional 'marine society' as a consequence of UK political devolution.
- Increasing bureaucratisation and centralisation at EU and national levels. Increasing influence of transnational private sector companies and NGOs.
- Europhile/Eurosceptic countertrends (i.e. a greater sense of common European interests and identity on one hand, and increased nationalism and scepticism of European institutions on the other).
- Development of RACs and personal networks between NGOs, governments, and the fishing industry.
- Declining social structure of fishing communities linked with steady decline of fleets and catches.

Regarding cooperation in Atlantic Europe, one panellist stated: "Many [actual] or potential improvements in collective action, participation and cooperation happen very slowly and with many difficulties to be overcome," such as in the case of ICZM and local fisheries management. Another panellist generally felt that while institutional and stakeholder cooperation is gradually increasing, "some stakeholders (e.g. fisheries and to a lesser extent oil & gas) are still very uncooperative and will not share data or information about current or future resource use, which is a serious problem."

Regarding social cohesion, one panellist stated: "Social cohesion is not necessarily increasing and in some cases appears to be unravelling." Another panellist identified a decline in social cohesiveness in some parts of the macro-region associated with impoverishment and social exclusion linked with the global economic crisis. A third panellist identified a "feeling that things are becoming increasingly disjointed." Conversely, one panellist pointed to the results of a study[147] that indicate "a shift towards greater macro-level social integration and economic capitalism within the EU27 countries."

Panellists identified a number of other trends concerning aspects of social capital. One panellist discerned "Increasing bureaucratisation and centralisation at EU and national levels; increasing influence of transnational private sector companies and NGOs; growth of regional identities at sub-national levels related to devolved government and increasing community participation." The panellist added that the influence of transnational private sector companies and NGOs in particular needs to be strengthened so as to maintain a balance with bureaucratisation and centralisation at EU and national levels. One panellist pointed to "The development of RACs and personal networks between NGOs, governments, and the fishing industry." Another panellist identified the declining social structure of fishing communities linked with the steady decline of the fleets and catches. Other comments concerned the growth of regional identities at subnational levels related to devolved government and increasing community participation; and, as previously mentioned, a devolution of regional 'marine society' as a consequence of UK political devolution.

One panellist identified two important countertrends. On the one hand, there is a "greater sense of common European interests and identity amongst certain groups (Europhiles), partly as a consequence of EU integration and EU employment and migration patterns". On the other hand, there is "increased nationalism and

[147] FP6 European Lifestyles and Marine Ecosystems (ELME) project, see http://www.elme-eu.org

scepticism of European institutions (Eurosceptics), particularly in areas/groups of society hit by social change and/or economic decline."

Cultural capital

Cultural capital is related to both social capital and human capital. It is the accumulated connectedness, learning, experience and social memory[148] through which power structures (hierarchy) and status are successfully and advantageously reproduced in families, communities, societies, organisations, institutions and so forth. The assets of cultural capital may also be exploited by individuals and groups to alter their position within a hierarchy. Cultural assets can be tangible (e.g. heritage buildings and sites) or intangible. The latter includes the inherited values, beliefs, skills, knowledge, practices and traditions that constitute culture of a group. It also includes a group's worldview, religion, environmental or business philosophy and ethics; shared cultural networks and social–political institutions; and manifestations of cultural diversity within communities.

A crude example of cultural capital in the form of heritage is illustrated by the distribution of public aquariums, maritime museums and UNESCO world heritage sites in coastal regions on Europe's Atlantic seaboard (Figure 6.7).

[148] Social memory is the accumulated collective memory – embedded in values – of past experiences concerning natural resources, environmental and social changes, and successful adaptations.

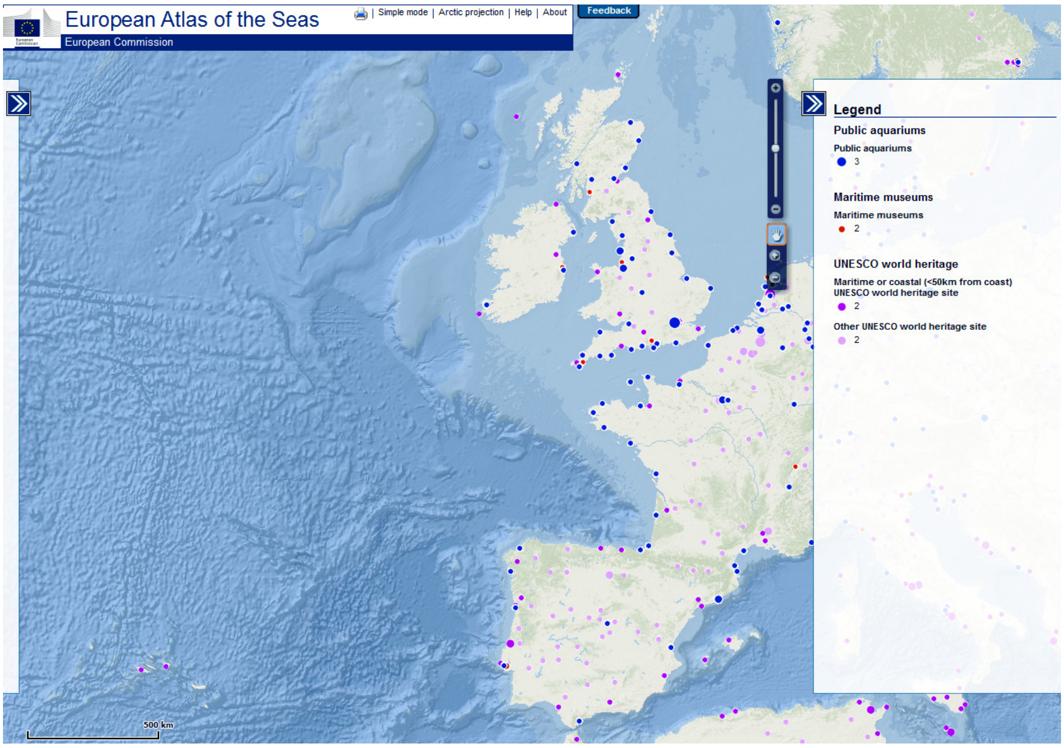


Figure 6.7 Cultural heritage sites on Europe's Atlantic seaboard. (Source: European Atlas of the Seas.[149])

Panellists were asked (Question 7a): *Can you identify or suggest any key aspects of cultural capital relevant in the context of the Atlantic Europe macro-region?* There was a range of responses from 14 panellists. Nine panellists' comments concerned maritime culture and heritage, history, 'Celticity' or cultural landscapes. For example, one panellist suggested that "The maritime cultural heritages of individual states and sub-national regions may be a considerable force for maintaining some kind of cultural stability." Another panellist stated:

> "I think there is a possibility to engage both decision-makers and the public on the 'maritime' culture of Europe and how this unites them across hierarchical and international boundaries. This includes areas of cultural importance both on the coastline and underwater (i.e. submerged archaeological sites) but also living artefacts like fishing villages and coastal communities."

[149] http://ec.europa.eu/maritimeaffairs/atlas/maritime_atlas/

This comment points to potential use of Europe's maritime cultural heritage as an effective bridge between maritime stakeholders across different levels and scales.

A third panellist stated:

> "The cultural issue is not very clearly addressed [in general]. Maritime culture in Europe is a historical attribute of many countries. The green paper Towards a future Maritime Policy for the Union: A European vision for the oceans and seas is a good example of the importance of having a common strategy for Europe. Still, the importance of sustainable development in the region [rests] on well-being issues for the local community and that should be reflected somewhere."

A fourth panellist identified "historical roots and connections to the sea." A fifth panellist stated: "Historically the influence of conflict, most particularly WWII, needs to be considered. This has both macro political and local development footprints." A sixth panellist suggested that "Common history and cultural achievement, perhaps also (though less desirable) relating to common enemies" are key aspects of cultural capital in Atlantic Europe. These three comments allude to the significant influence of path dependence or 'history matters' on EASES.

Regarding the issue of what may loosely be labelled 'Celticity', a seventh panellist identified: "Common Celtic influences (especially Brittany, Cornwall, Ireland, Isle of Man, Scotland and Wales, but also parts of Spain – Galicia and Asturias – and central and northern Portugal – Cantabria and León)". This came with the caveat that in Atlantic Europe there are "at least two very separate constitutional, legal and welfare systems (e.g. Zweigert and Kötz 1998; Esping-Anderson 1990), and different professional and academic cultures (e.g. Hofstede 1980; Galtung 1980)."[150] However, another panellist stated: "I can't say that I'm

[150] Esping-Anderson, G. (1990) *The Three Worlds of Welfare Capitalism*. Princeton, NJ: Princeton University Press. Possibly either Galtung, J. (1980) *The True Worlds: A Transnational Perspective (Preferred Worlds for the 1990's)*. New York: Free Press; or Galtung, J. (1980) *Peace and World Structure*. Copenhagen: Christian Ejlers. Hofstede, G. (1980) *Culture's Consequences:*

aware of a 'Celtic' heritage, but there are many natural regional links, e.g. between Cornwall, Brittany, southern Ireland in terms of fishing and aquaculture."

A ninth panellist considered cultural landscapes in the Atlantic Europe macro-region, including cultural and natural heritage sites, to be certainly important as "they give examples for sustainable natural resource use and management." The same panellist added that:

> "More general cultural capital aspects in larger parts of the EASES may include common symbolic resources of European-occidental culture [such as Protestant and Catholic religions, worldviews and ethics (human exemptionalism paradigm and new ecological paradigm; anthropocentric and ecocentric] because of their significance for resource management and sustainable development strategies."

It is worth noting that the notion of cultural landscapes may be interpreted in terms of sociocultural system memory.

Two panellists commented directly on the fisheries sector in Atlantic Europe. One panellist stated: "Many inshore fisheries had at one time strong cultural capital. However, much of this has eroded as these fisheries have been greatly reduced, or in some cases, collapsed (sometime due to no fault of their own)." Another panellist referred to fishing communities, which derive a large part of their cultural identity and social structure from the marine system, and whose social structure is declining as a result of a steady decline of the fleets and catches. Both comments point to the loss of resilience in the fisheries subsystem in general: a key interaction between the social and ecological domains.

One panellist considered the perception of nature and region an important aspect of cultural capital and, therefore, how issues and problems are framed in terms of change. Another panellist considered how the perception of the macro-region's place within an expanding EU might change with the political and economic

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International Differences in Work-Related Values. Beverly Hills, CA: Sage. Zweigert, K. and Kötz, H. (1998) *An Introduction to Comparative Law*. Third Edition. Oxford: Clarendon Press.

climate. The same panellist also identified language as a major factor; and that "different sectors have markedly different cultural capital (e.g. high in fishing; low in port management, probably)." Another panellist stated that the "Atlantic Arc affinity with the sea is a key cultural driver which could be useful for developing a common approach to management reform."

One panellist commented that although they could not identify or suggest any relevant aspects of cultural capital on a macro-regional basis, "there are local examples where partnerships or other such programmes have increased cultural capital." Likewise, another panellist suggested that "It seems that social and cultural capital are more important at sub-regional and local levels – [where] their specific qualities become manifest." Also concerning the local level, a different panellist stated that "The process of industrialisation has generally reduced local ecological knowledge and cultural capital" in the Atlantic Europe region.

Other comments by panellists included the following: The valuable cultural capital potential of recreational cultures, for example, sailing, angling and diving. The importance of lay and vernacular knowledge, and domestic culture, particularly in relation to activities such as fisheries. Common cultural capital is inherent in the arts and sciences, and in political developments in Atlantic Europe. Maritime heritage needs careful management at all geographical scales.

Political capital

Political capital refers to an individual's or group's ability to engage in political decision making. This, according to Sørensen and Torfing (2003), depends on their rights and levels of access to decision-making processes (endowment assets); ability to make a difference in these processes (empowerment capacity); and perception of themselves as political actors (political self-identity). In other words, political capital arises from actors' participation in interactive political processes and political arrangements[151] that link civil society to the political system. Therefore political capital may be held by (1) individual citizens and office holders regardless of whether elected or selected; and (2) collective forms

[151] Political arrangements are political and legal structures that promote sociopolitical stability, democracy, government efficiency, good governance and social justice.

of political competence including civil society, agencies and government. Political capital also includes the institutional conditions for the development of political capital.

Political capital is not the same as political power, although there is a relationship between the two. Political capital is not the same as social capital, even though it is enhanced through connectedness. Political capital may overlap with cultural capital in the sense that political capital can be reproduced to maintain an individual's or group's status and position, or exploited to alter their position within an institution or hierarchy.

Panellists were asked (Question 8a): *Which key groups, networks, organisations or institutions have the greater ability and, conversely, the lesser ability to engage in political decision making concerning and affecting the Atlantic Europe macro-region?* Below, the responses from 13 panellists have been divided (unranked) into two principal categories according to the considered ability of key groups and institutions to engage in political decision making. These are followed by a summary (Table 6.6).

Nine panellists identified groups and institutions with a greater ability to engage in decision making relating to Atlantic Europe. One panellist considered OSPAR to have a significant ability to engage as well as national (i.e. member state) governments, while MEPs and groups that represent the Atlantic regions in Brussels (e.g. the AAC) "may have more influence than they are due". Another panellist stated:

> "National political parties, uniting on the basis of common ideological/cultural backgrounds, have a greater ability. Stakeholder lobby groups have sometimes greater, sometimes lesser abilities. The most successful EU lobby groups had been the coal lobby (shortly after World War II) and until recently agriculture."

A third panellist identified the European Commission's DG MARE and DG Research as well as national governments of member states. A fourth panellist listed DG MARE, DG ENV, national fisheries and environmental agencies/ministries, NEAFC, OSPAR and industry groups (mainly fishing, oil and gas, offshore wind, and to a lesser extent aggregate extraction), adding that "Environmental groups can have effects, but usually are not as influential as industry". Conversely, another panellist stated: "Primarily national lobby groups, e.g. Scottish Fishing Federation are adept at working locally, nationally, and at the EU level. Conservation ENGOs are also well engaged, e.g. WWF."

A sixth panellist considered that region-wide, the EU has a greater ability to engage is it encompasses the whole boundary [of the macro-region]; more locally, local authorities have a greater ability. Another panellist stated:

> "All EU institutions and national governmental institutions (they have formal political power and the power structures change only slowly); certain economic actors and transnational corporation also have strong ('non-legitimate') power and can engage in political decision-making, but here one would have to identify individual firms (e.g. in the food production branch)."

An eighth panellist alluded to key structural arrangements (networks, vertical links) and issues of legitimacy:

> "I think networks between government (at all levels), NGOs and business are the most powerful actors (if they exist). In addition vertical linkages and transparency are important preconditions for successful (and accepted, legitimated) engagements."

The other panellist to respond listed the following:

- "The fishing sector has a high potential ability to engage in decision-making. Not particularly realised at present, but potential, and networks exist.
- Tourism and marine eco-tourism provides some coherence in terms of shared interests. Marine ecotourism though has been slow to come together as an industry to present common views – but there is potential for this.

- NGOs in environmental and economic areas can have high networking across the area – and represent an under-utilised means of engaging across the region. WWF particularly has a good network and coherent activities and contacts, currently being utilised in CFP reform, for example. A limited number of other NGOs have valuable networks doing similar.
- Aquaculture is of importance across France, Spain, Portugal, Ireland, Scotland – and there are good connections. Although SW England and Wales are under-utilised in terms of aquaculture, there are also good connections and networking, through seafood dealers, fishing and individuals. This represents an area of high potential."

This response highlights that in reality there is often interdependence and overlap between social, cultural, political and economic capitals. For example, when an actor's ability to engage in political decision making is strongly related to active connections and trust between actors. That is, actors that coalesce around a shared sociocultural identity and socioeconomic interest to form a group, network or institutional arrangement that, in turn, enhances their ability to engage in political decision making.

The panellists also identified groups and institutions with a lesser ability to engage in decision making relating to Atlantic Europe. One panellist stated that "Lesser ability at all levels would reside with the individual." A second panellist considered communities and citizens to be less engaged due to resources, organisation and commitment; adding that "This is highly dependant on the national political discourse." Another panellist also considered resource user groups such as fishermen, local community and citizen groups, and the newcomers in the public policy processes (NGOs, social and environmental movements, etc.) still have less influence in general; "However, this has to be differentiated: some have obviously larger ability to engage in political decision-making and have been co-opted by governmental institutions." A fourth panellist stated that there are numerous organisations that cannot really engage, "but then they may not have a great deal to say!"

A fifth panellist identified a difference between the northern and southern areas of the Atlantic Europe macro-region in respect of political capital; the southern area networks have a lesser ability to engage compared to the northern area networks:

> "The main obstacle in this respect, in my opinion, is the absence of a cross North-South perspective. The networks are very limited in terms of geographical areas. In this sense, in southern waters the organisational networks have problems achieving links at European level. As a consequence, they have lesser ability to engage in political decision-making processes."

This comment points to the two principle geographical aspects of the Atlantic Europe macro-region: the northern and southern aspects, which may be perceived as a fundamental division.

Table 6.6 Ability of groups, networks, organisations and institutions to engage in political decision making concerning or affecting the Atlantic Europe macro-region.

Greater ability to engage	**Lesser ability to engage**
• OSPAR • NEAFC • EU and EU institutions in general • European Commission • DG Maritime Affairs and Fisheries • DG Environment • DG Research • European Court of Justice • European Parliament/MEPs • Inter-governmental networks (all levels) • Member State national governments, governmental institutions • National and industry, agriculture and fishing sector lobby groups/networks • National political parties	• The individual • Communities, citizens • Resource user groups • NGOs, social and environmental movements • Southern area networks

• Local/regional authorities • Regional representatives, lobby groups • NGOs and NGO networks in general • Environmental/conservation NGOs • Transnational corporations, businesses, business networks • Stakeholder lobby groups in general	

Other responses concerning political capital fall outside of the above two categories. One panellist considered a future scenario regarding a shift in importance between territorial levels and suggested that:

> "With increased regionalisation and participation at the regional level the role of Member States will change dramatically. In the long run the concept of Member State will become trivial as issues are either dealt with at the international level (EU, supranational) or at the sub-regional local level. As this whole system is in flux one cannot point at which parties are most important as roles and the rules of the game are changing."

Regarding stakeholder influence, another panellist forecast that stakeholders in the CFP (especially after the 2013 reform) and the MSFD "will have a profound influence on the maritime components of the EASES system".

One panellist considered regional and local authorities key actors to engage relevant stakeholders in any political or decision-making process in Atlantic Europe; however, they will need to make use of all mechanisms and policy tools available from other macro-regions and the supranational level. Another panellist stated:

> "The main reasons for greater or lesser ability do not seem to be lack of knowledge or capacity but the dominant power structures that are still focussed on governmental national institutions and such that derive their power from them – the power structures change only slowly towards de-

> centralization and participatory, co-management or new governance structures."

Panellists were also asked (Question 8b): *Are there any relevant office holders, groups, networks, organisations or institutions (at whatever level) that you consider to be excluded from political decision making concerning and affecting the Atlantic Europe macro-region?* There were responses from eight panellists. Regarding exclusion from political decision making relevant to the Atlantic Europe macro-region, panellists identified the following resource user groups, civil society groups and other actors as being excluded or else having little if any influence: the private sector, "particularly from an environment perspective"; fisher lobbies, which "have little influence, probably because their number dwindles"; inshore fisheries and small-scale aquaculture; recreational anglers and recreational industry (e.g. ecotourism); environmental and social movement NGOs; and local community and citizen groups.

One panellist stated:

> "Inshore fishing and small aquaculture is under-represented, and generally viewed as a small sector in decline. This is a pity as – although small – it does represent a group of shared experience and heritage, [which] could be utilised to undertake positive and sustainable marine management activities particularly in sensitive and protected areas. They could use sustainable gear in controlled ways, and their presence on the seas would provide an effective monitoring and enforcement mechanism. However this would require significant change in they way inshore fisheries are viewed by relevant authorities at all levels."

Another panellist commented that

> "Civil society groups, such as environmental groups, often fall between the cracks and may not even have permission to attend many decision-making meetings (i.e. do not have observer status, or as in the case of NEAFC, observer status has greatly restricted access)."

A different panellist commented on the limited ability – approaching exclusion – of key resource users groups, such as fishermen, in Atlantic Europe to engage in political decision making relative to other user groups. Furthermore,

> "In spite of the manifold efforts to create participatory and co-management systems in many policy and management fields and to decentralize decision-making, the inclusion of key resource users groups (for water and soil) is still limited."

Two panellists did not consider any such actors to be excluded from political decision making; one commented that although some actors may be ignored, their deliberate exclusion is less likely to occur.

In relation to key institutions, political capital varies between the different Directorates-General of the European Commission. One panellist considered the bifurcation between nature conservation and fisheries at European Commission level and consequent disparity between DG MARE and DG ENV:

> "Given the bifurcation between nature conservation and fisheries in Europe from a legal perspective […] there is a key tension on the Commission level reflected both in the relationship between Directorate Generals (DGs) and their legislative output. In brief, DG Environment is understaffed and underfunded in comparison with DG Maritime Affairs and Fisheries (DG Mare). Legislatively, DG Mare produces Regulations which are directly binding on Member States whilst DG Environment produces Directives which need to be implemented by Member States through the creation of national legislation. This produces a tension whereby Member States' activities regarding fishing are directly regulated and controlled by the Commission, whilst [member states] are responsible for enacting nature conservation within their territories. In situations where nature conservation objectives are at risk by fishing activities, this can be an impasse.

Consequently I feel that the disparity between the DGs is a key issue. And DG Mare was formerly known as DG Fisheries until very recently – this shift to 'maritime affairs' is a reflection of the new Integrated Maritime Policy and its philosophy of making Europe a leading maritime economy. Meanwhile, the new Marine Strategy Framework Directive is under the auspices of DG Environment and thus achieving its objective of attaining 'good environmental status' of Europe's marine environment by 2020 is left to Member States to implement via maritime spatial planning, whilst fisheries continue to be controlled at the Commission level.

I think that the CFP Regional Advisory Councils have some ability to inform the process, but this needs to be further explored, especially given the new IMP and MSFD and plans for regional integration and cooperation."

Economic capital

Economic capital (also referred to as manufactured, physical, produced, built and human-made capital) is generated via economic activity. Commonly viewed as a standalone capital, economic capital may be more appropriately understood as a type of social capital.[152] It comprises tangible stocks of infrastructure (e.g. ports, transportation networks and coastal defences), produced assets (e.g. machinery, fishing vessels, and other means of production), technological capital (i.e. science and technology), information and public works. Economic capital also comprises intangible economic assets such as power, reputation, entrepreneurial skills, knowhow and intellectual capital.

Furthermore, economic capital includes access (e.g. to information, infrastructure or goods); land and seabed property and property rights; coastal and offshore spatial resources; markets (e.g. financial markets) comprising market places (physical or virtual infrastructure), participants (buyers and sellers), institutions

[152] One panellist responded that "Economic capital may be defined as a subset of social capital. They may, however, contradict each other, as in their relation to natural capital: economic capital relying on natural capital, social capital being an independent factor."

and social capital; and market-based incentives (e.g. to reduce environmental impacts, preserve biodiversity or invest in ecosystem services) such as charges (taxes and fees), tradable pollution permits, subsidies and liability rules.

Figures 6.8 to 6.11 depict examples of the spatial distribution of economic capital on Europe's Atlantic seaboard, including maritime infrastructure, coastal defence works, marine renewable energy and fishing vessels.

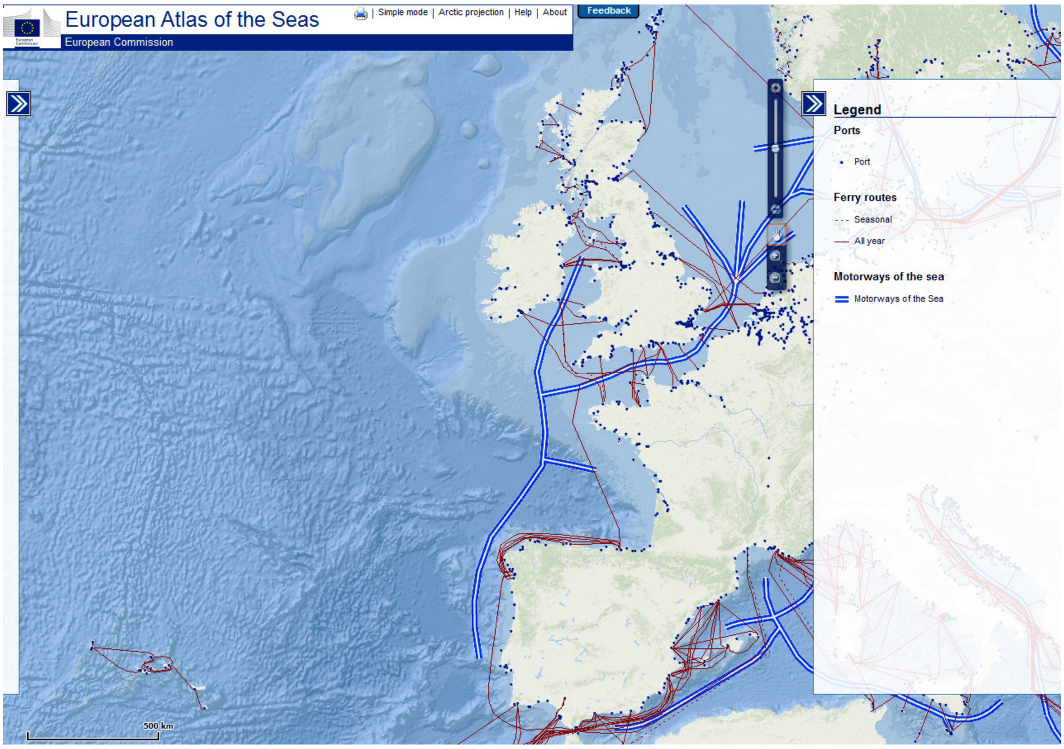

Figure 6.8 Maritime infrastructure: ports, ferry routes and motorways of the sea. (Source: European Atlas of the Seas.)

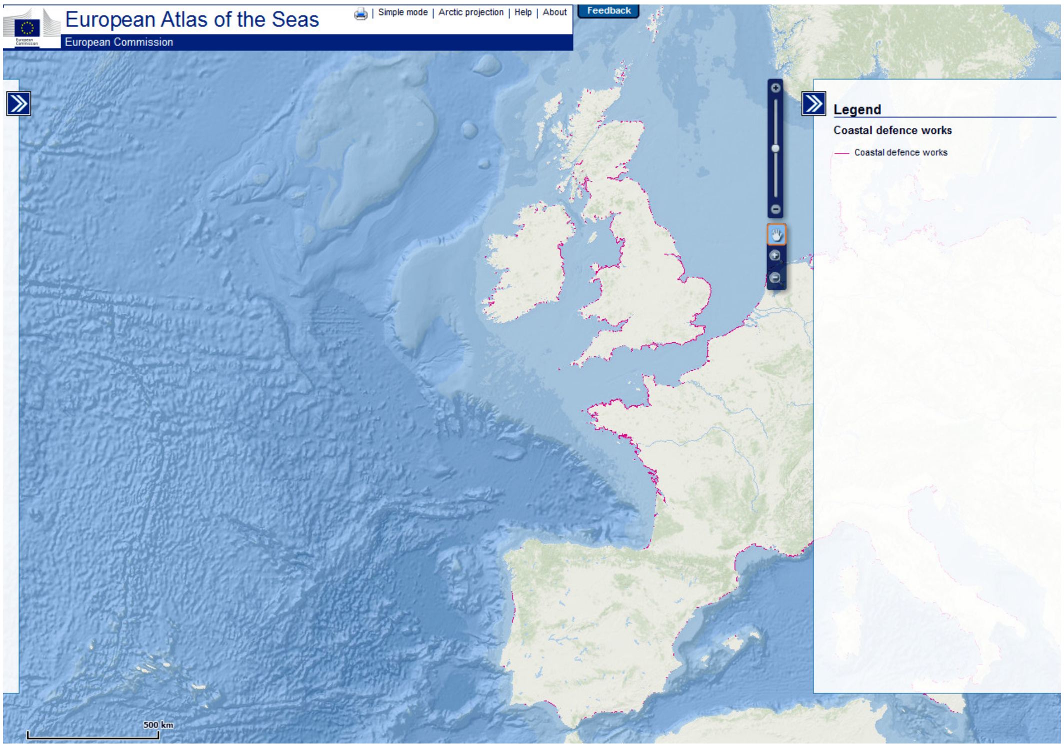

Figure 6.9 Coastal defence works. (Source: European Atlas of the Seas.)

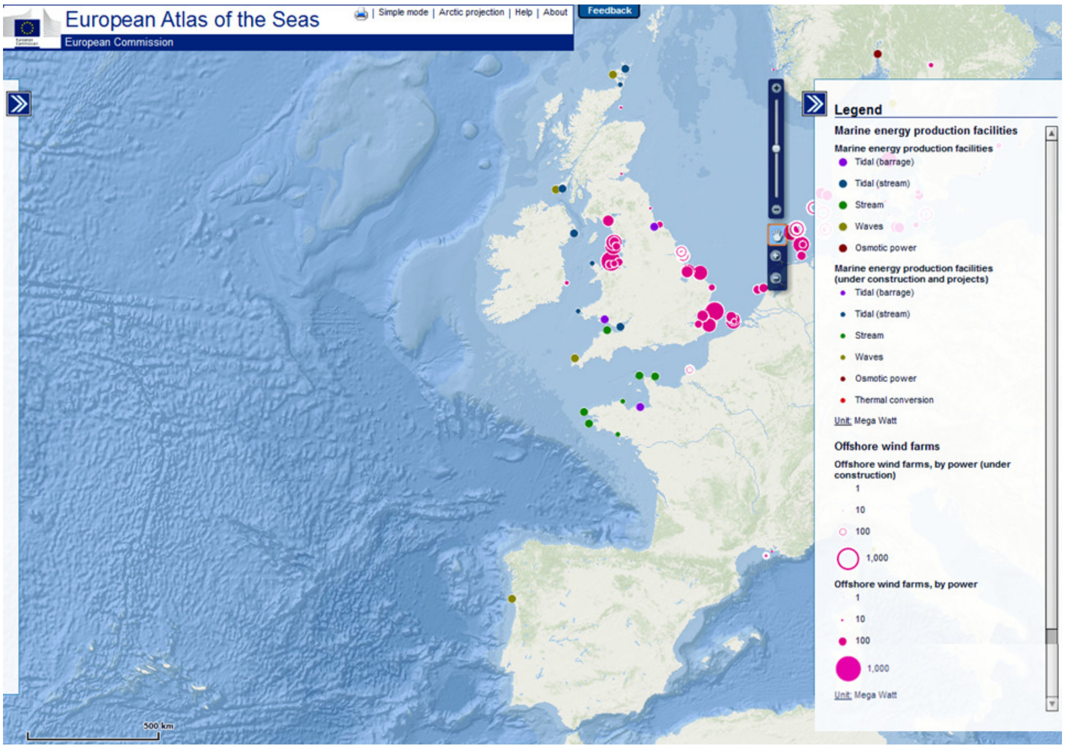

Figure 6.10 Marine renewable energy existing and under construction: tidal, stream and wave energy production facilities, and offshore wind farms. (Source: European Atlas of the Seas.)

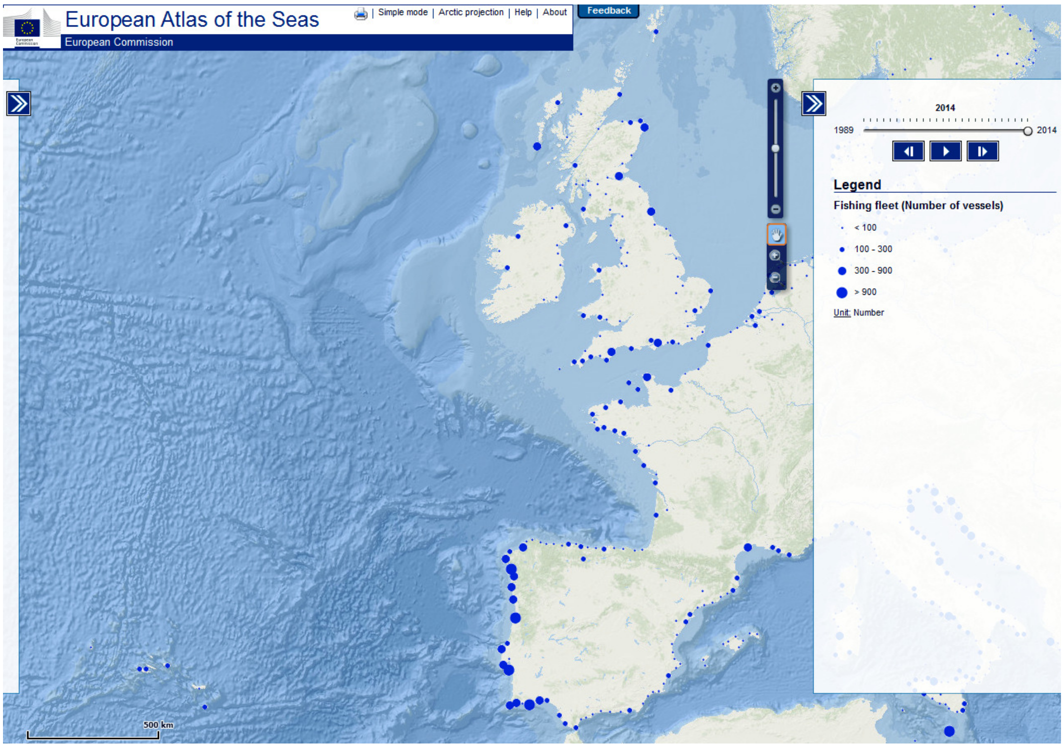

Figure 6.11 Fishing fleet: number of vessels by port (2014). (Source: European Atlas of the Seas.)

In terms of the 'blue growth' of different maritime economic activities, Ecorys (2014: 10) estimated the total size of the maritime economy of the Atlantic Europe macro-region bordering the Atlantic Ocean sea basin to be at least €26.8 billion. This accounts for more than 800,000 jobs (excluding maritime economic activities that could not be quantified).

The more mature maritime economic activities that are important in Atlantic Europe are offshore oil and gas, maritime transport and shipping, coastal and nautical tourism, fishing for human consumption, shipbuilding, coastal protection, maritime surveillance, marine aquaculture and desalination. The least mature activities are environmental monitoring, offshore wind, blue biotech, deep-sea mining and ocean renewable energy (Ecorys 2014: 12).

Ecorys estimate the gross value added (GVA) per maritime economic activity (Table 6.7) and employment per maritime economic activity (Table 6.8) in each of the member states (France, Ireland, Portugal, Spain and the UK) bordering the Atlantic Ocean sea basin.

Table 6.7 GVA per maritime economic activity (allocated to Atlantic Europe) and per country (€ million).

	FR	IE	PT	ES	UK	Total
Shipbuilding						
Shipbuilding & repair	1,241	7	83	1,067	1,677	4,075
Construction of water projects	n.a.	4	84	410	108	606
Maritime transport						
Deep-sea shipping	789	23	122	176	421	1,531
Short sea shipping	1,419	283	190	184	959	3,034
Passenger ferry services	186	23	36	95	379	719
Inland waterway transport	16	n.a.	0	0	8	24
Food, nutrition and health						
Fisheries for human	2,238	259	834	2,760	213	6,304
Fisheries for animal	n.a.	n.a.	5	9	17	31
Marine aquaculture	258	37	6	116	95	512
Blue biotechnology	n.a.	9	n.a.	n.a.	n.a.	9
Agriculture on saline soil	322	n.a.	120	n.a.	n.a.	442
Energy and seabed materials						
Oil and gas	n.a.	137	0	4	785	926
Offshore wind	n.a.	4	n.a.	n.a.	n.a.	4
Ocean renewable energy	minimal	1	n.a.	n.a.	n.a.	1
Carbon capture and storage	n.a.	n.a.	n.a.	n.a.	n.a.	0
Mining	29	n.a.	n.a.	0	10	39
Marine minerals mining	n.a.	n.a.	n.a.	n.a.	n.a.	0
Desalination	n.a.	n.a.	n.a.	97	0	97
Leisure and tourism						
Coastal tourism	1,416	453	905	2,061	2,118	6,953
Yachting and marinas	417	45	n.a.	694	14	1,170
Cruise tourism	11	n.a.	39	100	148	298
Coastal protection						
Coastal protection	n.a.	n.a.	6	4	n.a.	10
Maritime monitoring and surveillance						
Maritime surveillance	n.a.	n.a.	n.a.	n.a.	n.a.	0
Environmental monitoring	n.a.	n.a.	n.a.	12	n.a.	12
Total	8,342	1,289	2,428	7,789	6,952	26,800

Source: Ecorys 2014: 33-34, Table 3.4.

Table 6.8 Employment per maritime economic activity (allocated to Atlantic Europe) and per country (number of individuals).

	FR	IE	PT	ES	UK	Total
Shipbuilding						
Shipbuilding & repair	22,422	155	3,472	18,501	25,476	70,026
Construction of water projects	n.a.	17	1,520	8,598	643	10,778
Maritime transport						
Deep-sea shipping	7,906	154	1,758	2,507	3,884	16,209
Short sea shipping	14,226	1,886	2,739	2,620	14,207	35,678
Passenger ferry services	2,647	154	698	1,507	29,408	34,414
Inland waterway transport	245	n.a.	n.a.	0	1,069	1,314

Food, nutrition and health						
Fisheries for human	45,586	6,391	47,050	95,880	14,317	209,224
Fisheries for animal	n.a.	n.a.	281	337	430	1,048
Marine aquaculture	15,336	1,705	2,085	20,340	988	40,454
Blue biotechnology	n.a.	185	n.a.	n.a.	n.a.	185
Agriculture on saline soil	11,405	n.a.	24,604	0	n.a.	36,009
Energy and seabed materials						
Oil and gas	n.a.	790	0	n.a.	710	1,500
Offshore wind	n.a.	101	n.a.	n.a.	n.a.	101
Ocean renewable energy	minimal	50	n.a.	n.a.	n.a.	50
Carbon capture and storage	n.a.	n.a.	n.a.	n.a.	n.a.	0
Mining	323	n.a.	n.a.	0	436	759
Marine minerals mining	n.a.	n.a.	n.a.	n.a.	n.a.	0
Desalination	n.a.	n.a.	n.a.	1,068	0	1,068
Leisure and tourism						
Coastal tourism	32,129	5,836	44,155	64,499	170,806	317,425
Yachting and marinas	16,922	800	n.a.	13,042	700	31,464
Cruise tourism	150	n.a.	758	1,589	1,503	4,000
Coastal protection						
Coastal protection	n.a.	44	63	40	n.a.	147
Maritime monitoring and surveillance						
Maritime surveillance	n.a.	n.a.	n.a.	n.a.	n.a.	0
Environmental monitoring	n.a.	n.a.	n.a.	n.a.	n.a.	0
Total	169,297	18,268	129,283	230,528	264,577	811,853
Source: Ecorys 2014: 34-35, Table 3.5.						

Ecorys (2014: 35-36) draw a number of conclusions based on the assessment of the maritime economic activities – economic capital – in Atlantic Europe (Tables 6.7 and 6.8):

- France provides the largest contribution to GVA, while the highest employment is found in the UK. Figures for Spain are of similar magnitude while the smaller economies of Portugal and Ireland are reflected in their maritime activities figures.
- In four of the five countries, fisheries and coastal tourism are the two largest sectors in terms of employment. In terms of GVA the picture is similar, although in the UK shipbuilding ranks second and in most other countries this sector is also among the largest four. Furthermore, short sea shipping is also an important sector across Atlantic Europe.
- Comparing largest sectors spread across the sea basin, the share of coastal tourism in the maritime economy in terms of GVA is around 30% in Ireland, Spain and the UK, but close to 40% in Portugal compared to 17% in France. In terms of employment the largest relative importance is found in the UK

with 65% (39% for the sea basin as a whole). For the fisheries sector, the share is around 30% in France, Portugal and Spain, 20% in Ireland and only 3% in the UK. Similar figures apply for employment in this sector. Short sea shipping has the highest relative importance in France and Ireland (17% and 22% respectively), while shipbuilding is much more important in the UK (24%) than anywhere else (Ireland 1%, Portugal 3% and of moderate importance in France 15% and Spain 14%).

To provide a balanced overview of the strength of the Atlantic Europe maritime economy and, therefore, its economic capital, the Ecorys analysis identifies (1) present maritime economic activities that are mature and large in size; (2) fast growing activities that may increase their contribution in the short and medium term and support growth of the maritime economy; and (3) activities that enable Europe to build a future competitive position and contribute to the wider policy goals of the Europe 2020 Strategy. These are summarised as the seven largest (Table 6.9), seven fastest growing (Table 6.10) and seven most promising (Table 6.11) maritime activities.

Table 6.9 Seven largest activities today in each Atlantic country.

France	Ireland	Portugal	Spain	UK
Coastal tourism (accommodation)	Fisheries for human consump.	Fisheries for human consum.	Coastal tourism (accommodation)	Offshore oil & gas
Fisheries for human consump.	Coastal tourism (accommodation)	Coastal tourism (accommodation)	Fisheries for human consump.	Coastal tourism (accommodation)
Short sea shipping	Short sea shipping	Agriculture on saline soils	Shipbuilding and ship repair	Passenger ferry services
Yachting and marinas	Marine aquaculture	Short sea shipping	Construction of water projects	Short sea shipping
Shipbuilding and ship repair	Offshore oil & gas	Shipbuilding and ship repair	Short sea shipping	Shipbuilding and ship repair
Deep-sea shipping	Yachting and marinas	Deep-sea shipping	Deep-sea shipping	Fisheries for human consump.
Passenger ferry services	Cruise tourism	Construction of water projects	Passenger ferry services	Deep-sea shipping
				Source: Ecorys 2014: 45, Table 3.7

Table 6.10 Seven fastest growing activities in each Atlantic country.

France	Ireland	Portugal	Spain	UK
Cruise tourism	Fisheries for human consump.	Construction of water projects	Offshore oil & gas	Fisheries for animal feeding
Shipbuilding and ship repair	Passenger ferry services	Short sea shipping	Cruise tourism	Shipbuilding and ship repair
Fisheries for human consump.	Short sea shipping	Deep-sea shipping	Fisheries for human consump.	Cruise tourism
Fisheries for animal feeding	Offshore oil & gas	Passenger ferry services	Fisheries for animal feeding	Short sea shipping
Passenger ferry services	Deep-sea shipping	Coastal tourism	Short sea shipping	Fisheries for human consump.
Coastal tourism (accommodation)	Shipbuilding and ship repair	Shipbuilding and ship repair	Passenger ferry services	Deep-sea shipping
Inland waterway transport	Construction of water projects	Fisheries for human consump.	Coastal tourism	Coastal tourism (accommodation)
				Source: Ecorys 2014: 46, Table 3.8

Table 6.11 Seven promising maritime economic activities in each Atlantic country.

France	Ireland	Portugal	Spain	UK
Ocean renewable energy	Ocean renewable energy	Blue biotechnology	Ocean renewable energy	Blue biotechnology
Blue biotechnology	Blue biotechnology	Ocean renewable energy	Blue biotechnology	Offshore wind
Marine minerals mining	Environmental monitoring	Environmental monitoring	Desalination	Ocean renewable energy
Shipbuilding	Offshore wind	Offshore wind	Marine minerals mining	Environmental monitoring
Offshore oil & gas	Yachting and marinas	Marine minerals mining	Offshore wind	Shipbuilding
Environmental monitoring	Cruise tourism	Offshore oil & gas	Environmental monitoring	Offshore oil & gas
Maritime surveillance	Coastal protection	Shipbuilding	Maritime surveillance	Cruise tourism
				Source: Ecorys 2014: 51, Table 3.14

The Ecorys analysis elaborated on six maritime economic activities that are highly relevant for Atlantic Europe: shipbuilding and ship repair (Table 6.12), ocean renewable energy, fisheries (Figures 6.12 and 6.13), aquaculture (Table 6.13), short sea shipping (Table 6.14), and yachting and marinas (Table 6.15). These comprise a mix of mature, fast growing and promising economic activities.

Table 6.12 Overview of economic importance of the shipbuilding and ship repair sector in Atlantic Europe, 2010.

	GVA (€ million)	Employment	Enterprises
France	1,238	22,397	85
Ireland	7	155	40
Portugal	78	3,472	349
Spain	1,099	19,056	804
UK	1,641	24,929	n.a.
Atlantic total	**4,064**	**70,009**	**1,278**
			Source: Ecorys 2014: 78, Table 4.1

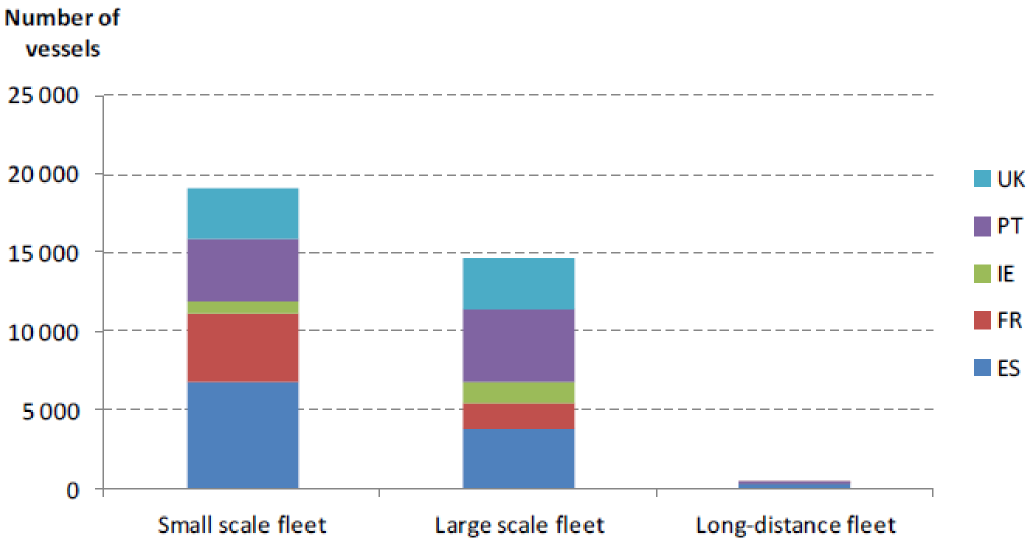

Figure 6.12 Number of fishing vessels per category and per member state of Atlantic Europe. (Source: Ecorys 2014: 116, Fig. 6.1.)

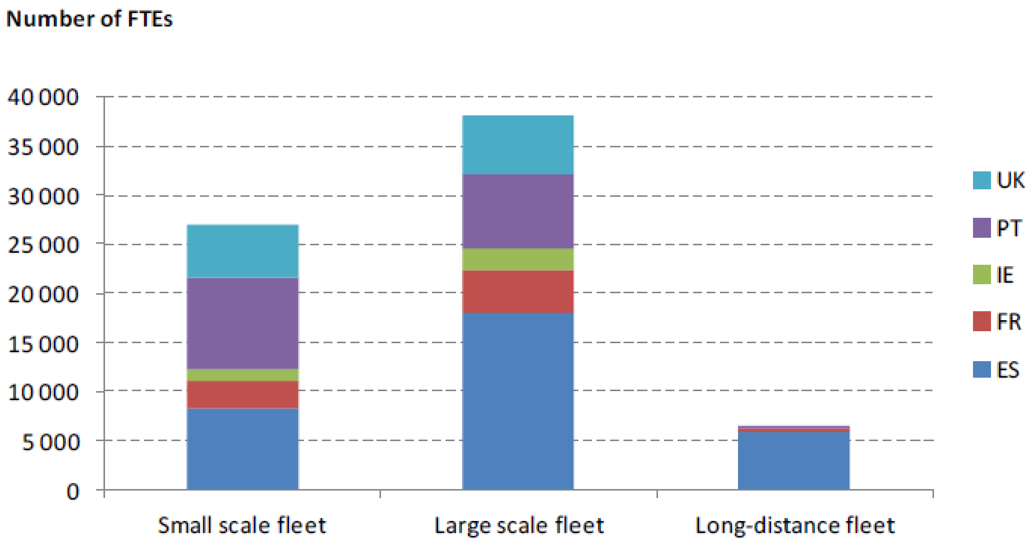

Figure 6.13 Distribution of employment (in full-time employment, FTE) according to the different fleet segments per member states of Atlantic Europe. (Source: Ecorys 2014: 118, Fig. 6.4.)

Table 6.13 Number of workers (male and female) employed in aquaculture production, and mean wage, in Atlantic Europe countries.

	Male workers	Female workers	Percentage female workers	Mean wage p.a. (€)
France	12,784	7,030	55%	22,700
Ireland	1,573	146	9%	26,600
Portugal	1,889	430	23%	7,200
Spain	19,852	8,056	41%	20,600
UK	4,000	0	18% (Scotland)	18,300
Source: Ecorys 2014: 140, Tables 7.1 and 7.2				

Table 6.14 Overview of economic importance of short sea shipping in Atlantic Europe, 2010.

	GVA (€ million)	Employment	Enterprises
France	853.7	8,560.2	296.2
Ireland	282.9	1,886.0	226.0
Portugal	189.6	2,739.0	168.0
Spain	181.7	2,593.4	319.8
UK	770.3	11,407.9	n.a.
Atlantic total	**2,278.3**	**27,186.5**	**1,010.0**
Source: Ecorys 2014: 149, Table 8.2			

Table 6.15 Indicative figures on GVA, employment and number of enterprises in the yachting and marinas sector in Atlantic Europe.

Country	Regions	GVA (€ million)	Employment jobs	No. of enterprises
France	Haute Normandie, Basse Normandie, Picardie, Pays de La Loire, Bretagne, Poitou-Charentes, Aquitaine	818	33,180	13,920
Ireland	Entire coastline	45	800	100
Portugal	Entire coastline (including Azores and Madeira)	n.a.	1,761	n.a.
Spain	Galicia, Asturias, Cantabria, Basque Country, Canary Islands	990	16,800	700
UK	North West England, South West England, South Western Scotland, Scottish Highlands & Islands, Wales, Northern Ireland	220	14,200	n.a.
Atlantic total		**6,700**	**64,476**	**n.a.**
Source: Ecorys 2014: 167, Table 9.1				

Finally, the share of the population of EU coastal regions living in maritime service areas reflects the access aspect of economic capital in Atlantic Europe. A maritime service area is an area that can be reached within a given travel time, starting from a location at the coast and using the existing transport network.

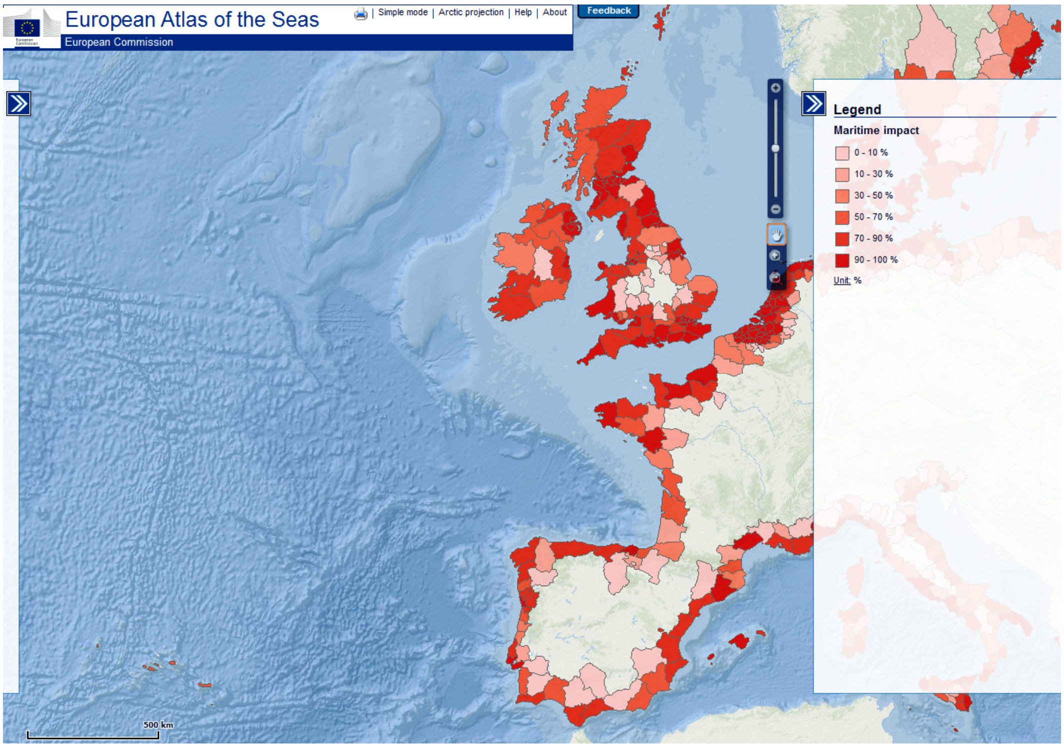

Figure 6.14 Maritime impact: population impacted by maritime activities in Atlantic Europe. (Source: European Atlas of the Seas.)

Panellists were asked (Question 9a): *Are there any specific aspects of economic capital that you think should be highlighted as having a key role in the functioning of the Atlantic Europe macro-region?* Key in the sense that it is an asset or capacity that must be maintained, in the face of disturbances, to facilitate societal functioning; an asset or capacity that it is important to strengthen and build in order to cope with change and recover from future disturbances. There were responses from 14 panellists (including two responses moved from question 3a). Four themes emerged: infrastructure, market-based incentives, information and property rights.

Regarding path dependence, one panellist stated that “Europe has a huge amount of history hence massive capital infrastructure exists already.” Seven panellists listed types of infrastructure, including information infrastructure; energy infrastructure and energy systems to develop energy mixes with more renewable energy components; coastal protection infrastructure (in terms of climate change, sea level rise, etc.); underwater cables and pipe infrastructure; and sea ports (especially Milford Haven, Liverpool, Dublin, Brest, Le Havre, Nantes, Lisbon, Leixões, Setúbal, Oporto and Algeciras), cargo terminals and maritime transport network infrastructure. One panellist highlighted fishing and merchant fleets as important aspects of economic capital in Atlantic Europe.

In terms of power, one panellist cited the "Strong influence of agriculture, aquaculture, fishing, maritime industries and tourism on the regional economy" as affecting the functioning of Atlantic Europe. Another panellist mentioned the property rights systems for natural resources. The responses of three panellists concerned market aspects of economic capital. A third panellist highlighted markets, trade and the transnational banking system regarding their ability to create financial flows and provide credits. A fourth panellist identified "Market-based incentives/economic instruments (taxation, subsidies etc.)". Another panellist stated: "Market-based incentives likely play a greater role in more economically developed European countries like the UK." Meanwhile, a different panellist asked:

> "What about non-market value things, like the value of having a walk on a nice clean beach on a breezy day? Or the fish market establishment that has been there forever, that is a tradition for the city and which enhances social gathering and informal trade in the community? Non-market value issues are very important. They are tradeoffs to consider in economic analyses."

Panellists were then asked (Question 9b): *Are there any trends in Atlantic Europe concerning key aspects of economic capital that you are aware of and consider to be important?* The trends identified by eight panellists include the following:

- The global trend towards privatisation and commercialisation of natural resources, which is not necessarily supportive of sustainable resource management.

- Continuing globalisation of production and distribution functions within the private sector.
- Movement towards a single integrated market, which constrains economic independence.
- Outsourcing by industry and an increasing focus on service industries (linked with the growing importance of tourism).
- Loss of trust in the banking system due to the financial crisis.
- Shifts from industrial to service sector based local/regional economy (linked with movement of affluence and land use change).
- Increasing use of the marinescape to accommodate human activities; hence, economic capital out at sea is increasing, favouring larger economic activities (wind farming, oil and gas) over smaller groups of activities.
- Capitalisation of nature conservation (i.e. investing in closed areas such as MPA).
- Increasingly integrated and spatially focused maritime planning. "Offshore wind planning is also pushing maritime planning in general to become more integrated and spatial", as one panellist stated.

The panellists provided some additional comments regarding economic capital. According to one panellist, despite the importance of science and politics in the creation of policy, "in its implementation, economics will always come to the top of the list." Another panellist highlighted the broader context:

> "The global economic situation affects the region in manifold ways, changing over time. At present economic decline and global financial/economic crisis are important – in the long run the development of global food markets and prices and of energy markets/prices is important for the development of the region."

One panellist pointed to perverse subsidies[153] in the fisheries sector:

[153] Perverse subsidies are those subsidies that, rather than helping society achieve a desired goal, exert adverse effects both economically and environmentally (Myers and Kent 2001).

> "Fisheries are no longer self-supporting in many cases, with many perverse economic subsidies (including, but not limited to, tax-free fuel, engine upgrades, etc). Without a reform of such subsidies, we cannot expect market corrections."

Financial capital

Financial capital consists of stocks of money for purchasing or producing goods and services; funds lent or invested to purchase or support productive economic capital; savings (i.e. surplus) and pensions; fluid mediums representing market value, store of value, wealth, and flows and exchanges (trade) of goods and services; credit and debt, subsidies and grants, and access to them; and insurances. Financial capital may also be understood as a type of social capital, a means of allocating and mobilising other forms of capital so as to deliver benefits. Ekins *et al.* (2008) point out that the EU Structural Funds (SF) are financial capital:

> 'The SFs are the product of a political process, which has determined their allocation to certain regions of the European Union in order to achieve certain social and economic objectives. They represent the power to mobilize and create other kinds of capital rather than embodying real productive power themselves' (p. 65).

In particular, the European Regional Development Fund (ERDF) is the main financial capital investment in the EU Atlantic Area programmes (Table 6.16).

Table 6.16 EU Structural Funds (ERDF) investment in Atlantic Area programmes.

Programming period	EU contribution (€)	National contribution (€)	Total public contribution (€)
2000-2006	119,991,130	0	205,717,187
2007-2013	104,051,233	54,746,957	158,798,190
2014-2020	140,013,194	45,353,298	185,366,492
Source: European Commission, DG REGIO[154]			

[154] http://ec.europa.eu/regional_policy/en/atlas/programmes [accessed 17/7/2016].

Panellists were asked (Question 10a): *Are there better ways of mobilising and creating other forms of capital than through existing EU structural fund interventions?* There was a range of responses from eight panellists, with opinions ranging from yes certainly to not necessarily to there are no better ways. Comments included the following:

- National regional policy funds should retain their importance.
- There should always be alternatives and improvements to creating capitals, for example, from evaluating institutional effectiveness and efficiency.
- Less government-dependent approaches to intervention and redistribution of resources should be developed, for example, funds independent from governmental institutions or global economic players, specific public–private partnership models, and funds/institutions that directly support local resource users/producers.
- Better direction of funds derived from EU taxation of agricultural and fisheries to support sustainable activities.

Two panellists commented on problems concerning EU structural funds, including (un)availability of regional co-funding, inefficient evaluation, bureaucratic obfuscation, lack of transparent and accessible administration, undemocratic tendency for the same clique of beneficiaries to receive grants, risk-averse awards process, partisanship of awarding bodies, and politicisation of funds at local level. Another panellist commented that other EU funds (i.e. other than the main structural funds) have been effective with positive impact, despite the confusing range of initiatives.

6.7.4 Groups, organisations, institutions and governance

The workbook objective of this part of round one was *to identify which social components (groups, networks, organisations and institutions, and processes such as governance) are essential to understanding the structure and functions of EASES*. This concerns the functional grouping of components (actors and processes) in the social domain of EASES. In particular, those organised groups, networks and institutions that are associated – through resource use, property rights, management, governance, political and economic functions – with the natural capital, ecosystems and spatial resources of the Atlantic Europe macro-region. The CPMR Atlantic Arc Commission is a particularly significant example (see Figure 6.15).

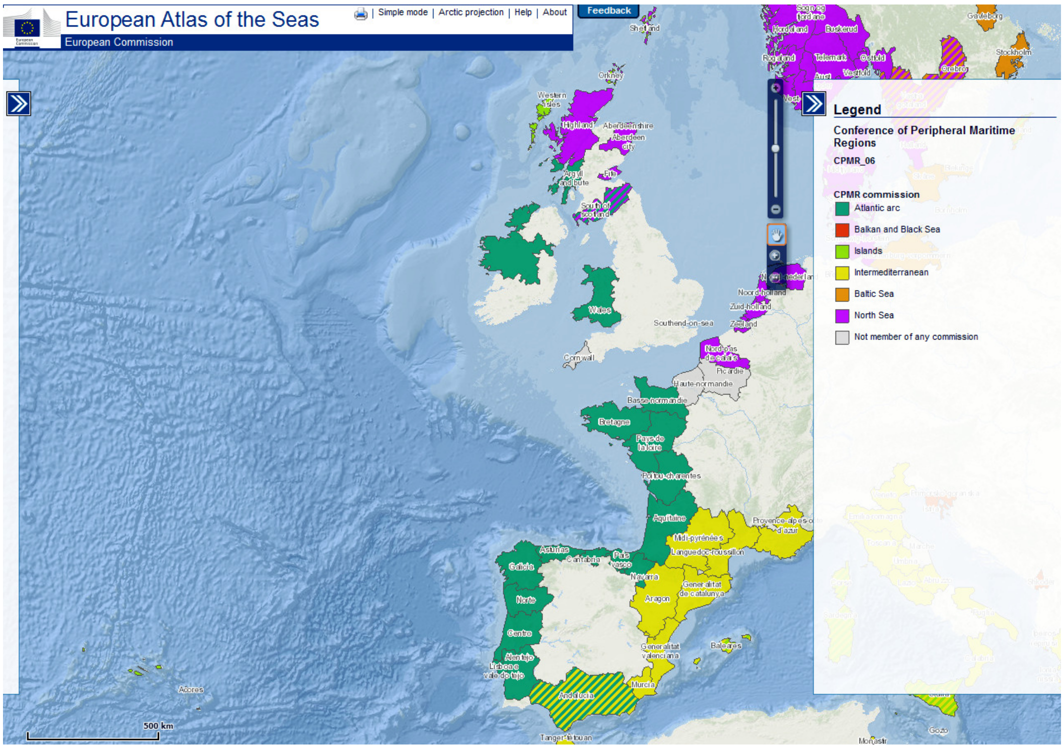

Figure 6.15 Member regions of the CPMR, including the Atlantic Arc Commission (March 2014), in Atlantic Europe. (Source: European Atlas of the Seas.)

Governance is addressed in Chapter 1 (section 1.1) and Chapter 4. Briefly, 'governance' refers to the system of multilevel structures and processes by which people in societies make decisions and share power and, based on cultural norms and values, create the conditions for institutions to fit diverse settings at different scales (Folke *et al.* 2005; Lebel *et al.* 2006). In this sense, institutions are structures of the governance system. They comprise (1) institutional rules, that is, a set of formal and informal principles, rules and norms defining the rights and responsibilities of participants in a repeated setting; and (2) institutional arrangements, which are the ways people organise their activities and coordinate their collective action (Ostrom 2005). For instance, institutions for guiding and regulating human interactions with ecosystems might include resource access and allocation rules, property rights, collective arrangements and coordinated markets. Figure 6.16 summarises the key groups, networks, organisations, institutions and governance systems identified in the conceptualisation of EASES.

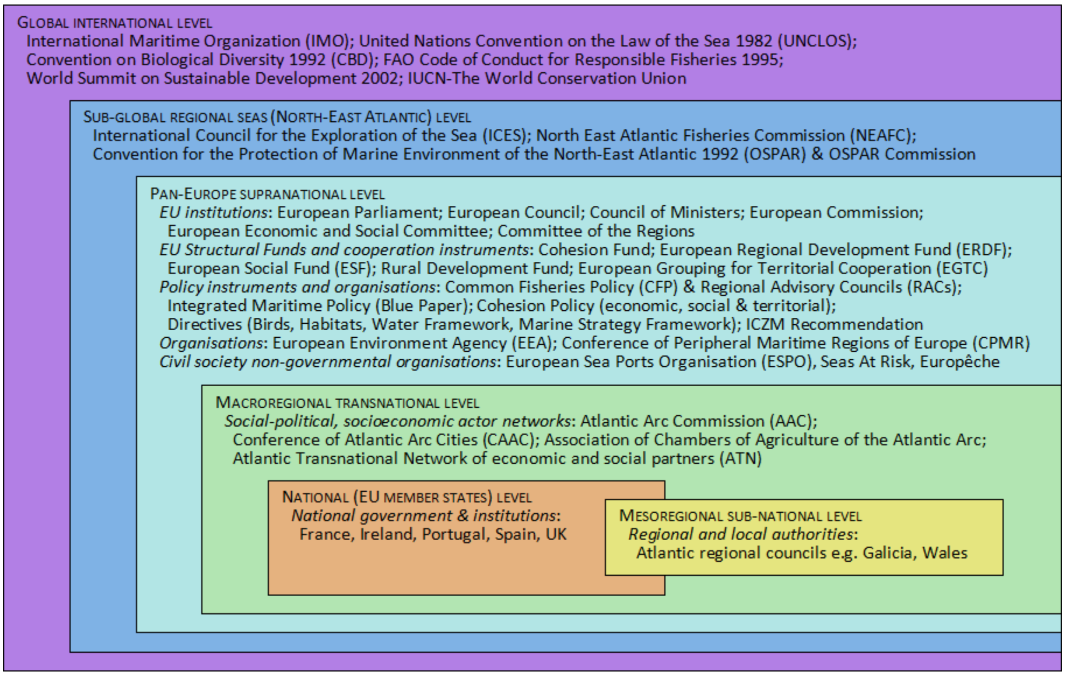

Figure 6.16 Key groups, networks, organisations, institutions and governance systems relevant to Atlantic Europe.

Panellists were asked (Question 4a): *What do you consider to be key groups of people, networks, organisations, institutions and governance systems in or across the Atlantic Europe macro-region?* They may be ones that function exclusively at the level of Atlantic Europe or at encompassing (higher) or nested (lower) levels, but which nevertheless have a significant influence at the macro-regional level. There were responses from 15 panellists concerning key groups, networks, organisations (hereinafter 'groups') and institutions. Responses are synthesised in Table 6.17, which is organised according to the approximate hierarchy of spatial levels used in the round one workbook.

Table 6.17 Key groups of agents/actors in and across Atlantic Europe.

Global/international level: • United Nations Convention on the Law of the Sea (UNCLOS) (2). • International Maritime Organization (IMO). • Organisation for Economic Co-operation and Development (OECD). • International (large, corporate) NGOs (4).
Sub-global/international/regional seas level: • International Council for the Exploration of the Sea (ICES) (3). • Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) and OSPAR Commission (5). • North East Atlantic Fisheries Commission (NEAFC) (3). • Other fisheries and regional seas conventions/commissions (2). • NGOs (2).
Pan-Europe/supranational level: • EU and EU Institutions in general (4). • European Commission (3). • DG Maritime Affairs and Fisheries (2). • DG Environment. • Structural Funds/Cooperation Instruments (3). • Other EU institutions and relevant legislation: Common Fisheries Policy (4), Common Agricultural Policy, Marine Strategy Framework Directive (2), Habitats Directive, Water Framework Directive. • National representatives at EU level (2). • Nature conservation NGOs.
Macro-regional/transnational level: • Regional Advisory Councils (RACs). • Atlantic Transnational Network of economic and social partners (ATN).
EU member State/national level: • Member States, national governments, ministries, governmental institutions, national legislation in general (8). • National fisheries and environmental agencies. • National ICZM strategies/plans (2). • Nature conservation NGOs.
Meso-regional/subnational level: • Meso-regional institutions in general. • Regional and local authorities. • Chambers of Agriculture and Chambers of Commerce. • Civil society groups, NGOs in general, fishermen's organisations (5).
Other (unspecified or cross-level): • Private corporations, corporations with maritime interests, industry groups (non-governmental), representatives of industry in general (4). • Professional organisations with maritime interests. • Research institutions.

Numbers in brackets denote the number of same or near equivalent responses given by different panellists.

6.8 Hierarchy and cross-scale interactions

The fourth objective of round one was to determine the key structural relationships and cross-scale interactions between the macro-regional level and other levels. That is, between system components (actors and processes) at different hierarchical levels in relation to the focal level system (EASES). The workbook objectives of this part of the study were *to identify (1) the key structural relationships between the focal level of the Atlantic Europe macro-region and the levels above and below it in the systems hierarchy; and (2) the associated cross-level and cross-scale interactions that have significant influences on the functioning of EASES*. These involve relationships between key components of the ecological and social domains.

Conceptually, EASES represents a particular level of a nested hierarchy of interdependent SES. Such a hierarchical structure comprises relatively discrete yet interconnected levels, each consisting of a set of co-evolving ecological and social components. Interactions may occur within scales (between levels) or between different scales. Any governance architecture concerning European territorial cohesion and maritime affairs must coordinate governance processes, institutional rules and arrangements, and policy actions across multiple levels and different scales. Figure 6.17 depicts the hierarchical relationship between EASES and other system levels.

Figure 6.17 Systems hierarchy depicting the structural relationship between EASES at the macro-regional level and other system levels.

Panellists were asked (Question 13a): *Do you have an opinion regarding the conceptual nested hierarchical structure* [Figure 6.17] *used to relate the focal level (Atlantic Europe/EASES) to other levels of organisation?* There were responses from 11 panellists. Eight panellists considered the conceptualisation variously satisfactory, reasonable or useful. One panellist stated: “This is more or less the way everyone does it.” Another panellist found it a good tool “if it is assumed as an ideal-type, without taking for granted integrated relationships across the system.” Another thought “this is a key approach to understanding this complex system.”

Figure 6.18 plots EASES on different scales, taking into consideration panellists’ responses to question 13b below.

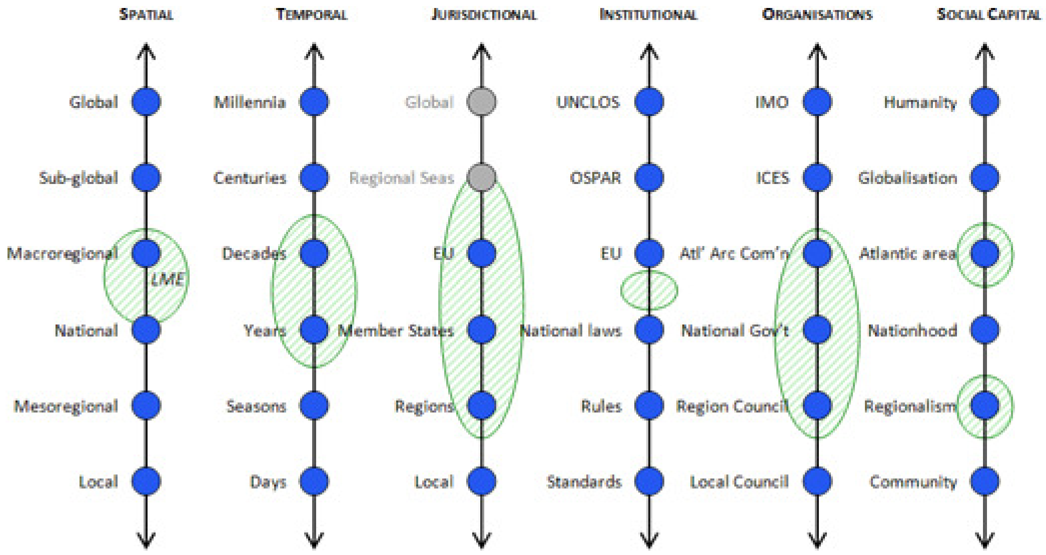

Figure 6.18 Relative position of EASES plotted (as ovals with green hatch) against multiple scales associated with Atlantic Europe.

Panellists were asked (Question 13b): *A number of different scales were suggested* [in Figure 6.18, since modified]. *Are there any that you think should be added or removed?* There were responses from 13 panellists. Two panellists thought none should be either added or removed; four panellists found them satisfactory. Suggested additions (or modifications) included cultural factors involved in social connectedness; something more explicitly environmental; religion, financial institutions and campaigning individuals; sense of humanity and community; and the UN Charter or International Court of Justice in The Hague on the jurisdictional scale.

Panellists were asked (Question 13e): *Can you identify or suggest key interactions between different scales that (might) significantly influence the functioning of EASES?* This question refers to Figure 6.18 (since modified). Panellists suggested key interactions between:

- Spatial, jurisdictional, institutional and organisational scales, which reinforce each other through positive and negative feedbacks.
- Spatial and temporal scales, which presently dominate in policy and resource management practice.

- Spatial scales and social capital (transboundary cooperation, connectedness, etc.).
- The global and sub-global dimensions.
- Financial flows, policies and legislation acting externally on EASES.
- The differing levels of institutional functioning and implementation of environmental legislation between EU member states, which slows progress towards achieving key environmental and biodiversity protections.

Two panellists made general comments. One mentioned interactions between spatial and temporal scales, but considered this question to be too complex to be addressed here. The other panellist suggested that "Agreed-upon core indicators (ecological, social, economic) would allow for better linkages and coordination. Local level indicators could of course still be added as required."

Of the four panellists who suggested key interactions between scales, one stated the following:

> "The key interactions [that affect EASES] seem to happen between spatial, jurisdictional, institutional and organizational scales – they reinforce each other (positive and negative feedbacks). Between spatial and temporal scales as they presently dominate in policies and resource management practice (decades and generations as temporal scales seem to be lacking in the planning and future orientation of many resource users and management institutions). Between spatial scales and social connectedness (the problems of transboundary cooperation, social capital, connectedness)."

Another panellist focused on interactions between member states and the EU regarding the implementation of EU nature protection legislation:

> "The differing levels of implementation and functioning of Member States within the European Union, for example some countries are remiss with their obligations under the Habitats Directive and have been

> taken to the European Court of Justice regarding these infringements. This kind of discrepancy slows progress towards achieving an international network of well-managed protected areas (i.e. Natura 2000). This will likely also be an issue under the MSFD and hence affect the overarching goal of Maritime Spatial Planning through the Integrated Maritime Policy."

The panellists were also asked (Question 13f): *Can you identify or suggest any significant scale mismatches concerning EASES?* Scale mismatches occur when there is significant variance between the scale, dimension or capacity of one system component, process or function and that of another, for example, when institutional arrangements are significantly misaligned to ecosystem scale (Cumming *et al.* 2006). Four panellists responded to the question. However, panellists also suggested mismatches in response to other questions in round one. Therefore, the panel identified the following scale mismatches.

One comment concerned the rationale for the EU transnational cooperation INTERREG IIC programme, European Spatial Development Perspective (ESDP) and current EU territorial cohesion objectives, which includes facilitating the cross-scale matching of cross-border and transnational geographical structures (e.g. river basins, coastal areas) with territorial management through spatial planning and institutional arrangements. This points to overcoming the mismatch between geographical/ecological (spatial) and territorial management (organisational/institutional/jurisdictional) scales.

Another comment concerned the vulnerability of migratory marine species to exploitation when outside the Atlantic Europe area. This points to a scale mismatch between ecological (spatial and temporal) attributes and EU/national territorial jurisdictions and related sea-management areas.

One panellist suggested a mismatch between generally more open (permeable and interactive) biogeographic boundaries in the ecological domain and generally more closed (excluding or isolating) political and administrative boundaries in the social domain. In other words, a mismatch between ecological and institutional/

organisational/administrative scales concerning the degree of boundary openness (itself a scale).

Another identified a spatial mismatch between the actual physical continental shelf area and the continental shelf of coastal state jurisdiction as defined under UNCLOS.[155] That is, a mismatch between ecological and jurisdictional scales.

A different panellist commented on the mismatch between fisheries management areas (ICES areas and RACs) and biogeographic regions including LME, MEOW and ICES ecoregions, and OSPAR regions. Put simply, a mismatch between ecological/biogeographic regions and economic/management areas concerning fisheries.

One comment concerned the often patchy and piecemeal approach to regulation of human activities, often without any spatial basis. This points to a mismatch between spatial and institutional and/or jurisdictional scales.

One panellist pointed to the spatial mismatch between operating areas of fishing fleets from Atlantic Europe countries and both EU territorial jurisdictions and fisheries management areas. In other words, a mismatch between EU fisheries operations taking place inside and outside EU jurisdiction.

Another panellist identified scale mismatches between the dimensions of small-scale and large-scale activities within particular maritime sectors. For example, between relatively large-scale fishing and shipping activities, and renewable energy projects, and small-scale inshore fishing, niche activities or marine ecotourism.

The response of one panellist points to a mismatch ("an inherent contradiction") between the increasing dependence on financial capital-related economic growth and the necessity of maintaining the natural capital basis for this.

[155] See http://www.un.org/Depts/los/clcs_new/continental_shelf_description.htm [accessed 14/7/2016].

A different panellist pointed to a mismatch concerning the availability of EU financial capital and the availability of matching co-finance at (macro-)regional level, and the disparities in the amounts of available co-finance between different Atlantic Europe regions. That is, a mismatch between different capacities to make financial capital available, involving mismatches between spatial, institutional, organisational and socioeconomic scales.

Another panellist suggested that "Social connectedness [across] spatial/temporal scales might not be related with jurisdictional and institutional scales." In other words, a mismatch between spatial and temporal and jurisdictional and institutional scales concerning social capital (connectedness).

Regarding the mismatch between the dimensions of global problems and solutions and the macro-regional level constituents of them, one panellist stated: "Climate change and ocean acidification are global problems that require global solutions even though there is significant CO2 input from within the EASES area." The panellist added: "Another issue is the fishing of EU flagged/owned vessels in foreign waters and a general lack of accountability for those practices. This can lead to a false sense of sustainability within the EU." In other words, a complex mismatch between spatial, jurisdictional, institutional, organisational and socioeconomic scales.

One panellist emphasised the complexity and difficulty involved in undertaking such an exercise (i.e. identifying scale mismatches concerning EASES):

> "The analysis of cross-scale interaction should be done thoroughly and in-depth: the complexity of these interactions is a main difficulty for all policies and management strategies relevant for sustainable development, and it may not be easy to reduce that complexity to a small number of factors (according to the 'rule of hand')."

This view was corroborated by another panellist, who stated: "The linkage and interaction between scales seems to become very complex." A different panellist cautioned that "shaping reality like this is not doing justice to underlying structures and processes. Especially individual actors linking [hierarchically or cross-sectorally] play an important role."

This was followed by two questions: (Question 13c) *Can you identify or suggest key interactions between the focal level of Atlantic Europe/EASES and the levels above?* And (Question 13d) *Can you identify or suggest key interactions between the focal level of Atlantic Europe/EASES and the levels below?* In both questions, panellists were also asked to state the character of the interactions and resulting influences; and indicate the dominant direction of the interaction (i.e. towards the focal level, towards the higher level or interaction in both directions). The cross-level and cross-scale interactions suggested by panellists in response are incorporated into Figure 6.19.

In Figure 6.19, each level is represented by an adaptive cycle. The arrows indicate directionality or bi-directionality of the stated influence. Dark blue arrows represent cross-scale and cross-level interactions identified by panellists in response to round one questions 13c and 13d. Light blue arrows represent interactions inferred by the researcher from panellists' responses to other questions in the round one workbook. Different processes and phenomena are loosely categorised (using coloured boxes) according to their predominant social–ecological character. Where the researcher considered it appropriate, two or more similar responses are represented by one interaction. Four responses to question 13d have been omitted from the figure for clarity.[156]

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[156] Omitted responses concern key interactions between the focal level (EASES) and lower levels:

- Influence generally flows down toward national then local level; some local level initiatives could enhance national or subnational regional level initiatives.
- Funding, political influence or justification.
- Probable shift in importance from EU toward macro-regional, national and lower levels arising from requirements of EU legislation/directives.
- Feedbacks from the global capitalist economy to the maritime economy at nested territorial levels and vice versa arising from the effects.

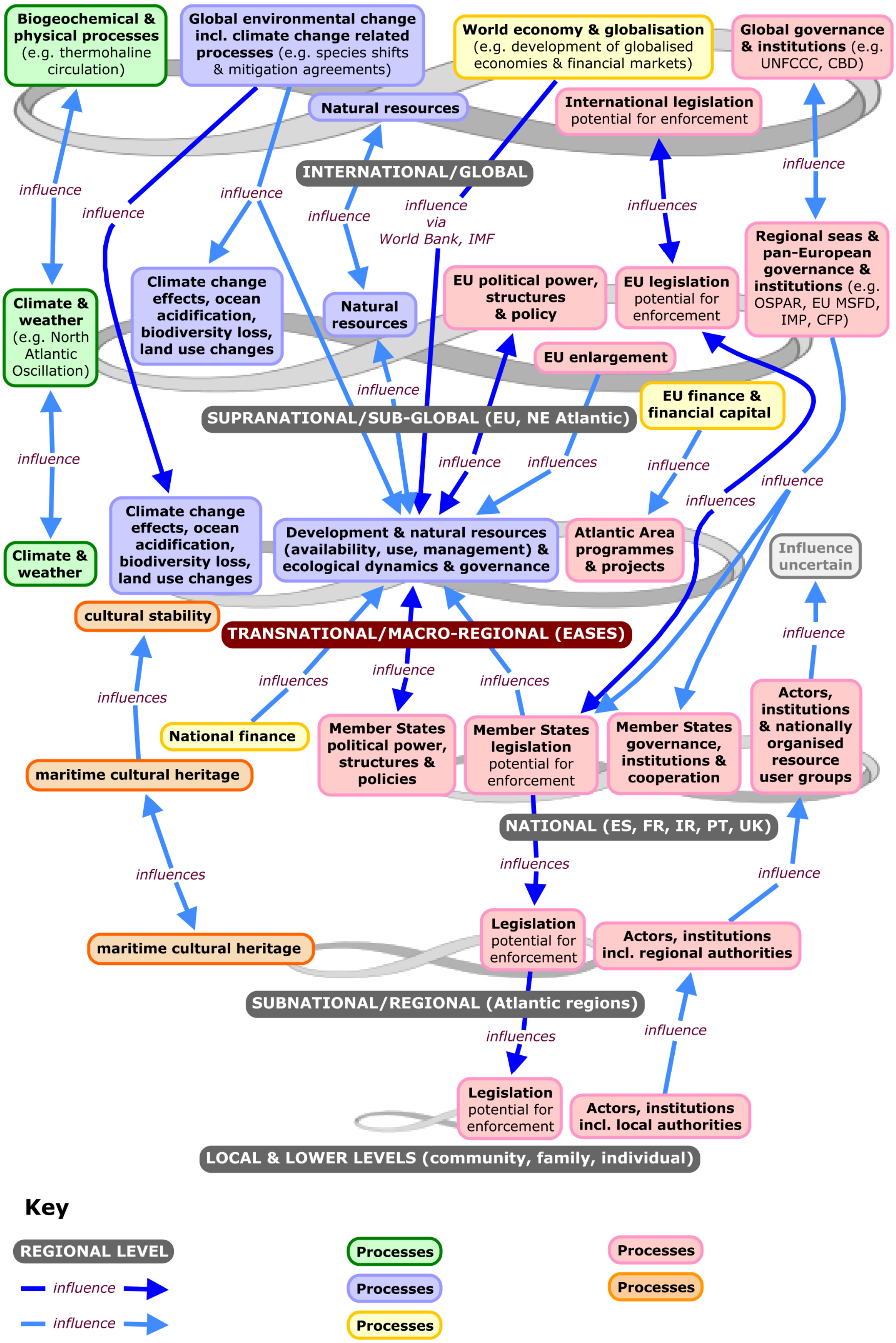

Figure 6.19 Key cross-scale and cross-level interactions identified by panellists during round one (report, sections 2, 3 and 4).

In addition, earlier in the workbook, panellists were asked (Question 3b): *What do you consider to be the key non-renewable and renewable natural resources (if any) that are introduced (e.g. imported) into the Atlantic Europe macroregion from 'outside'?* A range of key natural resources, including additional environmental resources and services, sourced from outside the Atlantic Europe macro-region was identified by 12 panellists. These are summarised in Table 6.18.

Table 6.18 Key natural resources introduced to Atlantic Europe.

Renewable natural resources: • Fish and fish stocks (7) including fisheries products, seafood and seaweed products. • Agricultural biomass, principally food (5).
Non-renewable natural resources: • Energy resources (in general). • Fossil fuels, (offshore) oil and gas (8). • Minerals and metals (3).
Environmental resources and services: • Biodiversity (3) including alien (introduced) species such as zebra mussels, and migratory species. • Leisure and tourism destinations (external environments of long-range tourism).
Note: Numbers in brackets denote the number of same or near equivalent responses given by different panellists.

Key structural relationships and cross-scale interactions are briefly discussed in Chapter 7 (section 7.4).

6.9 Identifying key drivers of change in EASES

The fifth objective of round one was to identify key disturbances and other drivers of change that influence EASES. This is linked with the sixth objective, which was to identify the character of the key changes taking place in the system's social and ecological domains.

A disturbance is an event, process or action that is relatively discrete in time; it causes (triggers or drives) some form of disruption to a system's structure and function, resulting in a change to the system's phase or a shift between phases.[157] A shock is a sudden and often surprising disturbance. A disturbance may be characterised by its duration, frequency of recurrences, magnitude, variability, predictability and desirability. Human activities that intentionally or unintentionally affect ecosystems are disturbances. Disturbances and shocks at one level or scale may result in negative and/or positive consequences at another level or scale. This has relevance where disturbances taking place at higher and lower system levels affect the Atlantic Europe macro-regional level, and where disturbances in the social domain affect the ecological domain and vice versa.

6.9.1 Historical profile and temporal boundaries

The workbook objective was *to construct a simple historical timeline for EASES that includes key disturbances and shocks that have influenced the system and triggered principal phase shifts, thus configuring the present state of the system.* This sought to identify key ecological, social and economic disturbances, shocks and crises that have historically influenced the configuration and dynamics of EASES.

EASES is dynamic. The configuration of its structure and its patterns of behaviour change over time in response to internal and external influences. These influences may be pressures (relatively steady forces) or disturbances (events). In addition to the capacity for self-organisation in response to multiple pressures, EASES has the capacity to reorganise following disturbance. In turn, nonlinear feedback processes acting across scales can, sometimes after a considerable time lag, modify the internal dynamics and possibly the external influences themselves. An understanding of the complex, dynamic and phased behaviour of EASES may be gained through exploring how the system has responded over time to discontinuous events and processes in the past, including natural disturbances and human activities. As described in Chapter 2 (section 2.4), there are two main

[157] Examples of disturbances include climate change, weather, hurricanes, floods, financial crises, technological innovations, policy and management interventions, new administrations, revolutions, wars, terrorism, epidemics, globalisation, new social values and so on.

forms of SES change: slow, often gradual and fairly predictable 'transitions'; and at other times rapid, often abrupt and surprising 'shifts'.

The historical time span over which it is appropriate to consider EASES is an issue. For example, on the one hand, ecological changes may depend on long-term natural cycles over millennia. On the other hand, key changes in the social domain will likely reflect shorter term and more recent planning, policy and political cycles. But not necessarily. Ecological changes within a lifetime may reflect recent management decisions and interventions. Conversely, present day socioeconomic trends may have evolved from distant historical events. Furthermore, the consideration of future system trajectories (scenarios) with regard to sustainable development necessarily involves consideration of the historical trajectory that led to the present system configuration.

Such historical profiling relates to the subjective identification of the temporal boundaries of EASES. The spatial boundaries of the Atlantic Arc/Area macro-region have varied over the last two to three decades. This has depended in part on the evolving perception of actor networks such as the AAC. It is reflected in the varying size of the Atlantic Area comprising different combinations of eligible NUTS 2 regions included in successive EU Atlantic Area operational programmes for transnational cooperation. There is also the historical perception concerning Europe's extensive Atlantic Ocean dominion that existed from the 1400s onwards. Since the early to mid-20th century, this perceived Atlantic boundary has, in general, contracted back towards Europe's coastline. Thanks to the Internet and satellite imagery, European society may once again perceive a more distant offshore boundary to Atlantic Europe. These issues are beyond the scope of this thesis.

A timeline (simplified version presented in Figure 6.20) was used in round one to suggest various development periods, management eras, disturbances and policy events that appear relevant to the Atlantic Europe maritime macro-region.

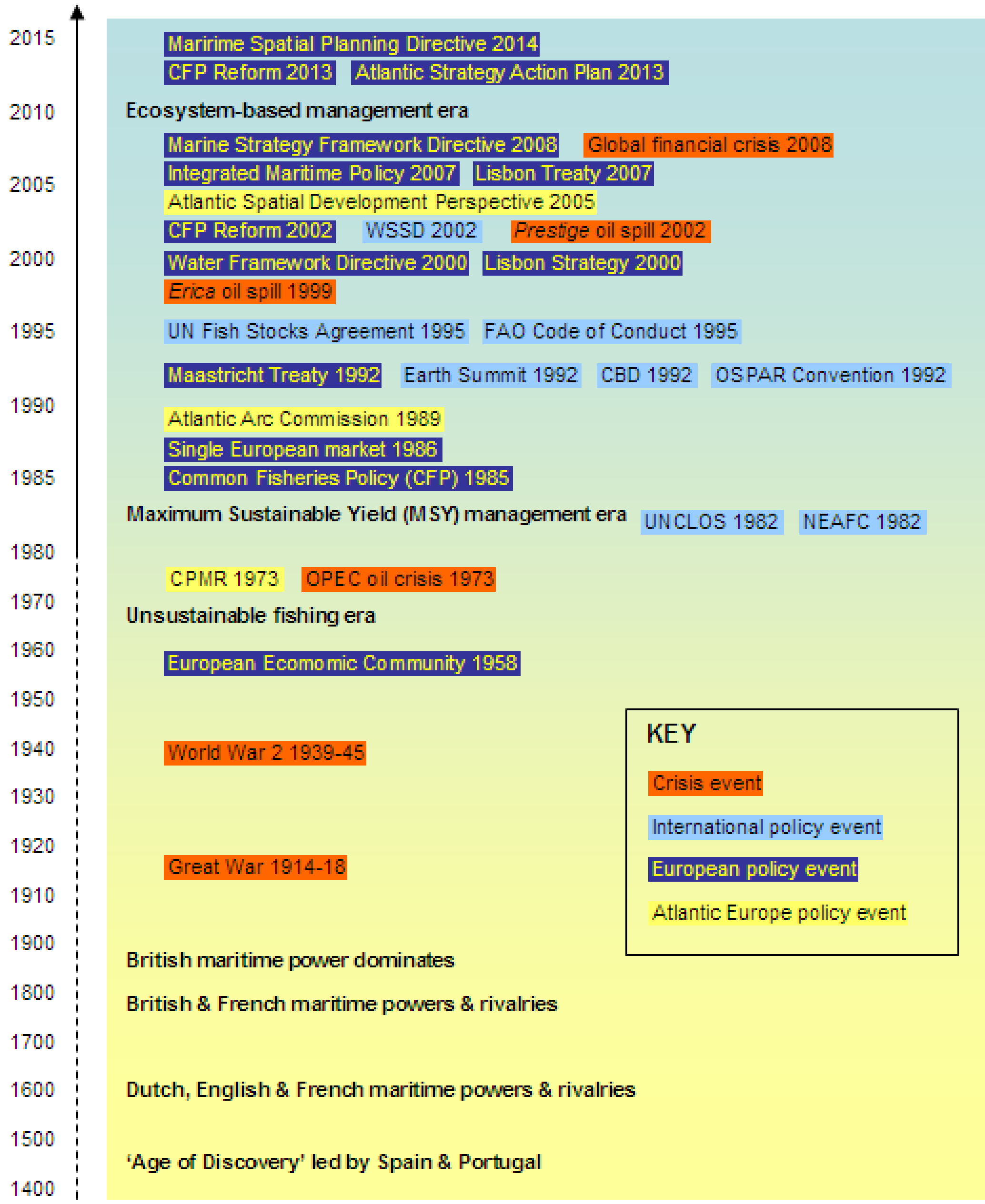

Figure 6.20 Historical timeline of major development periods, disturbances and policy events relevant to Atlantic Europe.

Panellists were asked (Question 14a): *How far into the past and how far into the future do you consider it appropriate to examine EASES?* The responses from 14 panellists covered different temporal ranges. Several horizons emerge from the responses and are summarised in Figure 6.21. Looking to the past, these horizons are the mid-20th century (ca. Second World War), the Industrial Revolution (ca. 1750-1850) and the Early Modern Period or Age of Discovery (ca. 1500).

Looking to the future, they are in the band 2030 to 2050 and then around the end of the 21st century.

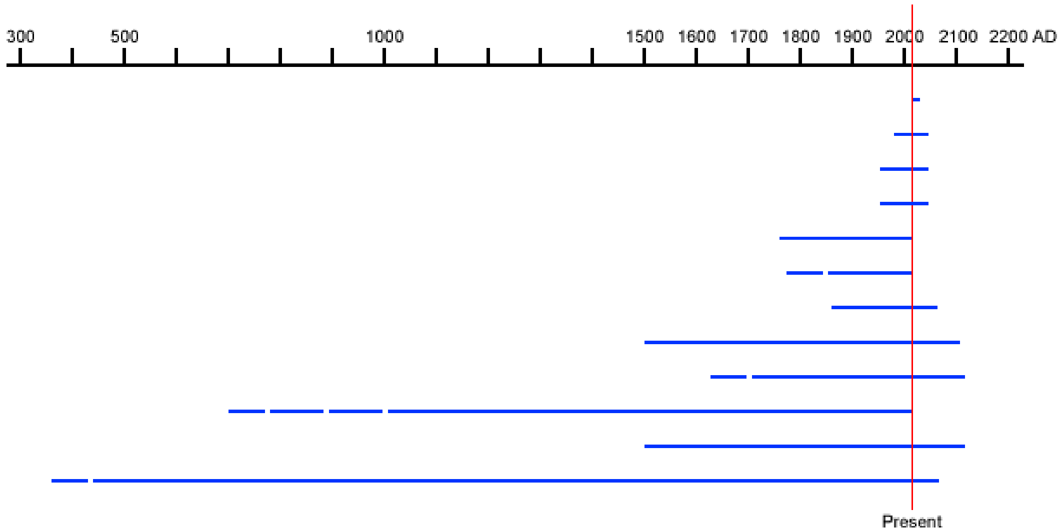

Figure 6.21 Diagram of temporal ranges (past and future) suggested by panellists.

6.9.2 Key disturbances

The workbook objective was *to identify and characterise key disturbances affecting the Atlantic Europe macro-region at present, in the recent past and potentially in the near future*. Disturbances concerning the social and ecological domains can be subdivided into press and pulse disturbances. Press disturbances result from sustained pressure. Pulse disturbances are discrete actions, processes or events that occur, cease, and then maybe recur. For example, an oil spill from a shipwreck is a pulse disturbance; a busy shipping lane represents a press disturbance. However, such categorisation is imprecise as it depends on the level or scale of observation. Fishing activities may be considered a sustained pressure on a fish stock, yet they comprise repeated, often seasonal bursts of capture activity. Nevertheless, in considering a fishery over a decade, for example, it would seem more appropriate to view fishing activity as a press rather than pulse disturbance.

Here we are concerned with the suite of disturbances (triggers and drivers of change) that have in the recent past altered, are currently altering, or are capable in the future of altering, the essential structure and function of EASES and its development trajectory. This suite includes disturbances that occur at encompassing (higher) and nested (lower) system levels, which interact across levels and scales to affect the Atlantic Europe macro-region. It also includes disturbances occurring at the macro-regional level. For example, global processes such as climate change or globalisation as well as local processes such as port expansion and regional processes such as Atlantic spatial planning are all disturbances that may affect the macro-region.

Panellists were asked two connected questions. (Question 15a): *What do you consider to be the key disturbances affecting the Atlantic Europe macro-region at present, in the recent past, and in the near future?* And (Question 15b): Of the disturbances you gave in response to 15a, are there any you consider to be particularly harmful or threatening? Taken together, 10 panellists identified the key contemporary disturbances listed in Table 6.19.

Table 6.19 Key disturbances affecting Atlantic Europe.

- Global environmental change.
- Climate change including sea level rise (8).
- Tsunamis, storm floods.
- Globalisation.
- Global financial crisis.
- Scarcity of fossil fuels.
- Cumulative anthropogenic impacts.
- North Sea regime shift.
- Selective adjustment of ecosystems.
- Fisheries, fishing and overfishing (6).
- Coastal development including building (2).
- Energy generation including renewable (2).
- Tourism and recreation (2).
- Marine litter.
- Eutrophication.
- Risky transport.
- Warfare and financial collapse.

Numbers in brackets denote the number of same or near equivalent responses given by different panellists.

Six panellists considered climate change to be particularly harmful or threatening. Two panellists pointed to fisheries, aquaculture and overfishing. Otherwise, global change in general, globalisation, fossil fuel scarcity, building development and overall cumulative anthropogenic impacts were each highlighted by a panellist.

Panellists were also asked (Question 15c): *Can you identify or suggest any novel types of disturbances emerging that could affect EASES?* The following were identified by six panellists:

- Environment-related immigration patterns (a minor disturbance to EASES) linked with Mediterranean Sea LME-related environmental policies involving North African countries.
- Different or new ways of utilising oceans and coast (e.g. shipping, artificial platforms for working or living space, and exploitation of living resources, benthos and sediments).
- Trends towards privatisation, commercialisation and patenting of natural resources and the linked processes of genetic modification/engineering of organisms.
- Possibly accelerated environmental (including climate) change.
- Shifts in species range and consequent shifts in linked exploitation activities.
- A lower carbon future with reduced travel and changing fuel costs (making many boat-based activities unprofitable).
- Increased ports activity and harbour infrastructures.

These results are used in the analysis in Chapter 7 (section 7.4).

6.9.3 Key changes and trends

The workbook objectives were *to identify and characterise (1) key changes taking place in the Atlantic Europe macro-region at present, and 2) any associated trends in these changes*. This part looked at key changes taking place in EASES that result from the identified disturbances, plus any trends. These may be indicative of a potential future system trajectory.

The term 'key changes' refers to important changes taking place in the social and ecological domains of EASES that have been triggered or driven by the disturbances. They may involve, for example, changes in biodiversity, ecosystem service flow, resource use, harvesting strategy, policy and planning, management, social capital, demographics, funding or economic development. The term 'trends' refers to the general directions in which these changes are progressing over time.

Panellists were asked (Question 16a): *What do you consider to be the key changes occurring in the Atlantic Europe macro-region at present and what are their trends?* These changes may be taking place across the whole macro-region or involve particular components or subsystems. The responses from nine panellists are presented as an unranked list in Table 6.20. The key changes and trends identified by panellists also include relevant responses to other questions in the workbook.

Table 6.20 Key changes occurring in Atlantic Europe.

- Global environmental change, especially climate change, with trends of different phenomena in different directions.
- Increasing anthropogenic cumulative (negative) impacts on the environment and natural resources.
- Deteriorating resource quality/availability/production conditions.
- Increasing proportion of marine and land protected areas, and (possible) associated problems of resource availability and scarcity.
- Declining fisheries (fleets, catches and communities), including industrialised fisheries, inshore fishing and small-scale aquaculture, reducing pressure from fisheries.
- Expanding aquaculture sector.
- Increasing loss of marine biodiversity from overfishing.
- Continuing process of industrialisation (including agriculture) over long-term.
- Rise of new industries and innovative growth sectors, including (marine) renewable energy production technologies, aquaculture, and tourism/recreation.
- Increasing coastal development.
- Increasing (gradually) institutional and stakeholder cooperation.
- Increasing participation in management systems (ICZM, local fisheries) and (possibly) IMP and MSFD governance.

- Increasing integration between sectors and management activities.
- Increasing integration of policies (e.g. IMP and MSFD) and associated management activity.
- Increasing trend toward planning, policy and political thinking that considers the marine dimension.
- Greening of the marine policy discourse, including CFP reform.
- Changing global economic and financial situation, including decline-recovery-growth-crisis cycle, developing global energy markets and prices.
- Depopulation or very low population growth in some areas (versus future immigration patterns).
- Economic, social and political adjustment to environmental change over long-term.
- Cultural shift from modern to post-modern over very long-term.
- New and changing ways of exploiting ocean and coastal space and resources.
- Increasing use of marinescape to accommodate human activities.
- Increasing EU territorial integration, regionalisation and participation at regional level.
- Increasing bureaucratisation and centralisation at EU and national levels.
- Increasing European identity amongst certain groups.
- Increasing nationalism and scepticism of European institutions.
- Increasing (at macro-level) or decreasing (in some parts of macro-region) social cohesion.
- Intensification of resource use, linked with economic and population growth.
- Increasing structural and functional dependence, through development and resource use, on global economic changes.
- Continuing trend towards privatization, commercialisation and patenting of natural resources.
- Continuing movement towards single, integrated market.
- Increasing influence of transnational private sector companies and NGOs.

6.10 Human activities

The workbook objective was *to identify which key human activities contribute to the complex cluster of problems challenging the sustainability of EASES*. There is a large body of scientific and grey literature addressing the many human activities taking place in the North-East Atlantic and adjacent maritime regions of Atlantic Europe. The objective here was not to compile an exhaustive list of these human activities. Rather, it was to identify only those human activities that are considered key in terms of their influence on the internal structure and functioning of EASES.

Human activities can be considered the functions of different sets of sectoral social and economic processes. A human action or intervention affecting a SES's internal processes and functions may be located (1) within the system's internal structure; (2) outside it and, therefore, an external influence mapped as a boundary condition; or (3) straddling the system's boundaries.

Multiple human activities on land, in the atmosphere and at sea result in pressures and disturbances affecting marine and coastal environments and the human societies that depend on them. Whether induced directly or indirectly, intentionally or unintentionally, system responses may significantly affect ecosystem structure and function, biodiversity and flows of ecosystem services. Consequently, human activities affect the ability of ecosystems to sustain human well-being and social and economic development. Of course, human activities also interact directly with the social domain. The consequences or impacts of human activities are often perceived as undesirable. The cumulative and indirect impacts,[158] interactions between pressures, disturbances and responses, and potential synergistic effects[159] arising from multiple and overlapping human activities and from ecological processes and events, all contribute to what have been called 'complex problem clusters' (Schmandt 2006: 2352).[160] In other words, multiple interacting problems of unprecedented complexity challenge the sustainability of the maritime dimension and stand in the way of balanced and sustainable development of Europe's maritime spaces and coastal regions.

Panellists were asked (Question 5a): *Which human activities do you consider to be key in terms of pressures, disturbances and consequences (impacts) for EASES, that is, the Atlantic Europe ocean and coastal macro-region?* Panellists were also

[158] Cumulative impacts are the combined result of incremental changes and additive effects involving several individual impacts. Indirect impacts (sometimes referred to as secondary impacts) are not a direct result of the human activity, but occur away from the original effect or as a result of a complex pathway.

[159] Synergistic effects arise when interactions produce a total effect greater than the sum of the individual effects, so that the character of the final impact is different to the character of both the individual impacts and the cumulative impact.

[160] According to Schmandt (2006) a 'complex problem cluster' arises from multiple, cumulative and interactive stresses caused by demographic and economic growth that impact, directly or indirectly, on natural systems: 'It is these complex problem clusters that stand in the way of sustainable development' (p. 2352).

asked to indicate if they considered the human activity to be located primarily inside, outside or straddling the boundaries of EASES/Atlantic Europe.

In most cases, each panellist listed multiple activities they considered key. For sake of clarity, these are presented in Appendix F and summarised in aggregate form in Table 6.21. The table shows key human activities and associated key pressures and consequences, and principal location of the activities relative to the boundaries of EASES/Atlantic Europe (i.e. inside, outside or straddling). The numbers in brackets indicate the number of same or near equivalent responses given by different panellists.

Many of the responses included both sea and land based activities. One panellist placed importance on the combination of activities as well as the way management systems deal with activities and associated pressures and effects. Another panellist placed importance on the cumulative impacts from many sources, which are “growing and probably nearing thresholds”. A third panellist made explicit mention of uncertainty with regard to the relatively unknown meta-consequences of the rapidly expanding aquaculture sector. Another panellist mentioned unpredictability with regard to climate change impacts.

The majority of the consequences (impacts) itemised by panellists may be considered negative. They include modification of the environment and, significantly, future options arising from a variety of activities at sea and on land. Two panellists referred to competition for space and taking space away from ecosystems, particularly by the coastal development of infrastructure (including ports). Three panellists listed either change or loss of biodiversity variously as a consequence of coastal development and other land-based activities (industrial, urban-domestic, agricultural) and destructive fisheries practices. Other negative consequences mentioned included economic losses resulting from destructive fisheries practices, and the impact on traditional ways of life from tourism and/or infrastructure development.

The positive consequences of certain human activities considered by different panellists include: the importance of fisheries for local communities; the growing economic significance of tourism in coastal areas; the employment provided by shipping and port activities; and the likely future importance of renewable energy production.

Table 6.21 Key human activities, associated pressures and consequences, and principal location of activities relative to boundaries of EASES/Atlantic Europe.

Activity	**Pressures and consequences**	**Principal location relative to boundaries**
Exploitation of natural resources in general	Modifies environment and future options	Not specified
Fisheries, fishing (15)	• Fisheries cover the largest area and extract the largest biomass from marine ecosystems • Overfishing • Destructive fishing practices and methods (bottom-trawling, shellfish-dredging, driftnets, pair-trawling) habitat damage, bycatch, loss or change of biodiversity • Ecosystem dysfunction • Economic loss	Inside and straddling
Aquaculture (2)	Unknown meta-consequences e.g. industrial fisheries for aquaculture feed	Inside (but with impacts outside e.g. feed fisheries)
Agriculture (3)	• Nutrient enrichment and run-off leading to eutrophication, algal blooms, anoxic 'dead' zones • High water consumption	Inside
Mineral and aggregate extraction (2)	Not specified	Mainly inside
Oil & gas exploration, extraction (3)	Not specified	Inside
Energy production in general	Not specified	Straddling
Renewable energy production incl. offshore (3)	Not specified	Inside
Fossil fuels burning, anthropogenic CO_2 (5)	• Climate change • Ocean acidification • Change in sea level	Straddling but mainly outside
Industry, urban, domestic and other land based activities in general, that affect coastal zone, coastal waters (8)	• Wastewater disposal and other land-based sources of pollution • Biodiversity loss	Mainly inside
Coastal development	• Competition for space	Mainly inside

incl. urbanisation, infrastructure (9)	• Loss of biodiversity • High water consumption, wastewater production	
Transport and trade (marine, land, air) in general (2)	Not specified	Straddling
Shipping, marine traffic (6)	• Port infrastructure consumes large land areas but also provides employment • Air pollution • Ship strikes, oily discharges, introduction of non-indigenous species	Straddling
Communications and fuel infrastructure (cables, pipes)	Not specified	Not specified
Coastal engineering	Not specified	Straddling
Tourism and recreation (5)	• Destruction of ecosystem services and traditional ways of life • Environmental consequences • Economic significance (benefits)	Mainly inside
Anthropogenic noise	Stress on cetaceans and other marine organisms	Mainly inside
Habitat destruction activities in general	Habitat destruction	Not specified
Conservation in general	Not specified	Straddling
Management activities incl. policy, strategic planning (3)	Not specified	All (inside, straddling, outside)
Political activities or lack of	Short-termism compromising national heritage	Not specified
Combination, accumulation of activities (2)	Cumulative impacts from many sources "growing and probably nearing thresholds"	Not specified

Human activities are discussed in the analysis in Chapter 7 (section 7.4).

6.11 Summary

This chapter described the conceptualisation of EASES as an analytical construct for understanding maritime macro-regions in general and the Atlantic Europe macro-region in particular. After first considering the SES as an integrative unit of analysis, the chapter provided an overview of the study of the unit of analysis (EASES) selected for this research. The bulk of the chapter then described the results and analysis. This included an outline of the geographical and ecological, and sociopolitical and socioeconomic characteristics of EASES. The system boundaries were defined and boundary conditions described in order to identify what is included in EASES. The chapter then identified the key system structures, processes and functions of EASES. First, the multiple capitals framework used for defining EASES in terms of different 'critical' capitals was described. Second, natural capital, including ecosystem services, associated with the Atlantic Europe macro-region were identified. Third, critical assets and capacities ('capitals') associated with human society in the macro-region were identified. The fourth subsection identified key social components (in terms of groups, organisations, institutions and governance) essential to understanding the structure, processes and functions of EASES. Together, these produced a snapshot of EASES at the present time.

Next, the chapter established the key structural hierarchical relationships between the Atlantic Europe macro-regional level and other levels; and the associated cross-level and cross-scale interactions that have significant influences on the functioning of EASES. It then identified key disturbances and other drivers of change that affect EASES, and the character and trend of key changes taking place in the system. This included the construction of a historical profile and temporal boundaries for EASES. Finally, the chapter determined the key human activities that contribute to the complex cluster of problems affecting the sustainability of EASES.

Chapter 7

Maritime regional sustainability, social–ecological system resilience and governance architecture: linking the concepts in Atlantic Europe

This chapter draws together insights from across the previous chapters and links concepts to answer the research questions and arrive at a number of conclusions.

7.1 Introduction

The EU's Integrated Maritime Policy (IMP) framework (European Commission 2007a) was introduced to address sustainable development and sustainability of marine areas and coastal regions (see Chapter 4, section 4.5). The IMP promotes an integrated governance framework for Europe's maritime affairs at all levels of decision making, including the transnational macro-regional or sea basin level (European Commission 2008a). However, at the beginning of this thesis, I drew attention to a central problem: traditional systems of governance have struggled to deal with the global changes, complex interactions and pervasive uncertainties that challenge a transition towards marine and coastal sustainability in Europe's maritime macro-regions and sea basins. The design and implementation of an effective multilevel system of maritime (ocean and coastal) governance presents a major challenge to EU policy makers.

The purpose of this research was to gain knowledge about a multilevel adaptive governance architecture that combines notions of sustainability and development in the context of European maritime macro-regions in general, and Atlantic Europe in particular. I have argued that the design of integrated maritime governance should be informed by theory of complex adaptive social–ecological systems (SES) (see Chapter 2), including resilience theory (see Chapter 3). Furthermore, I have argued that SES-based governance architecture is necessary for the EU to successfully meet the challenges of achieving regional sustainability in the maritime dimension (see Chapter 4). Therefore, this research set out to gain insight into potential governance architecture by using a SES as a conceptual framework and analytical tool.

A study was conducted to conceptualise the European Atlantic social–ecological system (EASES) as the unit of analysis. EASES was used for understanding the Atlantic Europe maritime macro-region as a SES. The final conceptualisation of EASES that emerged from this research (see Chapter 6) provides a basis for relating governance architecture to SES resilience and maritime regional sustainability in Atlantic Europe. Six research questions were formulated to guide the research process in general and the study of EASES in particular (see Chapter 1, section 1.2).

In the following sections, I answer the research questions (RQ) using insights gained from the previous chapters and findings from the study of EASES. Section 7.2 explains SES thinking as a conceptual framework. Section 7.3 outlines the concept of resilience as an analytical lens for understanding SES. Section 7.4 considers EASES as the unit of analysis, which partly answers the second research question (RQ2). The next three sections, which deal with the analysis of EASES, are needed to answer the remainder of the question. Section 7.5 describes the key sources of resilience in EASES, which answers the third research question (RQ3). Section 7.6 analyses the dynamics of persistence and change in EASES and considers how these relate to a sustainability transition, which answers the fourth research question (RQ4). Section 7.7 concerns resilience management and identifies strategies for building resilience in EASES, which answers the fifth research question (RQ5). Then, section 7.8 outlines some general design guidelines for SES-based governance architecture, which answers the sixth research question (RQ6). Section 7.9 synthesises the concepts of maritime regional sustainability, SES resilience and governance architecture, which answers the first research question (RQ1); finally, the chapter ends with a number of conclusions.

7.2 SES thinking: a conceptual framework

This thesis adopted a SES approach to the analysis of the Atlantic Europe maritime macro-region. It is an approach based on the fields of social ecology and sustainability science (see Chapter 5). The SES approach uses concepts from complex adaptive systems (CAS) theory and resilience theory to investigate society–nature relations. It is concerned with understanding the dynamic relationships between humans, society and the rest of nature; and with producing usable knowledge for sustainability. The approach involved constructing a SES as the unit of analysis. In this case, EASES was conceptualised to represent and understand the Atlantic Europe maritime macro-region (see Chapter 6).

The conceptual framework that guided this research performed three main functions: First, it accommodated concepts derived from different disciplines and perspectives. Second, it allowed relevant concepts and their (assumed) relationships to be identified and organised in a coherent way. Third, it provided a general explanation of key concepts and relationships, which in turn served as the theoretical foundation and justification for the conceptualisation of EASES. The conceptual framework has two parts. The first part describes the theory of CAS in general and SES in particular (see Chapter 2). The second part describes resilience theory (see Chapter 3). The framework provides a coherent structure for linking the abstract theoretical level to concrete analytical level, integrating concepts and knowledge, and for thinking about complex, continually changing social–ecological realities. The conceptual framework was modified and refined over several iterations during the research process to reflect new information and understanding. It is not intended to be fully comprehensive or universally applicable.

Overall, the framework of complex adaptive SES theory provided a foundation for the conceptualisation of EASES described in Chapter 6. In the following section, I outline the second part of the conceptual framework: resilience theory.

7.3 Towards a deeper understanding of SES resilience

Resilience theory is an important element of the conceptual framework for a SES approach to sustainability research and practice. It is described in Chapter 3. Resilience and related concepts of adaptability and transformability provide an organising framework and analytical lens for understanding the complex relationships and interactions between individuals, societies, economies and the rest of nature. In other words, resilience is a way of thinking about complex SES dynamics (Berkes and Folke 1998b; Berkes *et al.* 2003a; Folke 2006; Walker and Salt 2006; Folke *et al.* 2010).

In section 3.3, I identified nine key aspects of resilience capacity of a SES: absorption, resistance, measure, reorganisation and renewal, self-organisation, adaptability or adaptive capacity, transformability or transformative capacity, anticipation, and panarchy. In section 3.4, the different sources of resilience in a SES were explained. I then addressed the processes by which resilience is diminished and lost (section 3.5) or, conversely, gained and increased (section 3.6). In section 3.7, adaptation, adaptability (adaptive capacity), transformation and transformability (transformative capacity) were described. These interrelated concepts are crucial to understanding resilience dynamics of complex adaptive SES. I will discuss these aspects of resilience in relation to EASES in sections 7.5 and 7.6, which will go some way towards answering my third (RQ3) and fourth (RQ4) research questions respectively.

A resilience perspective provides a way of understanding how to improve society's ability to persist and develop by dealing with disturbances and change. Moreover, a SES resilience perspective can improve the ability of governance systems to deal – under conditions of uncertainty and surprise – with rapid global changes and complex social–ecological dynamics at multiple levels of organisation and across multiple scales (Duit *et al.* 2010). As explained in Chapter 1, SES resilience has important implications for EU maritime governance in general and the governance of maritime macro-regions in particular. I propose that multilevel adaptive governance can be focused on building SES resilience to help achieve sustainability in the Atlantic Europe maritime macro-region as represented by EASES.

The study of EASES identified key characteristics that determine resilience, both in terms of sources of resilience and resilience dynamics. These SES characteristics require resilience management in the context of multilevel adaptive governance (see section 7.7). In the next section, I consider EASES as the unit of analysis for understanding the Atlantic Europe maritime macro-region, which partly answers the second research question (RQ2).

7.4 Analysis of the Atlantic Europe maritime macro-region using EASES

A conceptual SES is a hybrid entity and integrative unit of analysis that can be specified at any focal level of interest, such as a level of organisation in a hierarchy. This research is based on a study of EASES: a SES selected and conceptualised to represent the Atlantic Europe maritime macro-region. The conceptualisation of EASES that emerged from the study is described in Chapter 6. EASES is used as the unit of analysis for understanding key characteristics of the macro-region, in particular, those characteristics relevant to resilience, adaptability and transformability (RQ3); resilience dynamics (RQ4); and resilience management (RQ5). These three areas of analysis are discussed in sections 7.5 to 7.7 respectively. This section addresses, in part, the second research question (RQ2): How can a maritime macro-regional SES (i.e. EASES) be conceptualised and used as the unit of analysis for understanding a potential governance architecture for maritime regional sustainability in Atlantic Europe? Together, this understanding provides the basis for some general design guidelines for SES-based architecture for integrated maritime governance, outlined in section 7.8.

The basic geographical, ecological, sociopolitical and socioeconomic characteristics of EASES are described in Chapter 6 (sections 6.4 and 6.5). In summary, EASES is located in the North-East Atlantic. Its geographical scope encompasses Europe's Atlantic seaboard and adjacent ocean space. In general, the seaward component of EASES is spatially consistent with two contiguous large marine ecosystems (LME), namely the Celtic-Biscay Shelf LME and Iberian Coastal LME. The landward component is commensurate with the EU Atlantic Area or Arc transnational cooperation territory. The Atlantic Europe macro-region has a strong sociopolitical and socioeconomic identity. This is in no small measure due to the emergence of the Conference of Peripheral Maritime Regions of Europe (CPMR) and its Atlantic Arc Commission (AAC) and similar transnational actor networks. The Atlantic Europe space and identity have been consolidated by successive EU Atlantic Area transnational cooperation programmes. The social complexity, diversity and dynamics of the macro-region are captured in the Atlantic Spatial Development Perspective (ASDP) (CPMR 2005). Clearly, the geographical scope of EASES is characterised by a duality between the social land component and ecological marine component. However, this is only superficial.

Defining boundaries

Complex systems are inherently difficult to conceptualise and describe. Constructing a SES as a unit of analysis involves setting system boundaries in space and time, which define system extent and scale. Defining boundaries and describing their conditions are necessary to identify what is included in the system and what is not: what components, relationships, patterns and processes respond to internal dynamics and transboundary processes while functioning as a whole, and what do not. In other words, boundaries distinguish the system from its environment (i.e. anything external to the system).

Defining SES boundaries is a contentious issue due to different ontological and epistemological positions. In round one of the study, the panel of 19 experts helped to establish and clarify the spatial and temporal boundaries of EASES, and describe the boundary conditions.[161] As discussed in section 6.6 and shown in Figure 6.2, the spatial boundaries and scope of EASES were initially established by combining two sets of recognised spatial units and their boundaries: the two contiguous LME and Atlantic Area territory mentioned above. When asked

[161] In response to study questions 1a, 1b, 2a, 2b, 2c and 14a.

whether any spatial units and boundaries should be added or removed from those listed in Table 6.2, the panel's opinion was divided. Eight panellists, giving different reasons, thought none should be added or removed, while eight panellists suggested additions, which are listed in section 6.6. Significant overlap and duplication among spatial units, particularly between LME, MEOW ecoregions and OSPAR regions, was identified by four panellists. One panellist suggested boundary simplification could be achieved by removing superfluous units.

SES are open systems that continually interact with their environment through transboundary processes. Describing conditions that characterise the boundaries of EASES helps to clarify three important issues. First, what is included in EASES, that is, the system's key internal structures, processes and functions. Second, the relevant factors that occur outside EASES, that is, the key external conditions belonging to larger-scale systems. These 'exogenous controls' (Chapin *et al.* 2009b: 12) determine or influence the structural arrangements, patterns of behaviour and dynamics of EASES. Third, the key transboundary flows and exchanges between EASES and other external, either adjacent or higher-level/larger-scale, systems. Such boundary conditions are dynamic, continually changing in response to both internal and external dynamics. In round one, panellists were provided with an initial conceptual model of EASES. They were asked whether any external conditions should be added or removed, and to identify key transboundary flows and exchanges.

The identification of the temporal boundaries of EASES was connected with the objective of constructing a historical profile of the system (see subsection 6.9.1). To gauge the temporal range of EASES, panellists were asked how far into the past and into the future they considered it appropriate to examine the system. The different ranges suggested by 14 panellists are presented in Figure 6.21. The three past time horizons that emerged are the periods around the Second World War, Industrial Revolution and Age of Discovery; and the two future horizons are in the band 2030-2050 and around the end of the 21st century. Furthermore, as previously discussed, the spatial boundaries of EASES vary over time. In particular, the spatial boundaries of the EU Atlantic Area programmes have varied over the last two decades due to different combinations of regions included. Next, I turn to what is included within the boundaries of EASES.

Identifying structures, processes and functions

The boundaries of SES are established around functional groups of social and ecological entities, for example communities, institutions, landscapes/seascapes, ecosystems or biogeographic regions. In the case of EASES, we are dealing with functional boundaries defined at the macro-regional level of organisation: the focal level of interest. Therefore, the study identified key social and ecological components (agents and processes), structures (patterns of relationships between and arrangement of components) and functions that influence the dynamic configuration (or regime) and behaviour of EASES. This snapshot was constructed using a multiple capitals framework developed for the analysis of EASES in terms of critical assets and capacities. The rational for this analytical framework is presented in subsection 6.7.1. In the study of EASES, panellists were asked to identify key aspects of different capitals they considered important to the functioning of the Atlantic Europe macro-region. Here, I briefly discuss the results, which are presented in more detail in section 6.7 (subsections 6.7.2 to 6.7.4).

The concept of natural capital was used to understand the ecological domain of EASES (see subsection 6.7.2). Natural capital comprises stocks of natural assets or resources used by humans, which are of value to human society. I extend the notion of natural capital to include the capacity of the environment to produce and maintain these stocks. Natural capital includes non-renewable natural resources sourced within the Atlantic Europe macro-region, such as fossil fuels (e.g. offshore oil and gas), aggregates (e.g. marine sand and gravel) and minerals. It also includes renewable natural resources such as commercial stocks of fish and shellfish; sources of renewable energy (e.g. offshore wind, wave and tidal); and agricultural land and biomass for food production. Five panellists pointed to an additional category: spatial resources. This includes areas of high biodiversity (e.g. marine nursery areas such as estuaries and cold-water coral habitats); environmental sink areas where human-made waste is redistributed, stored, processed and absorbed; and sites for, *inter alia*, renewable energy production, shipping lanes and living space.

The base of natural capital provides a flow of benefits to people. Ecosystem services are the variable flows of tangible and intangible benefits people obtain from both natural and human-modified ecosystem functions. Following the suggestion of one panellist, I used the Millennium Ecosystem Assessment (MA 2005) classification of ecosystem services to group responses into four categories along functional lines: provisioning, regulating and cultural services that directly affect people, and supporting services needed to maintain the other services. Key ecosystem services associated with Atlantic Europe are listed in Table 6.5. They include provisioning services such as food production (e.g. fisheries and farm crops); regulating services such as climate regulation, sinks for waste, water purification and coastal protection; cultural services such as maritime heritage, coastal tourism and marine recreational resources; and supporting services such as primary production and habitats for species.

To understand the social domain of EASES, the study identified critical assets and capacities ('capitals') associated with human society in the Atlantic Europe macro-region. The framework looked at social, cultural, political, economic and financial capitals (see subsection 6.7.3). (Human capital is a property of individuals and was treated as a component of social capital.) Social capital is the connectedness both between people within groups and between different groups. Panellists considered bonding connections, trust and cooperation to be aspects of social capital critical to the functioning of the macro-region. Panellists also identified a number of specific trends in social capital (listed in section 6.7.3). Cultural capital is the accumulated connectedness, learning and experience through which power structures, hierarchy and status are advantageously reproduced in social groups. Panellists identified maritime culture and heritage, history, Celticity[162] and cultural landscapes as relevant to the macro-region. Political capital refers to an individual's or group's ability to engage in political decision making regarding the Atlantic Europe macro-region. Panellists indicated

[162] The quality or state of being Celtic. Source: http://www.merriam-webster.com/dictionary/celticity [accessed 8/11/2015].

that international, supranational (EU), national and regional level actors have a greater ability to engage compared to actors at community and individual level (see Table 6.6). Economic capital is generated via economic activity. Infrastructure (including energy, information, coastal protection, underwater cables and pipelines, ports and transport network infrastructure), market-based incentives, knowledge and property rights play a key role in the functioning of the macro-region. Financial capital is, on the one hand, the monetary resources that can be used to acquire other types of capital and, on the other hand, the means of allocating and mobilising other forms of capital so as to deliver benefits. In the latter sense, EU Structural Funds (SF) are financial capital (Ekins *et al.* 2008).

The study also sought to identify key functional groups of social components (actors and processes) that help us understand the structure and functions of EASES. In other words, what are the key groups of people, networks, organisations, institutions and governance systems of the Atlantic Europe macro-region? These are listed in Table 6.17 and summarised in Figure 6.17.

Hierarchy and cross-scale interactions

As described in Chapter 2 (section 2.3), CAS are characterised by nested hierarchical structure and nonlinear cross-level and cross-scale linkages and interactions, including crucial feedbacks. At the start of this thesis (section 1.2), I proposed that the macro-regional level of organisation is a key focal level regarding a multilevel governance framework for achieving maritime regional sustainability. In the conceptual hierarchy, the focal level system (represented by EASES) encompasses successively lower-level systems. In turn, EASES is embedded in successively higher-level systems. Thus, macro-regional level components, structures and functions are simultaneously interconnected and interdependent with agents, processes, structures and functions at both higher and lower levels of organisation. The interconnections and interactions are provided and influenced by social and ecological processes operating across different scales and levels.

The study also identified a number of scale mismatches concerning EASES. The majority involved mismatches between ecological scale and the scale of territorial and management jurisdictions, and management, institutional and administration processes, particularly regarding fisheries resources.

Key drivers of change

EASES is dynamic. Its structure, patterns of behaviour and other CAS properties change in response to a mix of sustained pressures and discrete disturbances. (A shock is sudden, surprising disturbance.) These driving forces or drivers of change are processes that operate across various scales. In other words, drivers that influence the social–ecological dynamics of EASES originate in the dynamics at other times or places and at different levels of hierarchical organisation. Therefore, drivers may originate endogenously at nested levels within EASES or exogenously in the dynamics of the external environment.

Human activities

As outlined in Chapter 1, solutions must be found to complex problem clusters Schmandt (2006: 2352). These are multiple interacting problems of unprecedented complexity that challenge maritime regional sustainability. They arise from the interaction of multiple and overlapping human activities and ecological processes and events, which impact (directly or indirectly) on natural systems and the human societies that depend on them. Therefore, it is important to identify key human activities that contribute to the complex problem cluster affecting the sustainability of EASES. Sixteen panellists identified key human activities together with their associated pressures, disturbances and impacts, which influence the internal structure and functioning of EASES. These are summarised in Table 6.21. It is worth noting that the majority of the activities are located either inside or else straddle the boundaries of EASES/Atlantic Europe.

Returning to the second research question (RQ2), this section has shown how a specific maritime macro-regional SES can be conceptualised as the unit of analysis called EASES. The conceptualisation defined the system boundaries and their conditions, and identified key system structures, processes and functions. It determined key structural relationships and cross-scale interactions between the macro-regional level and other levels. It identified key disturbances and other drivers of change that influence EASES. It also identified which human activities challenge the sustainability of EASES. This partly answers RQ2. The characteristics of EASES determined here provide a basis for understanding potential governance architecture for maritime regional sustainability in Atlantic Europe. However, the areas of analysis discussed in the following three sections are needed to answer the remainder of RQ2.

7.5 Sources of resilience in Atlantic Europe

The study of EASES identified key characteristics that determine resilience in the Atlantic Europe maritime macro-region. I discussed the concept of resilience as an analytical approach to understanding SES in section 7.3. This section looks at the key sources of resilience already outlined in Chapter 3 (section 3.4) and answers the third research question (RQ3): What key factors determine the resilience, adaptability and transformability in EASES?

Resilience in EASES is the capacity to perform several functions: to persist by absorbing, buffering or resisting an amount of change; to recover, reorganise, rebalance and renew following disturbance; to maintain self-organisation rather than have organisation imposed; to make incremental adjustments to the system state in response to changes and continue to develop (adaptability); to fundamentally redefine and transform the system state and acquire a new development trajectory when necessary (transformability); to anticipate future variability and change, including surprises (foresight); and to influence the cross-scale dynamics of social–ecological change (panarchy).

Round two of the study identified a set of system characteristics that are sources of resilience of EASES. They are: redundancy, modularity, diversity, novelty and innovation, social capital, social memory, social learning, bridging organisations and stewardship. I discuss each of these in turn below. However, as one panellist commented, many of these sources are overlapping and interconnecting, which creates difficulties when describing and using them as abstract categories. I posit that sources of resilience should be taken into account by both resilience management (see section 7.7) and SES-based governance architecture (see section 7.8) for sustainability in the Atlantic Europe maritime macro-region.

Redundancies are overlapping and duplicated entities and attributes. A degree of redundancy among functionally similar social or ecological components and interconnections is essential to the capacity of EASES to reorganise and renew after disturbance. Elimination of redundancy may increase system efficiency, but possibly at the cost (often hidden) of reducing system resilience (Gunderson *et al.* 2010). In general, redundancy involves a trade-off between the costs (in terms of added time, effort and resources) and the benefits of improved system performance (Low *et al.* 2003).

Regarding environmental protection in the North-East Atlantic, in the study of EASES, panellists identified redundancies in administrative and management structures and processes. For example, between UNCLOS EEZ, OSPAR regions, IMO Western European PSSA and MSFD marine subregions (see Figure 6.2 and Table 6.2). One panellist commented on this mutual redundancy and stated that "in an ideal world the administrative bodies concerned would come to some consensual definitions for biogeographic, political and economic boundaries." However, in the resilience view, functional redundancies such as this provide 'insurance' in EASES, thus increasing system resilience.

Modularity refers to internal compartmentalisation of the system in space, time or organisational structure (Levin and Lubchenco 2008). A degree of modularity is essential to the capacity of EASES to absorb disturbance, and reduce the impact and spread of disturbances and shocks.

The structural integrity and functional coherence of EASES involve a trade-off between the degree of modularity and degree of connectivity between modules. On the one hand, a high degree of modularity (i.e. independence approaching total isolation between modules) impedes the spread of disturbance from one module to another and limits the severity of cascading, system-wide impacts. On the other hand, a high degree of connectivity (i.e. interdependence approaching total integration between modules) facilitates vital movement (flows and exchanges) between modules. But it also facilitates the propagation of disturbance and cascading effects within and across scales. Furthermore, sufficient interconnections are needed to allow modules to learn from the experiences of other modules (Janssen and Osnas 2005).

In SES, individuals and groups depend on the flow of information and resources throughout the whole system. Therefore, system and network architectures require a balance between a completely partitioned, unconnected modular structure and a totally integrated, globally connected one. Furthermore, a structure with slightly overlapping modules (e.g. loosely interconnected modules with strong functional interactions) may provide intermediate levels of modularity that are beneficial to system persistence (Webb and Bodin 2008: 96).

Modularity is linked with the concept of polycentricity, introduced by Ostrom *et al.* (1961) to help understand patterns of polycentric political systems in a variety of regional administration situations. The term 'polycentric' refers to multiple decision-making centres or institutions. Though formally independent of each other, these self-organising centres interact and may overlap in function as well as learn from each other's experiences, activities, experiments and innovations.[163] Pahl-Wostl (2009) defines polycentric governance systems as complex modular systems 'where differently sized governance units with different purpose, organization, [and] spatial location interact to form together a largely self-organized governance regime' (p. 357).

The concept of polycentricity is a key element of the European Spatial Development Perspective (ESDP) policy paper (European Commission 1999) and macro-regional Atlantic Spatial Development Perspective (ASDP) project (CPMR 2005). The AAC and CAAC have both endorsed a polycentric development model for Atlantic Europe with the aim of achieving better territorial and socioeconomic integration of the macro-region as a whole and its functional subareas. The political strategic objective of promoting and achieving polycentrism – as envisioned in the ASDP – has been incorporated into the EU

[163] In a modular system, novelty can be tested without severely disturbing other components. If the innovation is beneficial, it might be replicated (Janssen and Osnas 2005).

Atlantic Area programmes (Farthing and Carrière 2007; Gutiérrez and Fernández 2010).

The ASDP concludes that, given the territorial heterogeneity and disparities, priority should be given to promoting polycentric development in Atlantic Europe at the level of groups of regions. The emphasis should be placed on the strengthening and structuring of socioeconomically-advantaged polycentric spatial units or ‘motor subarea’ and their links with relatively disadvantaged interstitial ‘integration subareas’ (see section 6.5). In terms of EASES, the ASDP vision for future Atlantic Europe spatial development recognises that functional coherence (hence resilience) at the macro-regional level depends the development of balanced modularity and interconnectivity at the subarea level.

Different types of diversity are associated with the different critical capital assets and capacities identified in Chapter 6 (section 6.7). Diversity in all its forms is essential to the capacity of EASES to:

- Absorb or resist different types and amounts of disturbance.
- Spread risk and provide insurance against uncertainty, surprise and potential loss.
- Respond adaptively to change or, when necessary, create and shape change for transformation.
- Retain experiences (social memory) of change.
- Maintain options for future reorganisation and renewal.

Overall, in the ecological domain, the protection and restoration of marine biodiversity and ecosystem services (natural capital) helps maintain the resilience of EASES. In the social domain, the diversity of regionally and locally distinct maritime economic activities and associated infrastructure (economic capital) such as ports and their hinterland provide a corresponding example (European Commission 2013d). As the ASDP (CPMR 2005) analysis highlights, Atlantic Europe is characterised by a patchwork of ‘under-industrialised’ and ‘over-industrialised’ areas that, together with the economic activity specialisations, is reflected in the complex regional employment patterns. The macro-region has developed and continues to develop a set of diversified maritime economic activities (see section 4.5) that are important elements of Atlantic Europe development (sustainable ‘blue growth’) and increase the resilience of EASES.

During the study of EASES, different panellists commented on the importance of biodiversity. For example, three panellists identified marine species, and two panellists identified high biodiversity areas, including fish nursery areas and habitats supporting fisheries, as key natural capital of EASES. In the social domain, regarding fisheries in EASES for example, one panellist emphasised the necessity of diversification within fisheries and diversification from fisheries to other maritime activities (e.g. tourism, recreation and renewable energy production) to sustain development of coastal communities and regions. In addition, the panellist pointed out that economic diversification is also a means of safeguarding cultural diversity; clearly a strategy for maintaining and building sources of resilience.

Novelty and innovation are essential to the capacity of EASES to undergo successful adaptive renewal and radical transformation in the face of rapid directional changes. Innovation results from interactions among a diversity of individual and social agents (actors) who are willing to experiment, test new learning and explore new configurations, strategies and activities. Without novelty and innovation, a SES may become over-connected and dynamically locked, with capital tied up and unavailable.

The strategy of increasing the capacity for research (novelty) and innovation is a key feature of the Action Plan for the Atlantic Strategy (European Commission 2013b). The Action Plan acknowledges that novelty and innovation are needed for the macro-region to compete in the global market. In other words, they are required to maintain and build resilience. Innovation is central to the EU’s Blue Growth strategy for the maritime economy of the macro-region bordering the Atlantic Ocean sea basin (Ecorys 2014). Innovation can also help to develop cost-effective marine protection measures that can contribute to the implementation of the MSFD (European Commission 2014a: 2). A key theme of the AAC’s work programme for sustainable regional development is research and innovation to improve the overall competitiveness of Atlantic Europe. The AAC's working group on innovation has identified four priority areas for cooperation among Atlantic regions: ships of the future; marine mineral resources; biological resources and biotechnologies; and development, surveillance and security of the coast (AAC 2015).

In the study, two panellists identified innovation as a knowledge-related process that originates both within EASES and externally to EASES (i.e. innovation is transferred across its open boundaries via flows and exchanges). One panellist commented on the reorientation of capital in the maritime economy towards new innovative growth sectors such as aquaculture and tourism/recreation. Another panellist linked economic diversification in coastal fishing communities to innovation and the emergence of new economic functions, for example, marine renewable energy production technologies. A different panellist considered the need to mobilise EU structural funds (financial capital) to "genuinely promote innovation and sometimes risky ventures, rather than going to established organisations and activities." Other examples of innovation in EASES mentioned by panellists included local processes such as small business innovation or port expansion, and novel regional processes such as maritime spatial planning.

Social capital is essential to the capacity of actors in EASES to collectively and effectively deal with social and environmental change through connectivity, anticipation, response, adaptation, transformation and learning. Social capital is a fundamental source of resilience and an important societal asset for social and economic development in EASES.

People rely on social capital to co-manage natural resources and resolve conflicts (Pretty 2003; Plummer and FitzGibbon 2006, 2007; Sanginga *et al.* 2007; Armitage *et al.* 2009). Furthermore, the capacity of societies to adapt (i.e. adaptability or adaptive capacity) to global environmental and social changes is partly determined by the ability to act collectively (Adger 2003; Chapin *et al.* 2009a; Kofinas and Chapin 2009). In this respect, specific forms of social capital are critical, depending on the context (Tompkins and Adger 2004). Social capital is therefore an important macro-social asset, including with regard to regional social and economic development (Helliwell and Putnam 1995; Woolcock 2001; Woolcock and Narayan 2000; Kaldaru and Parts 2008; Farole *et al.* 2011) and social and economic innovation (Biggs *et al.* 2010). In addition, there is growing recognition of the role of social capital in relation to EU regional development policy and programmes aimed at strengthening economic, social and territorial cohesion (Parissaki and Humphreys 2005; Paraskevopoulos *et al.* 2006; Barca 2009).

The development of social capital is crucial to adaptive co-management approaches in natural resource management and to adaptive governance of SES (Kofinas 2009). In an adaptive governance framework, social capital is fundamental to actors' capacities for coping and dealing with change (i.e. adaptability and transformability). Collaboration networks, collective action and the development of common understanding and policies play an important role during periods of renewal and reorganisation following disturbance and change (Folke *et al.* 2005).

There are multiple aspects of social capital as sources of resilience in EASES. Examples identified by panellists include:

> *Connections, trust and cooperation*. Connectivity in terms of bonding or inward-looking personal connections and networks between representatives of resource user groups or epistemic communities (e.g. fishing industry, scientists, government, governance bodies, NGOs, and businesses). Several panellists mentioned trust as an important factor. In round two, a panellist stated: "I would emphasize the role of "trust" and its value for social capital and building in long-term compliance with environmental regulations." In general, panellists considered cooperation, such as in the case of ICZM and local fisheries management, to be key social capital. However, although institutional and stakeholder cooperation is gradually improving, one panellist stated that "some stakeholders (e.g. fisheries and to a lesser extent oil & gas) are still very uncooperative".

Institutional relationships. One panellist identified "transnational institutions (rules, agreements, policies) rooted in national and transnational (macro-regional) stakeholder associations and regular meetings." Another panellist identified the "numerous regional and coastal management initiatives and policies [that] have helped to build relationships across institutions and are potentially good social capital builders". A third panellist identified central governance as being very important including, for example, the European Commission, OSPAR (a regional seas body), NEAFC and DG MARE (regional fisheries bodies) and the IMO (international shipping governance): "Each reaches out to different social sectors and stakeholder groups. Greater coordination is required amongst such groups, however."

Multilevel connections. One panellist identified "multilevel connections between governance levels, particularly local-national-EU." Another panellist specified the relationship between local initiatives and regional approaches to be key social capital in EASES. One panellist considered the web of institutional linkages in general to be important. Another panellist considered the "relationships between the state, private sector, voluntary sector and civil society (the public) at all geographical scales, namely, international regional, EU, national, and sub-national/local" to be key.

Stakeholder participation. One panellist stated: "Another key relationship is the role of stakeholder participation in environmental decision-making, for example the role of Regional Advisory Councils in the Common Fisheries Policy, and how this will potentially be expanded in the Marine Strategy Framework Directive and Integrated Maritime Policy."

Fisheries sector. One panellist stated that "The fishing sector is potentially a means of building social capital across EASES, as – although it can be a bit tribal – it has a 'brotherhood' aspect and relatively good networks across the region."

Social memory is the collective experience and history of a SES, including its ecosystem dynamics. Social memory is essential to the capacity of actors in EASES to collectively:

- Envision the future and better prepare for change and future events by building adaptability and transformability.
- Better cope with stress and shocks, and successfully reorganise and renew after disturbance.
- Create and shape change (novelty and innovation) for transformation.
- Learn to live with uncertainty and unexpected events.

Social memory is important for linking past experiences with present and future policies (Folke *et al.* 2005). Key challenges for adaptive governance include (1) how to foster and maintain social memory at times of gradual change so that it is available when a crisis occurs (Chapin *et al.* 2009b: 24); and (2) how to draw on and mobilise social memory during periods of rapid change in order to facilitate renewal and reorganisation (Folke *et al.* 2003, 2005).

The dynamics of social capital and social memory are interlinked. Folke *et al.* (2005: 453) contend that at critical times of change key individuals and social networks play an important role in drawing on social memory from across scales. Furthermore, Folke *et al.* (2005: 455) hypothesise that, in addition to the diversity and redundancy of actors, the combination of social roles of individual actors and actor groups (as part of social memory) provides resilience for reorganisation, allows for novelty and thereby enhances adaptability in the face of disturbance and crisis.

One panellist considered cultural landscapes in EASES, including cultural and natural heritage sites, to be important as “they give examples for sustainable natural resource use and management.” In this sense, the cultural landscapes of Atlantic Europe are a form of social memory that provides a source of resilience for resource management and sustainable development.

Another panellist stated: “There is a great deal of useful knowledge and networks out there” and that accessing and using “this in forms that are practically useful and navigable would be a great service”. Furthermore, the commercial world also “contains a great deal of useful knowledge and networking that could be shared without compromising commercial interests. Collecting and sharing this would also obviate the need for much planned work”. This points to an as yet untapped system memory in EASES. Another panellist identified resource use conflicts that have been resolved through “big efforts”, which represent an unharnessed source of social memory with potential to inform sustainable resource management strategies.

Social learning is essential to the capacity of actors in EASES to:

- Foster resilience and sustainability simultaneously at individual, social and macro-regional levels.
- Link individual learning to organisational learning (collective learning within an organisation or agency) and institutional learning (system-wide learning between and across organisations or agencies).
- Develop new insights and abilities that contribute to successful innovation, adaptation and transformation processes.

Social learning can be conceptualised as both a process of social change in which actors learn from each other, and an outcome of social interactions and deliberation among actors across multiple scales and levels (Folke *et al.* 2003; Pahl-Wostl *et al.* 2007; Fernandez-Gimenez *et al.* 2008; Armitage *et al.* 2009; Berkes 2009). Either way, responsive, iterative social learning is of central importance for self-organisation, adaptability and other aspects of resilience. Nevertheless, it is important to note that social learning may also be used as a way to maintain the status quo. Furthermore, social learning for the advancement of sustainability and fostering of resilience necessitates a degree of ‘unlearning’ concerning undesirable but persistent knowledge, beliefs and processes associated with maladaptation and unsustainability.

One panellist alluded to the importance of social learning in local-level humanistic development projects in which system-level change emerges from below as a result of human understanding of social–ecological interdependence. In this regard, the panellist suggested: “Any local workshops for education for sustainable development (at different levels [of] governments, education, civil society, industry etc.). I believe this will be an asset to EASES.” This can be interpreted to mean that knowledge and learning related processes occurring at lower, nested system levels are essential in terms of building general resilience. Another panellist identified “common learning platforms” as an important enabling condition for governance that is inclusive of both the northern and southern areas of EASES.

Bridging organisations are essential to the capacity of actors in EASES to:

- Foster resilience through diverse management practices and social mechanisms, including stewardship.
- Build and mobilise social capital.
- Connect and communicate across group, network or institutional boundaries.
- Resolve scale mismatches, e.g. between the spatiotemporal scales of ecological processes and the functional scale and scope of governance institutions responsible for natural resource management; or between the scales of environmental change and the scales of human ability to adapt and transform.
- Facilitate collective learning processes.
- Provide leadership, e.g. in producing a collective vision and goals.

Bridging organisations also play a crucial strategic role as catalysts and facilitators of multilevel interactions, creative problem solving and positive social change. Bridging organisations can help resolve spatial, temporal or functional mismatches, for example, between the scale of ecological processes and the scale of social organisation for ecosystem management and governance (Ernstson *et al.* 2010). As an integral part of adaptive governance systems and co-management approaches, bridging organisations reduce (nonmonetary) transaction costs of collaboration and conflict resolution, and provide social incentives to participate (Folke *et al.* 2005, 2009). Bridging organisations can create the flexibility and space for institutional innovations and the capacity to deal with abrupt change and surprise (Olsson *et al.* 2007).

One panellist identified ICZM, in particular national ICZM strategies, as a key institutional bridging framework across levels and scales in EASES: "They link different political levels, economic and administrative sectors and can coordinate national and EU marine and coastal policies." This, of course, is different to a bridging organisation. Another panellist commented that, "in spite of the manifold efforts to create participatory and co-management systems in many policy and management fields", the "power structures change only slowly towards de-centralization and participatory, co-management or new governance structures."

Essentially, there is no macro-regional level bridging organisation for EASES apart from the CPMR's AAC. The AAC exhibits several of the characteristics of bridging organisations mentioned above. For example, it helps build and mobilise social capital across EASES; connect across institutional (regional government) boundaries within Atlantic Europe; links different levels of governance (subnational regional governments to EU institutions); and, through the AAC's working groups, bridges scales such as between subnational regional governance and macro-regional environmental issues or local-level business innovation. The AAC facilitates a degree of social learning within EASES. It certainly provides leadership, a collective vision (e.g. the ASDP) and a collective strategy for the Atlantic Europe macro-region. In this sense, the AAC represents a key source of resilience. This is undoubtedly an area for further research.

Resilience-based stewardship is essential for responding to and shaping social–ecological change in EASES in order to sustain the portfolio of critical natural capital and ecosystem services upon which human well-being and society depends, now and in the future.

Within the framework of social–ecological governance and resilience-based natural resource management, stewardship is essentially a suite of approaches for sustaining the functional properties of SES over the long term (Chapin *et al.* 2009c). These strategies and practices are based on reducing vulnerability and enhancing resilience, adaptability (adaptive capacity) and transformability. Resilience-based stewardship recognises the importance of cross-scale interactions among ecological, social, cultural, political, economic and financial variables; and the important roles that past and future events play in determining outcomes (Chapin *et al.* 2009b).[164]

Strategies and actions for managing, building and enhancing resilience in EASES are summarised in Chapter 3 (section 3.6) and described in detail below in section 7.7. These form the basis of a resilience-based strategy for the stewardship of EASES.

The Action Plan for the Atlantic Strategy (European Commission 2013b) includes the specific objective of 'contributing to a more effective stewardship' (p. 6) in terms of exploring and protecting transboundary Atlantic marine waters and coastal zones.

In the study of EASES, panellists addressed various aspects relating to stewardship as a source of resilience. For example, one panellist considered the following institutions key to stewardship of the Atlantic Europe macro-region:

> "UNCLOS – sets the global framework for jurisdictions and for regional fisheries management. ICES – critical provision of marine science and increasing role in reform. CFP – key policy instrument that desperately needs reform. OSPAR – builds-in environmental protection across the region."

Regarding the management of human activities that affect EASES, one panellist considered that, although human impacts are relatively well managed, "the

[164] The concept of ecosystem stewardship continues to be developed to encompass the planetary scale. Planetary or Earth System stewardship involves shaping the trajectory of social–ecological change across local to global scales in order to enhance ecosystem resilience and human well-being. The overarching aim is to foster a social transformation towards a sustainable relationship between society and the biosphere in the face of accelerated and directional global changes (Power and Chapin 2010).

cumulative impact is very significant, plus the historic dimension of impacts are important to acknowledge." Another panellist stated that human activities are currently regulated in a patchy and piecemeal approach, which is also often not spatial: "Integrated spatial planning and management, which takes into account ecosystem level impacts, is required." A different panellist commented that there is a need to "Create a responsible governance system that builds on ownership or access regulations to provide an incentive for environmental protection and secondarily for the protection of livelihoods. In short: Privatize the commons."

A fourth panellist stated that "Human activities that affect negatively the environment or natural resources (overuse and pollution) are of main importance for sustainable development and resource management strategies in the EASES." However, the panellist also identified unwanted problems (e.g. resource unavailability and scarcity) emerging from the increasing number of marine and land protected area designations, which points to unintended and unanticipated consequences of human interventions in terms of management and policy decisions (i.e. stewardship). In this case, rather than being a source of resilience, stewardship may be interpreted as resulting in the loss of general system resilience due to tied-up (fenced-off) capital – in this case natural capital in a protected area – even when the aim of the intervention might have been to maintain or build specified resilience through designating an area to protect species, habitats or an ecosystem.

Regarding sources of resilience in EASES identified during the study, one panellist considered redundancy, diversity, social learning and bridging organisations to be key categories. Another panellist considered diversity, social capital, social memory and social learning key. Both panellists believed the other categories of sources derive from the four principle ones they selected. As the first panellist stated, for example, social capital and social memory "can be seen as closely linked to social learning which is a kind of overarching process". Furthermore, novelty and innovation "can also be said to be created through social learning and through cooperation via bridging organisations." A third panellist suggested that the EU provides a "common cultural and political umbrella" that can be considered a source of resilience. A fourth panellist raised the question of whether all these categories necessarily have to be in place or can they compensate for one another? This panellist commented that it is difficult to talk about the status of these sources at the level of EASES as a whole, due mainly to issues of spatial heterogeneity. For instance, is innovation a good source of resilience in the northern area, but not as much in the south?

At first glance, the term ‘source’ appears to mean a thing from which something – resilience – originates or can be obtained (Oxford Dictionary 2015). However, I prefer the more nuanced interpretations offered by two of the panellists. The first panellist understood the term ‘sources of resilience’ to mean “processes, factors and activities that help to create resilience.” The fourth panellist construed sources as “enabling conditions for coping and change”. Their interpretations better match RQ3. Overall, this section has identified the key factors or sources of resilience, and by extension adaptability and transformability, in Atlantic Europe and thus answered RQ3.

7.6 Resilience dynamics and the transition towards sustainability in Atlantic Europe

The conceptualisation of EASES described in Chapter 6 is used as the unit of analysis. It provides a basis for understanding co-evolutionary social–ecological dynamics of the Atlantic Europe macro-region. Resilience theory presented in Chapter 3 provides a framework for interpreting dynamic patterns of relationships and cross-scale interactions between multiple levels of organisation. Resilience dynamics are inseparable from the concepts of adaptation, adaptability, transformation and transformability, and from the notion of a sustainability transition. This section examines the resilience dynamics of EASES and answers the fourth research question (RQ4): What patterns and processes of persistence and change can be discovered in EASES that allow for a better understanding of how a successful social transition towards sustainability can be shaped?

Patterns and processes of change in EASES

The study of EASES identified (1) key patterns of system development and renewal using the adaptive cycle (Holling 1986) model of resilience dynamics;

and (2) key cross-scale interactions between multiple levels of system organisation using the panarchy (Gunderson and Holling 2002) model of cross-scale interactions between adaptive cycles at different levels. Adaptive cycle theory and the two models are explained in Chapter 2 (section 2.5). Here we are concerned with the qualitative character and sequence of changes experienced by EASES in its multilevel context. That is, with the system's dynamics as it successfully (or unsuccessfully) adapts or transforms in order to persist and continue developing.

The overall pattern of change at the macro-regional level of EASES is one of punctuated development and occasional critical transition. In other words, a pattern of dynamics that involves different phases and transitions (represented in terms of an *adaptive cycle* using italics); that emerges from complex human–environment interactions across multiple scales and levels (represented in terms of a panarchy using italics); and which reflects the co-evolution of interconnected ecological and social (including economic, sociopolitical, institutional, cultural and technological) systems.

Interplay between development, disturbance and renewal

There are long periods of incremental change as EASES adapts and develops (*adaptive cycle: fore loop or development mode of accumulation–conservation*). These are intermittently interrupted by periods of abrupt change that arise in response to disturbances, shocks or crises (*adaptive cycle: back loop or renewal mode of release–reorganisation*). These largely unpredictable interruptions are characterised by relatively rapid, sometimes chaotic, and potentially dramatic changes in patterns and processes among different subsystems. Take, for example, the long-term development of Europe's maritime dimension, much of it involving the Atlantic seaboard and Atlantic Ocean sea basin. The basic pattern of incremental, interwoven economic, sociocultural, political and technological maritime developments has evolved through several distinct but overlapping development modes, as shown in Table 7.1.

Table 7.1 Periods of European maritime development

Period	Maritime development mode
c. 9th to 13th centuries	Era of Scandinavian Viking expansion and maritime empire, involving development of long-distance trade routes, colonies and a North Atlantic maritime economy.
c. 13th to 17th centuries	Era of long-distance sea routes and trading networks involving the Hanseatic (League) merchants of northern Europe and the Mediterranean city-states of Genoa and Venice.
c. 15th to 18th centuries	Era of oceanic navigation, exploration, conquest and colonisation beyond Europe, fuelling mercantilism, the slave trade, rise of nation-states, and the Portuguese and Spanish then British, French and Dutch colonial empires.
c. 16th to 20th centuries	Era of European global hegemony, colonial empires and world trade, the Atlantic slave trade, imperial rivalries and wars, nationalism, mechanisation, the rise of industrial capitalism, and sociopolitical revolutions.
post-1945	Contemporary European maritime era, characterised by the: – rapid rise of overfishing and marine pollution; – evolution in international maritime transport (i.e. emergence of bulk carriers, supertankers and containerised shipping), which reduced transport costs and encouraged world trade (Lundgren 1996); – advent of large-scale development and mass tourism in coastal regions; – emergence of European economic and political union; and – rapid development of the international regulatory environment for human activities taking place in or affecting the oceans and seas.
late 20th to early 21st century	Current era of globalisation, financialisation, crisis-prone capitalism (Duménil and Lévy 2011; van Apeldoorn and Overbeek 2012) and rapid social–ecological change (Ommer and Perry 2011; Perry *et al.* 2011).

As the Table shows, the era of European global hegemony from the 16th century to mid 20th century was interrupted by periods of abrupt change involving, *inter alia*, wars and socio-political revolutions. Likewise, the current era of rapid global development is punctuated by back loop dynamics resulting from a plethora of disturbances, shocks and crises. The post-1945 era is a classic example of a renewal mode following the 'release' dynamics of the Second World War.

Focusing on the 'Atlantic Arc' or 'Atlantic Area', this European territory has undergone a long period of incremental sociopolitical and economic development since the 1950s. The maritime economy of the Atlantic Europe macro-region (and therefore EASES) continues to oscillate between 'accumulation' and 'conservation'. There have been interruptions: global-level disturbances such as the OPEC oil crisis of 1973 and the global financial and economic crisis of 2008; and regional- or local-level disturbances such as *Erika* oil spill off Brittany in 1999). Largely through the lobbying and cooperation efforts of the CPMR's AAC, the macro-region's stakeholders have turned such disturbances into windows of opportunity for adaptive reorganisation, innovation and renewal aimed at achieving sustainable social and economic development. The CPMR's 'Europe of the Sea' project – launched in 1993 – has promoted, for example, the development of EU Atlantic Area transnational cooperation programmes, an integrated maritime policy for the EU, sea basin macro-regional strategies, the European Maritime Day, a blue economy strategy for Europe and other initiatives subsequently adopted by the European Commission and other EU institutions. Through the AAC, such initiatives are aimed at the renewal and development of Atlantic Europe; in particular, the EU Atlantic Action Plan and 'blue growth' strategy received a major impetus from the 2008 global financial crisis and its aftermath in Europe.

In general, given the dominant pattern of development and renewal (driven by discontinuous events and processes), EASES superficially appears to have sufficient resilience capacity to tolerate and deal with a wide range of disturbances and their consequences so that system integrity, adaptive capacity and progression of development are maintained over long periods. In other words, EASES has the tendency to remain on the current development trajectory within the same basin of attraction (regime) and retain essentially the same functions, internal structure, panarchical (cross-scale) relationships with other levels, balance of feedbacks and, therefore, system identity (*adaptive cycle: new 'adapted' cycles are recurrences* *of earlier ones*). However, rapid global and regional social–ecological change should be factored in. In round two of the study, one of the panellists considered the focal level system EASES and its constituent social and ecological subsystems to be at the beginning of a release phase: "predicated on the fact that environmental systems are changing dramatically due to climate change and overfishing leading to a restructuring in socio-economic activity."

Critical transition to a new regime

At times in the past and potentially in the future, the 'normal' pattern of punctuated development is interrupted by instances of a particular class of abrupt change: a critical transition. Regardless of whether a critical transition is forced (regime shift) or deliberately initiated (transformation), such a radical change can occur when the system's development trajectory is approaching a critical threshold or tipping point, and either a disturbance or further incremental change is sufficient to propel the system towards exceeding the threshold (or multiple interacting thresholds). Once a critical threshold is crossed, an amplifying feedback drives a runaway, self-propagating process that causes disruption – chaotic change – in the SES (*adaptive cycle: release phase*). The strengthening of stabilising feedbacks soon causes the system to self-organise along a different development trajectory towards a new attractor (*adaptive cycle: reorganisation phase*). The system returns to a pattern of punctuated development. In this scenario, the SES emerges transformed with a fundamentally altered configuration and behaviour, and therefore a different system identity (*adaptive cycle: system enters accumulation phase of a new cycle with new or altered structures, control processes, and feedbacks*). In other words, the SES persists by shifting to a qualitatively different regime (i.e. an alternative basin of attraction). Furthermore, the new identity of the system may closely resemble or significantly differ from the former identity prior to the critical transition.

In round two, one panellist considered EASES to "probably" be approaching a transition in terms of the macro-regional focus on development ('blue growth') in new sectors of the maritime economy. As previously mentioned, the panellist believed that EASES and its subsystems are at the beginning of a release phase. Regarding higher-level encompassing systems, the same panellist identified the

EU as “possibly” approaching a transition, “beginning to play a different role in global economic order, and approaching a critical threshold with respect to global warming (different earth system due to ppm carbon, etc.).” However, a different panellist considered that neither EASES nor higher or lower level systems are, in the short term, approaching a transition that will “fundamentally alter system structure and behaviour”.

Another panellist considered that social elements of the global-level system – in terms of globalisation, global governance and international legislation – are between the conservation and release phases; whereas at supranational level, the EU is in the reorganisation phase (following the recent financial and economic crisis) without having undergone a critical transition. Another panellist commented that the idealised patterns of change in the adaptive cycle model are unsuitable: “empirical reality is anyhow different and historical reality of the socioeconomic components of EASES will hardly follow the simplified patterns of an adaptive cycle of ecosystems.” Nevertheless, the panellist did suggest that higher-level systems in general and parts of EASES and its subsystems are at the end of a conservation phase or at the beginning of the renewal mode (i.e. in the reorganisation phase) having undergone a transition following the financial and economic crisis.

Cross-scale dynamics

The co-evolutionary dynamics of EASES do not occur in isolation. Patterns and processes at the semi-autonomous macro-regional level of organisation are influenced by how social, ecological and coupled social–ecological dynamics interact nonlinearly across multiple scales and levels. In the case of EASES, scales relevant to governance and management include the three principal scales (spatial, temporal and organisational), the ecological scales of ecosystem functions and services, and various social scales (institutional, social network, demographic, social and socio-economic status, economic, jurisdictional, knowledge and technological).

In round one, panellists identified a range of key cross-scale relationships and interactions between patterns and processes occurring at different levels in the systems hierarchy, including the macro-regional level (see section 6.8). Figure 6.20 depicts a number of these interactions. Cross-scale interactions involve multiple scales, for example, institutional interplay across spatial, temporal, ecosystemic and jurisdictional scales. Cross-level interactions occur within the same scale, for example, between supranational, national and regional levels on the jurisdictional scale. Particular cross-scale and cross-level interactions play key roles in forming, maintaining and altering patterns of functional connectivity among multiple, hierarchically nested, semi-autonomous levels of social–ecological complexity and organisation. In this case among EASES (*panarchy: intermediate adaptive cycle*), embedded subsystems (*panarchy: smaller, faster adaptive cycles*) and encompassing systems (*panarchy: larger, slower adaptive cycles*).

Feedbacks are another crucial aspect of cross-scale dynamics. The interplay between stabilising and amplifying feedbacks that occur across different scales, levels and thresholds (scale discontinuities) is fundamental to the systems hierarchy of interconnected, interacting dynamics at different structural and functional levels of organisation (*panarchy: pattern of nested adaptive cycles*).

Upward and downward causation

Many characteristic patterns and processes relating to system development and renewal observed at the macro-regional level are to a large extent emergent rather than outcomes of self-organisation at this level. In other words, they arise through and are maintained by cross-scale and cross-level interactions with various dynamic phenomena (e.g. human–environment interaction, social–ecological adaptation, sociotechnical innovation, social and economic networking, and transnational territorial cooperation) that occur, over smaller spatial extents and shorter time periods, at lower embedded levels of organisation. The emergent macroscopic properties of EASES may feed back to influence (facilitate, adjust or constrain) the local rules of interaction and selection among individual social and ecological components at lower levels. In turn, changes to local rules and changes in response diversity may lead to adapted or new emergent patterns and processes at higher levels.

An example of an emergent property at the macro-regional level of Atlantic Europe is provided by the transnational actor networks, in particular the CPMR and the AAC (see section 6.5). Self-organisation among Atlantic Europe stakeholders – through cooperation in the AAC, CAAC and ATN – has led, in part, to the emergence of the current maritime policy landscape including the IMP, MSFD, Blue Growth strategy, Atlantic Strategy Action Plan and MSP Directive. Arguably, such policies and instruments would not (yet) have emerged at EU level without the collective efforts of transnational actor networks. One panellist suggested that self-organisation among corporations, companies and other economic interests shape stakeholder groups and networks, which then emerge as key actors at the macro-regional level to influence supranational (EU) level policies such as the IMP and CFP.

The emergence of the contemporary 'Atlantic Arc' or 'Atlantic Area' space has been associated with the emergence an 'Atlantic Europe' identity (Farthing and Carrière 2007: 333). However, such an identity is nothing new (Espineira 2014). For example, Cunliffe (2001) describes the emergence of an Atlantic Europe identity among interrelated human societies along Europe's Atlantic seaboard between 8000 BC and 1500 AD. Some panellists associated this emergent property – an Atlantic Europe territorial identity – with key changes. For instance, the strengthening of Atlantic regional identity relative to changing European identity in relation to future development or enlargement of the EU. One panellist linked increasing Atlantic macro-regionalisation with a diminishing role for the member state as the principal level of governance.

In other examples, several panellists pointed to emergent patterns arising from innovations and new uses of renewable resources. One panellist emphasised the emergence of disturbances from human economic, technological and management activities to affect regional marine ecosystems and fisheries, especially since 1945.

A similar relationship and pattern of interactions and feedbacks exists between the semi-autonomous macro-regional level and higher encompassing (supranational and global) levels of organisation.[165] In this sense, the emergent properties of EASES are simultaneously influenced by larger-scale patterns and slower processes over longer periods of time. Top-down influences may include constraints (restrictions) on various properties and dynamics of EASES, its subsystems and other components, but also interactions that variously select, activate, enable, facilitate, enhance, promote or propel lower level phenomena. Therefore, the organisation and persistence of pattern–process relationships among co-evolving social and ecological components at the macro-regional level are primarily outcomes of the dynamic interplay between upward and downward causation. This is not to deny, however, the crucial importance of human foresight, agency[166] and creativity in determining systemic causation, self-organisation, adaptation, development, renewal, transformation and so forth at the macro-regional level.

One panellist linked the growth of regional identities at subnational levels both to the devolution of administration (i.e. downward causation from higher levels or central government) and to increasing community participation (i.e. upward causation from lower levels).

Path dependence and legacy effects

The co-evolutionary dynamics of EASES exhibit strong path dependence. Present and future patterns of change are influenced by the legacies (lasting effects) and memory of past events and conditions, and social–ecological responses to them. This is in addition to being influenced by current conditions and human agency. At the macro-regional level, different aspects of EASES self-organise along a path-dependent trajectory linking current dynamics to past events (causation) and future changes. For example, the bottom-up emergence in 1989 of the AAC via the CPMR, which in turn emerged in 1973 from the Breton 1950s regionalism of the Comité d'Etude et de Liaison des Intérêts Bretons.

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[165] Regarding the conceptualisation of EASES, higher levels of organisation are treated as boundary conditions (see section 6.6) that represent the interactions between the focal level system (EASES) and its 'external' environment (the wider world).

[166] Here, human agency refers to the individual or collective capacity of actors to make and impose decisions that influence a SES.

Path dependence in macro-regional dynamics is linked to path dependence in both cross-scale dynamics and upward–downward causation (*panarchy: dynamics across multiple time frames*). Put another way, many historical drivers of social–ecological change are exogenous, originating outside the spatial boundaries of EASES or at higher encompassing levels of organisation (e.g. steps taken towards European cooperation and integration since the Second World War). Other historical drivers are endogenous, originating from lower embedded levels (e.g. major oil spills from tanker accidents in the waters of Atlantic Europe).

Legacy effects are the cumulative and evolving impacts of previous social–ecological interactions on subsequent dynamics (*adaptive cycle: effect of past cycles on current and future cycles*). The historical profile of EASES (subsection 6.9.1) points to past disturbances and crises that have interrupted major development periods, affecting the system state and trajectory. EASES is subject to different types of legacies, some of which are critically important to development (e.g. accumulation of adaptations and different types of capital) and to renewal (e.g. release and reorganisation of accumulated capital and other stored potential).

Memory

Memory is an important temporal link between past and present social–ecological dynamics of EASES. Memory is fundamental to actors' capacities to self-organise and deal with social–ecological change at the macro-regional level; particularly during periods of abrupt change, when collective or social memory of past experiences provides insight into alternative responses to disturbance, crisis or changing conditions (*adaptive cycle: back loop or renewal mode of release–reorganisation*). In this context, memory refers to the:

- Evolving capacity of actors to retain, recall and reconstruct knowledge and experiences of previous system states and alternative social–ecological responses to past disturbances and crises.
- Processes by which information, attitudes and behaviour are passed down among individuals and groups, from generation to generation.

- Ability of actors to selectively draw on accumulated legacies and memory of past changes, from different levels and across different scales, in order to influence present and future system behaviour (*panarchy: top-down 'remember' interaction, and bottom-up equivalent, which facilitate reorganisation and renewal of the intermediate adaptive cycle*).

Thus far, this section has answered part of RQ4 about what patterns and processes of persistence and change can be discovered in EASES. Now I turn to the remaining part of RQ4 regarding what understanding of resilience dynamics is needed to help shape a successful social transition towards sustainability.

Transition or transformation?

Before proceeding, it is necessary to clarify what I mean by a transition rather than transformation towards sustainability. I use the term 'transition' to mean a change from one phase of system development and renewal to another. In terms of the adaptive cycle, this involves different combinations of transitions between the accumulation, conservation, release and reorganisation phases. Transitions mark distinct phases of change within a system regime (basin of attraction). However, disturbance can induce a critical transition. This is marked by a sudden directional change in system behaviour when a threshold is exceeded and an amplifying (positive) feedback propels the system towards a new attractor in a qualitatively different regime. The trajectory from one regime to another is referred to as a regime shift or transformation. From a SES perspective, the difference between a regime shift and a transformation is this: the term 'regime shift' refers to unintentionally crossing into an undesirable system regime, whereas 'transformation' refers to deliberately crossing into a desirable one. Sometimes, the term 'forced transformation' is used to denote an imposed shift and 'deliberate transformation' an actively initiated one (Folke *et al.* 2010). Either way, a transformation involves fundamental change in a SES.

Transition towards sustainability

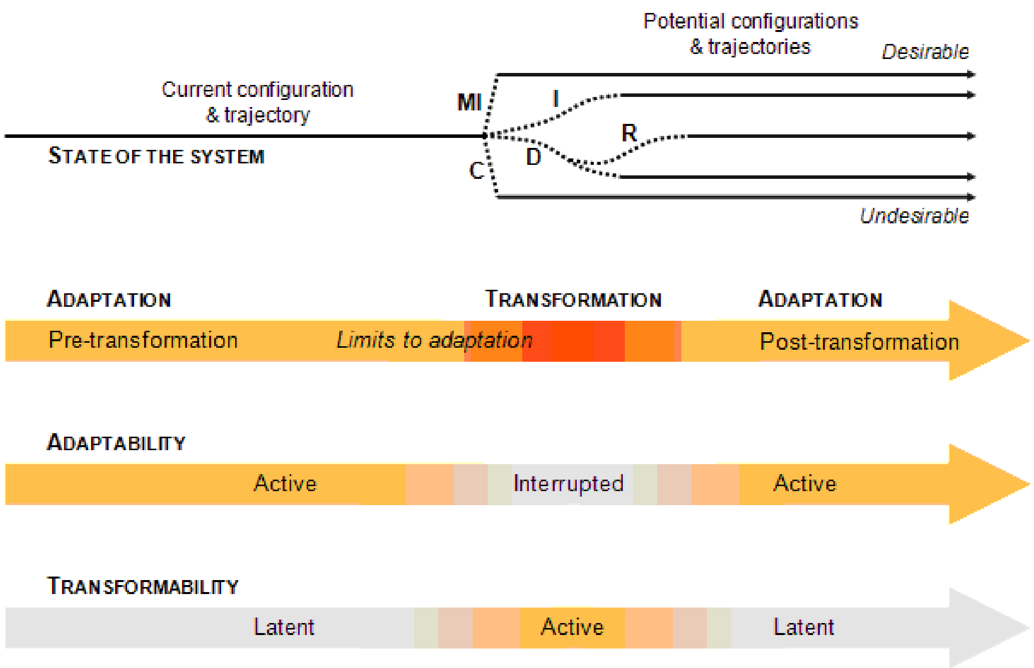
In *Our Common Journey* (NRC 1999a), the U.S. National Research Council described a transition towards sustainability as improving society's capacity to simultaneously 'meet the needs of a much larger but stabilizing human population, to sustain the life support systems of the planet, and to substantially reduce hunger and poverty' (p. 31). In resilience terms, society's capacity to successfully prepare for, initiate and steer SES dynamics along a trajectory of change towards a different regime depends on two essential aspects: adaptability and transformability. These are explained in detail in Chapter 3 (section 3.7). In short, adaptability (adaptive capacity) is actors' capacity for adaptation, that is, ability to make incremental adjustments to the system's configuration and behaviour. Transformability (transformative capacity) is actors' capacity for transformation, that is, to make a radical, often substantial change involving fundamental system reorganisation. Adaptation, adaptability, transformation and transformability are important components of society's collective ability and willingness to govern human–environment interactions and society–nature relations in SES.

It became apparent during the course of this research that in the SES and resilience literature adaptation and transformation are often treated as related but separate processes. It follows that adaptability and transformability are treated likewise. I believe such an excessive division or contrast is unnecessary and unhelpful. Therefore, I developed a hybrid adaptation–transformation framework for understanding SES dynamics regarding shaping a social transition towards sustainability.

Reconceptualised adaptation–transformation continuum

There are different perspectives concerning the conceptual divide between adaptation and transformation. As Löf (2010: 538) discusses, overlaps between adaptive and transformative mechanisms are confirmed in the literature, yet it is also apparent that adaptation and transformation are not mutually reinforcing. Löf suggests, therefore, there is valid reason for conceptually dividing adaptation from transformation, not least the need to accomplish each process using different policy strategies and tools. From the perspective of managing resilience, Engle (2011) argues that adaptability (adaptive capacity) influences potential SES outcomes (configurations and trajectories) by modulating between maintaining the status quo and fundamentally transforming it, depending on which is considered most desirable. In other words, adaptability is a fundamental property of humans and social systems that can determine both adaptation and transformation in a SES. Nevertheless, it remains unclear whether the capacities necessary to promote adaptation are the same as those that promote successful transformation (Nelson 2011). Löf (2010) sums up the situation: 'a deeper understanding of underlying mechanisms and potential trade-offs between adaptation and transformation is still lacking' (p. 530).[167]

Here, I propose an alternative to the dichotomous view of adaptation versus transformation. As already mentioned (section 3.7), patterns of adaptation may involve periods of radical transformational change as well as incremental adjustments. In the long-term view there is no cut-off point between adaptation and transformation, even though each represents a distinct category of process, action and outcome. Together they constitute a continuum. This is represented in Figure 7.1, which shows the temporal relationship between the state (configuration and behavioural trajectory) of a SES and its adaptive and transformative capacities (i.e. adaptability and transformability) before, during and after a transformation.



[167] Key challenges for research in this area concern the types or arrangements of adaptability that are necessary to prepare the system for transformation and renewal, and how these compare with those required for making incremental system adjustments (Nelson *et al.* 2007).

Figure 7.1 Temporal relationship between the state of a SES and its adaptive and transformative capacities before, during and after a transformation. The dotted lines in the figure represent different types of transformation: (M) maximal improvement, (I) improvement, (R) recovery to approximate pre-transformation state, (D) decline and (C) collapse.

In Figure 7.1, the potential for qualitatively different states of the system – varying between more and less desirable – to arise during the transformation depends on the context and character of the transformation, and the degrees of latent (activatable) and activated transformability. Adaptability resumes in the post-transformation period as the system continues to adapt and develop in a new, fundamentally different regime (basin of attraction).

Multiphase, multilevel transformation model

Transformations are often multiphase, multilevel processes that involve both incremental and abrupt changes (Olsson *et al.* 2006, 2010). The three-phase model represents a single transformation occurring over time at one particular scale or level; for example, the transformation in the governance of Chile's coastal marine resources as observed by Gelcich *et al.* (2010). This is shown in Figure 7.2; colour gradations represent a time lag leading into the preparation phase and overlaps between the three phases.

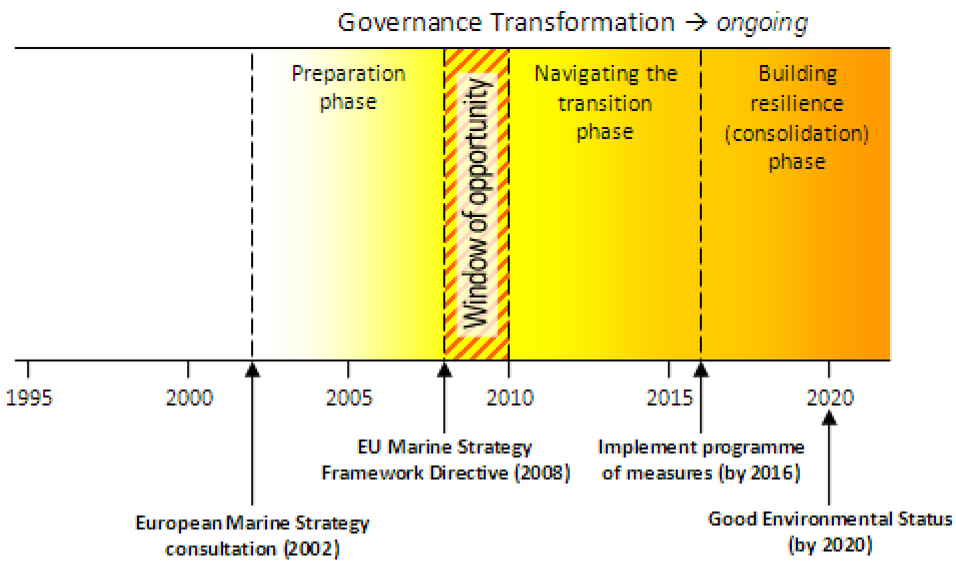


Figure 7.2 Three-phase model representing a transformation in governance. (Based on Gelcich *et al.* 2010: 16796, Fig. 2).

Using the EU Marine Strategy Framework Directive (MSFD) as an example, the model postulates that the preparation phase began with the first European Marine Strategy stakeholder conference in Køge, Denmark, 4-6 December 2002. The subsequent entry into force of the MSFD in July 2008 and two-year period for EU member states to transpose it into law provided the window of opportunity for initiating the transition phase. Navigating the transition is centred on the development – by member states using existing institutional structures, in particular the regional sea conventions – of regional marine strategies and implementation of programmes of measures by 2016 at the latest. The transition phase overlaps with the third phase: that of consolidating the transformation through building resilience of the new governance regime. Consolidation is centred on carrying out the measures, including those designed to achieve or maintain 'good environmental status' in Europe's marine environment by 2020 at the latest. The consolidation phase of the transformation is intended to be ongoing, with periodic reviews and revisions of the programmes of measures.

However, the perception of a transformation depends on the observer's spatiotemporal perspective and focus (Schoon *et al.* 2011). Therefore, it is conceivable that a transformation perceived to occur at the macro-regional focal level may in fact emerge from, or consist of, multiple transformations co-occurring in different subsystems at lower national, subnational regional and local levels (smaller, faster scales). Transformations at macro-regional and lower (embedded) levels may in turn trigger transformational changes at higher, encompassing supranational/EU and global system levels (larger, slower scales). Furthermore, transformational changes at higher levels can open up windows of opportunity for transformations (and adaptations) at lower levels. Meanwhile, the capacity to transform at one level will often draw on sources of resilience (e.g. social memory) from other levels and scales (Folke *et al.* 2010). This multilevel aspect of transformation is represented by the bottom-up 'revolt' and top-down 'remember' cross-scale interactions and cascade effects in the panarchy model (Gunderson and Holling 2002) of nested adaptive cycles. It follows that deliberate transformational change may be initiated at multiple levels of organisation, perhaps in a sequential and gradual way, so as to increase the likelihood of achieving a successful large-scale, long-term transformation towards sustainability (Folke *et al.* 2010).

For single transformations conforming to the three-phase model observed in case studies (Olsson *et al.* 2006, 2008; Gelcich *et al.* 2010) there may be significant overlap between phases (preparation, transition and consolidation) represented in Figure 7.2. When multiple transformational changes at different levels of organisation and spatial scale are considered over the long term, it is possible to construct a better picture of the type of multiphase pattern that may be involved in complex, multilevel social–ecological transformations, as represented in Figure 7.3.

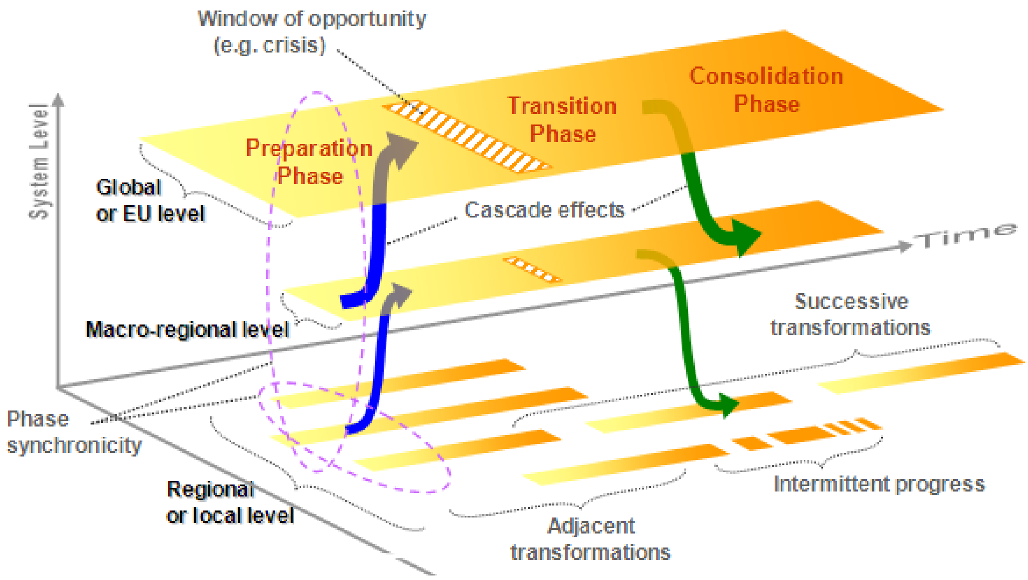


Figure 7.3 Model representing potential patterns of multiphase social–ecological transformations at multiple levels of organisation and spatial scale.

The model in Figure 7.3 was developed during the study of EASES to provide an explanation of the system's phase dynamics. As multiple transformations emerge and progress at different levels, relative arrangements may lead to synchronicity between phases (two dashed ovals highlight synchronicity between preparation phases both within a level and across levels). Synchronicity can facilitate cross-level and cross-scale cascade effects (green and blue arrows represent cascade effects) whereby transformational changes spread upscale or downscale through the dynamic hierarchical structure or panarchy.

Over time, different transformational changes may emerge, continue into the present or cease either gradually or abruptly. In each case, progress might be variously described as continual, intermittent, variable (accelerating or decelerating) or at times retrogressive. There may also be cascade effects in which transformational changes spread upscale or downscale, or both, giving rise to nested panarchical transformations. At each level, multiple transformational changes might progress in successive, adjacent or mixed arrangements. Depending on how such arrangements evolve, there may be a relatively high degree of synchronicity between transformation phases (and windows of opportunity) at different nested levels. This can facilitate positive or negative cascade effects. In the positive sense, for example, high synchronicity between preparations for transformation at local and subnational regional levels is likely to be beneficial. Likewise, synchronising supranational/EU and global level efforts to build resilience of an alternative regime increases the probability of success in consolidating a transformation or transition towards sustainability.

Finally, when viewed over the longer term of decades or centuries, larger-scale transformations consist of multiple sets of smaller-scale transformations that take (or have taken) place at different nested levels; all of which are embedded within a matrix of day-to-day, year-to-year adaptations. This transformational complexity needs to be reflected in the SES-based design and thinking of governance systems in general, and multilevel maritime governance systems in particular.

First of all, this section looked at patterns and processes of change in EASES. It then considered resilience dynamics of SES – specifically social capacities for adaptation and transformation – in order to better understand how shape a successful social transition towards sustainability can be shaped, thus answering RQ4.

7.7 Resilience management and strategies for building resilience in Atlantic Europe

The study of EASES identified sources of resilience and resilience dynamics that require management in the context of multilevel adaptive governance. This section discusses resilience management and the range of strategies and actions for managing resilience in EASES. It answers the fifth research question (RQ5): How can resilience in EASES be managed to reduce vulnerability to multiple hazards, increase capacity to tolerate and deal with change, and so achieve maritime regional sustainability?

7.7.1 Resilience management

The goal of resilience management is to ensure the focal SES (in this case EASES) either adapts to remain within a socially and ecologically desirable regime (basin of attraction) or transforms into such a regime or a combination of both (Walker *et al.* 2002, 2004). In other words, resilience management needs to ensure that managers and other key actors have sufficient (1) adaptability to actively prevent the system from being driven across thresholds into an undesirable regime, from which it is either difficult or practically impossible to recover (i.e. a 'trap'); and (2) transformability to actively guide a fundamental system transformation from a less desirable to a more desirable regime.

Management actions seek to preserve, nurture and control key SES properties essential to maintaining system functionality; properties that enable the system to variously adapt, transform, develop, renew and reorganise following major disturbance and disruption (Walker *et al.* 2002). This requires an understanding of how different aspects of resilience capacity interrelate in EASES (see section 3.3); what characteristics of EASES create or enable resilience (i.e. where sources of resilience reside); and how and when resilience can be diminished or lost and gained or increased (see sections 3.5 and 3.6 respectively).

The primary focus of resilience management is on deliberately maintaining and enhancing SES resilience over the long term. In some cases, however, managers may need to consider a deliberate reduction and loss of resilience, for example, to achieve fundamental system transformation to an alternative regime. Either way, resilience management involves strategies for fostering and manipulating the set of system characteristics that constitute sources of resilience (see section 7.5).

7.7.2 Potential strategies for building resilience in EASES

Overall, this research has identified a wide range of management strategies and actions with potential for enhancing and building social–ecological resilience in EASES (see Chapter 3, section 3.6). Below, I present three overlapping suites of largely complementary strategies for reducing vulnerability and increasing SES capacity for adaptation and transformation. Together, the strategies form a basis for developing a strategic and integrated stewardship approach to resilience management at the macro-regional level.

The set of strategies was originally suggested by the researcher (myself) in round two of the study of EASES. However, the low number of panellists (n=7) participating in the round has generally limited the usefulness of the responses. In other words, the strategies remain generalised rather than specific to EASES. Indeed, one panellist considered the set to be a “very good summary of the literature”, but stated how these strategies translate into EASES and corresponding practice “is the question though”. Clearly, this is an area for further research: one that would be suitable for an interdisciplinary or transdisciplinary project involving multiple stakeholders from Atlantic Europe.

Reducing vulnerability

Reducing exposure and sensitivity to disturbances adversely affecting EASES. Current and projected disturbances affecting EASES were identified during round one (Chapter 6, subsection 6.9.2). The overall disturbance regime includes multiple, overlapping and interacting anthropogenic and natural hazards ranging from shock events to sustained pressures. They may originate exogenously or endogenously and vary in frequency, magnitude and severity across EASES and over time. Examples of strategies to reduce either specified vulnerabilities or general system-wide vulnerability include:

> *Vulnerability assessment.* Identifying and assessing crucial vulnerabilities, causal processes, sensitivities to recent changes, thresholds of harm, risks and mitigation options.

> *Mitigation.* Reducing exposure by avoiding, eliminating or minimising known and novel hazards; or minimising, alleviating or compensating for their impacts.

Institution building. Developing institutional capacity and preparedness as well as (new) formal and informal institutions that minimise exogenous and endogenous hazards and their impacts.

Trajectory management. Planning and managing in the context of projected changes rather than in the historical range of variability.

Reducing sensitivity. Minimising the degree to which EASES or a particular component is responsive to or adversely affected by the magnitude and rate of change associated with a hazard.

Enhancing adaptability

Fostering the adaptability (adaptive capacity) of actors is a central approach to both reducing vulnerability and enhancing resilience in EASES (Chapin *et al.* 2009b). Rather than merely reacting to observed changes, enhancing adaptability for resilience involves proactive policies, strategies, planning and management practices to prepare for, cope with and shape change (Berkes 2007; Chapin *et al.* 2010). Examples of strategies to enhance adaptability for resilience in EASES at macro-regional and lower (national, subnational regional and local) levels include:

Fostering diversity. Conserving, nurturing and diversifying sources and different types of diversity in EASES, which increases the number and variety of latent or available building blocks, and the range of options for coping with, adjusting to and shaping change.

Fostering a mix of stabilising feedbacks and creative renewal. Managing the dynamic interplay between feedbacks that sustain fundamental system properties (including natural and social capital) of EASES and the disturbances that enable vital adaptations and create opportunities for reorganisation and renewal (involving experimentation and innovation) leading to development along a desirable trajectory.

Learning to live with change and uncertainty (Folke *et al.* 2003). Fostering social learning through manageable experimentation and innovation in order to build adaptive capacity of EASES and facilitate adaptation under conditions of rapid, directional and often unexpected social–ecological change. As one panellist pointed out, this strategy is particularly “relevant to problems faced at coasts such as rising sea levels, flooding and storminess.”

Deliberative democracy approach. One panellist suggested the high learning element is important for building capacity of decision makers and engaging society in building solutions regarding EASES.

Adapting institutions and governance to changing conditions. Adapting existing multilevel institutional frameworks and governance systems to deal with accelerating environmental, social and technological changes across local, regional and global scales. In other words, institutions (including regulatory structures and policy frameworks) urgently need to become more relevant, flexible, responsive and proactively involved in delivering adaptation and transformation in response to regional and global change. To do that, institutions must address critical challenges, including complex social–ecological dynamics, persistent and irreducible uncertainty, heightened vulnerability, demands for equity and path dependency (constraints imposed by past decisions). Institutions must also address the opportunities that institutional adaptation brings in terms of achieving multiple social benefits. While leadership and capacity building are key prerequisites for dealing with these challenges and opportunities, institutions also need to consider how to frame, incorporate learning and implement their approaches to adaptation. Furthermore, core institutional cultures must change if adaptive institutions are to succeed in responding to change.

Institutional transformation or restructuring. Fundamental reorganisation and structural change of institutions and governance systems in order to move towards greater flexibility in problem solving, innovation in developing solutions, capacity for learning and responsiveness to feedback. In other words, purposefully transforming the governance system to a new adaptive governance regime with sufficient adaptive capacity to address social–ecological dynamics at the macro-regional level.

Science–policy interface. Greater engagement between science and policy in general (as suggested by one panellist). Managing the construction and communication of usable knowledge across the science–policy interface in relation to EASES.

Public engagement. Fostering and embedding both participative and deliberative forms of public engagement in planning and decision making processes (particularly those concerning policy areas where adaptation is actually implemented). Governance practices with higher levels of deliberative public engagement (i.e. involvement, collaboration and empowerment or self-determination) can enhance both organisational and social learning for change (Petts 2006). Deliberation and negotiation during early stages of decision-making processes can help frame issues relevant to adaptation as well as gather public, civil society and private sector concerns and views to inform decision making. One panellist suggested emphasising the role of trust and its value for social capital and in building long-term compliance with environmental regulations, for example. Another panellist commented that, in terms of building collective action in EASES, "the approach of negotiating and defining shared futures seems highly relevant."

Equity. Addressing issues of equity and fairness, including managing the potential tensions and cross-sectoral trade-offs between equity and efficiency. Equity concerns not only the costs and benefits ('winners and losers') of adaptation decisions, but also the ways in which adaptation policies and decisions are made (Adger 2003). In the opinion of one panellist, equity should be prioritised "in order to gain understanding and acceptance by affected stakeholders and in the public".

Local context of successful adaptation. Local actors and institutions closest to the problem generally have first-hand experience of changes. They often possess key knowledge of how to meet the challenges of adaptation, as well as the competence and determination to drive effective local adaptation.

> *Fostering adaptive management and governance*. Different modes of multilevel governance (e.g. adaptive management, adaptive co-management, ecosystem-based management, integrated resource management, transition management, collaborative governance, interactive governance, adaptive governance, reflexive governance, and polycentric governance) that are designed to enhance adaptive capacity, build resilience and create adaptability and transformability in EASES and other complex maritime macro-regional SES.

One panellist stated that they would prioritise the following strategies for reducing vulnerability and enhancing adaptability:

> "vulnerability assessment, mitigation, institution building, trajectory management (these ones because I see them as rather concrete and practical); fostering diversity, adapting institutions and governance, fostering adaptive management and governance (these ones because I see them as overarching and allowing for integration)."

Enhancing transformability

Fostering the transformability of actors to make forward-looking decisions and introduce radical changes (transformations) to structures and processes in EASES in order to create a fundamentally new system regime. That is, the collective capacity to create a more desirable system configuration and potentially more beneficial trajectory of EASES that sustains and enhances essential ecosystem services, social development and human well-being. In the face of global change and uncertainty, there is increasing emphasis on promoting positive (intentional rather than forced) transformations in SES (or transitions in sociotechnical systems) rather than simply relying on adaptation to the current situation. According to Olsson *et al.* (2006), such transformations include shifts in social characteristics such as perception and meaning, network configurations, social coordination and associated institutional arrangements and organisational structures. Transformations also include redirecting governance into restoring, sustaining and developing the capacity of ecosystems to generate essential services.

Fundamental and far-reaching social–ecological transformations are needed to overcome the scale mismatch between ecosystems and governance systems; evade or escape from rigidity, poverty and other traps; avoid potential critical thresholds (‘planetary boundaries’) in the Earth System; and open up new trajectories of sustainability (Olsson *et al.* 2010). This requires transformational changes in governance as well as positive social transitions and ecological regime shifts.

There is an emerging suite of collective action approaches that increase the likelihood of successful transformation in the governance and management of SES (Chapin *et al.* 2010). The following strategies are based largely on work by members of the Resilience Alliance (Olsson *et al.* 2006, 2010; Folke *et al.* 2009; Chapin *et al.* 2009b; Gelcich *et al.* 2010), which suggests that transformations in SES generally occur in three phases: preparation, transition and consolidation. Examples of proactive strategies to enhance transformability, initiate transformational changes and guide steps toward successfully navigating transformations in EASES at macro-regional and lower (national, subnational regional and local) levels include:

> *Preparing for transformation*. The first phase involves preparing actors and EASES for potential transformational changes by engaging stakeholders in recognising system dysfunctionality; developing new knowledge regarding opportunities for transformations; identifying multiple possible futures (attractors) and considering their desirability compared to the current system regime; reframing perspectives and defining a collective vision of a new, more desirable regime and a potential pathway towards it; raising awareness and building social capital in readiness for change; and dealing with constraints and obstacles to transformation.

> *Navigating the transition*. Actively navigating transformations (in stages) through periods of turbulence and uncertainty (Olsson *et al.* 2006), in a collaborative and adaptive way, by exploiting windows of opportunity such as shocks, crises, social or policy innovations, and changes in governance. This requires social learning concerning the role and value of disturbance in

creating windows of opportunity (the release phase in the adaptive cycle) during which deliberate human interventions and manipulations can influence how EASES or a particular subsystem is reconfigured and renewed (the reorganisation phase). The extent to which actors in EASES make use of such a window of opportunity depends on adaptability and transformability: the capacities to adjust responses to, respectively, either avoid or succeed in crossing critical thresholds. Furthermore, initiating and navigating a deliberate transformation may require breaking down resilience of the old regime as well as building resilience of the new regime (Folke *et al.* 2010).

Building resilience of the new regime. As the social–ecological transformation towards sustainability unfolds, it is essential to foster resilience and adaptability (see above) of the new regime in order to stabilise and consolidate it. This should be an ongoing task (Gelcich *et al.* 2010). According to Chapin *et al.* (2009b: 331), building resilience in new conditions can be strengthened by actions that build trust, identify social values among actors of the new regime, and empower key stakeholders to participate in decisions that legitimise relationships and interactions of the new regime. Furthermore, resilience in EASES can be enhanced by eliminating barriers to cooperation among actors and broadly communicating a vision of the opportunities provided by the transformed regime.

In addition, concerning the set of strategies in common, one panellist commented that the "pre-conditions of success lie in raising capabilities of institutions to practise some of these approaches". Therefore, institutional capacity building in EASES is essential. In this respect, the CPMR's AAC is a key cross-scale institution, given that it represents the transnational governance of the Atlantic Europe macro-region, is composed of subnational regions, and links these levels with EU institutions, programmes and policy domains (ESPON 2013c).

Furthermore, the same panellist stated that "Creating arenas for place-based strategy generation is crucial for linking change in [EASES] with the scale of actions undertaken by relevant institutions" and for implementing an ecosystem-based approach in coastal and marine areas; coastal partnerships have, with limited success, demonstrated this in the coastal zone. As an established macro-regional governance arrangement, the AAC appears to be such an arena. The AAC provides a mechanism for a large number of stakeholders from member regions or potential member regions to work closely together on maritime or other development issues (ESPON 2013c: 20).

Another panellist considered that strategies for managing resilience in EASES ought to implement a combined mitigation and adaptation approach; this ought to be underpinned by equity as a guiding principle for dealing with conflicts and trade-offs between different sectoral interests. The panellist added that many of the suggested strategies are indicative of what needs to be done to adapt and transform institutions and governance by the relevant institutions themselves.

This section briefly discussed resilience management in general and potential strategies for managing resilience in EASES in particular, thus answering RQ5. Next, I address the design of SES-based governance architecture.

7.8 Design guidelines for SES-based governance architecture

EU policy makers face challenges of how to design, develop and implement an effective multilevel system of maritime (integrated ocean and coastal) governance. In this thesis, I have argued that the design of governance architecture for maritime regional sustainability in Atlantic Europe should be informed by the theory of complex adaptive SES (see Chapter 2), including resilience theory (see Chapter 3). In other words, SES-based multilevel adaptive governance architecture is necessary for the EU Integrated Maritime Policy (IMP) to meet the challenges of global change, sustainable development and a successful transition towards sustainability in the maritime dimension (see Chapter 4).

In Kooiman’s interactive governance framework, governance is essentially a relationship between two systems. Governance occurs through governance interactions (institutions and processes) between the governing system (institutions and steering mechanisms) and the system-to-be-governed (a SES)

(Jentoft 2007; Kooiman 2008; Kooiman *et al.* 2008). This perspective emphasises multi-actor, multilevel interactions at the heart of the governance system. The conceptualisation of EASES in Chapter 6 provided insight into the Atlantic Europe maritime macro-region or system-to-be-governed. The emerging EU governing system for maritime affairs is briefly described in Chapter 4 (section 4.5). The analysis of EASES in sections 7.4 to 7.7 above provides insight into various governance interactions and factors that influence them, which in turn provides the basis for some general design guidelines for SES-based multilevel adaptive governance architecture outlined below. These guidelines were developed for a specific case: governance architecture for maritime regional sustainability in Atlantic Europe. But they also have potential application to other European maritime macro-regions. Therefore, this section answers the sixth research question (RQ6): What are the necessary design elements for a SES-based architecture for integrated maritime governance for maritime regional sustainability in Atlantic Europe?

Foundation for design

In the context of maritime sustainability, governance requires architectures that are context based, visionary, integrative, function oriented and experimentalist. I have already elaborated on these five basic aspects in Chapter 4 (section 4.4). As mentioned previously, the design of architecture for sustainability governance does not begin with a blank slate. An already complex governance landscape simultaneously constitutes a constraining and enabling environment. Existing conditions are constraints on the emergence and development of new forms of sustainability governance, whereas the current governance landscape also provides an enabling environment for innovation. Furthermore, there is no blueprint for the design of architecture for sustainability governance; efforts to apply universal solutions to the governance of human–environment interactions and society–nature relations are seldom effective, often fail and may even be counterproductive.

The design of governance architecture must consider the whole governance system including its contextual boundaries and boundary conditions; diverse components (agents, institutions and processes); complex structures (relationships and arrangements); and dynamic interactions across scales and levels. Design, of course, requires a foundation and for this I selected the interactive governance approach (Kooiman *et al.* 2005, 2008; Kooiman and Bavinck 2013). It is a theoretical perspective that takes into account the diversity, complexity, dynamics and scale of governance systems. In this view, the processes of governing a social system, sociopolitical system or SES occur mainly through interactions between multiple actors at multiple levels of organisation. Therefore, governance is the totality of the governing interactions taken to solve social problems and create social opportunities (Kooiman *et al.* 2008). Interactive governance architecture is based on the integral relationship between three analytical components previously mentioned, that is, the system-to-be-governed, governing system and governance interactions between them. Governance is conceptually divided into three main categories of attributes: elements, modes and orders of governance, to which I have added a fourth: governance functions (see section 4.4).

Considerations from the study

The design of multilevel governance architecture for maritime regional sustainability in Atlantic Europe is supported to some extent by observations gleaned from the study of EASES.

Regarding the contextual boundaries of territorial governance, panellists had contrasting views on whether the northern and southern aspects of EASES differ enough to justify two different approaches to governance within the Atlantic Europe macro-region. One panellist considered that a geographical divide between a northern and a southern subregion would not be an optimal solution: "To have a joint region at larger spatial scale seems to bring advantages of integration, coordination and multi-scale governance." Conversely, another panellist considered the environmental differences between the two areas significant enough to justify the redefinition of EASES into southern and northern governance systems: "However, I am aware that practical resource constraints could prevent this from being a workable model for governance solutions". A different panellist focused on the regional seas aspect and suggested that, spatially, governance should follow the MSFD subregions (i.e. Celtic Seas, and Bay of Biscay and Iberian Coast). This should take into consideration the significant difference between the northern and southern sea areas, and their corresponding coastal zones.

In order to accommodate potential north–south compartmentalisation (rather than fragmentation) of governance architecture within EASES, one panellist stated:

> "The basic idea of multi-scale governance (as part of adaptive management and adaptive governance approaches) should be enough to deal with all differences, departmentalisation and sectoralisation problems that come up."

Another panellist suggested that, based on experience in cooperation mechanisms from Northern Europe (e.g. the Dutch-German-Danish Trilateral Wadden Sea Cooperation), multilevel governance should focus on cross-border collaboration of subregional systems; for example, the Bay of Biscay could be dealt with bilaterally between Spain and France. A third panellist considered relevant EU policy instruments, particularly the MSFD, to be important enabling conditions for regional multilevel governance, "which may help bridge north-south gaps." A different panellist stated that they assumed the AAC "has put in train efforts which would be difficult to revise" regarding macro-regional governance initiatives.

One panellist considered it essential to identify which governance structures and processes in EASES are available or necessary to strengthen diversity, social capital, social memory, social learning and other sources of resilience. Another panellist stated that governance systems need to be able to generate adaptive and reflexive processes of decision making and implementation "as these are an important source of resilience too."

One panellist suggested a territorial governance architecture based on the Type II multilevel spatial governance model (Hooghe and Marks 2003) applied to a patchwork of overlapping jurisdictions and centred on particular policy problems. Type I refers to the original spatial governance concept with non-intersecting general purpose territorial jurisdictions arranged hierarchically, while Type II views governance as a complex, fluid patchwork of numerous overlapping jurisdictions. Type I governance is designed around a human (usually territorial) community while Type II is designed around particular governance tasks or policy problems. In the particular case of a multiscale system with fuzzy boundaries such as EASES, the panellist believed that the Type II model addressed the notion of cross-scale matching of geographical structures (e.g. biogeographic regions) with territorial management through spatial planning and institutional arrangements.

In general, panellists considered a multilevel governance architecture is required to address the system complexity of EASES; and to account for the cross-scale dynamics of governance interactions between international, supranational (EU), national (member state), subnational regional and local (community) levels and institutions. One panellist stated "this type of governance is both internal and external to your system". Another panellist considered "the web of institutional linkages among the different levels involved is very important." A third panellist cautioned that "Overarching governance at the EU and international level is still required to review, coordinate, and implement marine nature conservation."

In another design-related comment, one panellist stated that "The scale of the problem should dictate the scale of the governance – a simple concept but often overlooked."

Overall, this research indicates that critical capital must be maintained in order to retain options for future social and economic development of EASES. Resilience capacity must be maintained to ensure that EASES can continue to deal with various, generally unpredictable, biophysical and anthropogenic disturbances, shocks and crises. This may involve adaptive processes of governance aimed at maintaining EASES within critical threshold levels and on its current development trajectory; or it may involve transformative processes aimed at deliberately shifting EASES across thresholds (or otherwise influencing the positions of thresholds) between alternative regimes so as to achieve a new development trajectory. Given the real world complexity of the Atlantic Europe macro-region, the challenge of developing an effective framework for integrated maritime governance requires an improved understanding of the resilience capacity of maritime SES in general and EASES in particular. It also requires an improved understanding of how cross-scale governance interactions between different levels of the governing system influence the system-to-be governed at the macro-regional focal level, that is, EASES.

Design guidelines

In the following paragraphs, I propose some general design guidelines for governance architecture founded on the five basic aspects and the interactive governance framework identified above. I purposefully use the term ‘guidelines’ rather than ‘principles’ because they are intended to inform and guide further development of EU maritime governance thinking. The term ‘design principle’ implies a fundamental condition or inflexible rule governing procedure, which is antithetical to notions of complex adaptive SES governance. Developing these guidelines further, including into a set of detailed design principles, is beyond the scope of this thesis.

The design of governance architecture for maritime regional sustainability in Atlantic Europe should be guided by:

1. A complex systems approach that uses concepts and other components of complex adaptive SES theory (see Chapter 2) to inform our understanding of the whole interactive governance system: the system-to-be-governed, governing system and governance interactions.

2. The conceptualisation of a SES at the focal level of interest (in this case, EASES at the macro-regional level) to inform our (i.e. governance actors’) understanding of the system-to-be-governed. This unit of analysis is used to identify key (1) boundaries and boundary conditions and the social and ecological components, structures and functions of EASES; (2) multilevel hierarchical structure and cross-scale interactions between EASES and higher and lower levels; and (3) human activities, disturbances and the resulting changes in EASES.

3. A resilience framework (see Chapter 3) for the analysis of not only the system-to-be-governed, but also the governing system and governance interactions. The framework is used for the analysis of the EASES in terms of capacities to perform different functions, including absorb or resist change, reorganise and renew following disturbance, adapt and develop, and promote and steer a transformation. It is also used to identify sources of resilience of EASES such as redundancy, diversity, novelty, social capital, social memory and social learning (see section 7.5). Modularity has implications for the design of a resilient governing system. Bridging organisations have a direct bearing on governance interactions. A resilience framework is also used to interpret social–ecological dynamics: patterns of relationships and cross-scale interactions between multiple levels of organisation (see section 7.6). Furthermore, a resilience framework guides elements of governance including visions, strategies and other instruments, and actions, all of which guide resilience management (see section 7.7).

This section combined insights from previous sections and chapters to present general design elements and some guidelines for SES-based architecture for integrated governance for maritime regional sustainability in Atlantic Europe, thus answering RQ6.

7.9 Summary and conclusions

This chapter synthesised insights gained from Chapters 2 to 4 and 6 in order to answer research questions (RQ) 2 to 6. It outlined complex adaptive SES theory as the basis of the conceptual framework, and the accompanying concept of resilience as the analytical lens for understanding SES. The chapter then considered EASES as the unit of analysis, which partly answered RQ2. This was followed by three sections that dealt with the analysis of EASES, which answered the remainder of RQ2. The first of these described key sources of resilience in EASES (answering RQ3). The second analysed resilience dynamics in EASES and considered how these relate to a transition towards sustainability (answering RQ4). The third looked at resilience management and identified strategies for managing resilience in EASES (answering RQ5). Following that, the chapter presented some general design guidelines for SES-based governance architecture, which answered RQ6.

Linking the concepts

The SES concept has important implications for Europe's relationship with the oceans and seas, especially with regard to the following issues:

- Sustainability of peripheral maritime regions of Europe.
- Development and implementation of integrated maritime governance and sea basin strategies for enhanced macro-regional level cooperation towards sustainable development of Europe's maritime sectors and coastal regions.
- Achievement of EU political objectives regarding sustainable economic growth and employment in Europe's maritime economy.

This thesis used analysis of a maritime macro-regional SES, conceptualised as EASES, to gain insight into how a complex adaptive SES perspective and the concept of SES resilience can inform the design of multilevel adaptive governance architecture. That is, governance architecture for maritime regional sustainability in Atlantic Europe in particular, and European maritime macro-regions and sea basins in general. Such SES-based governance architecture is necessary for the EU IMP to successfully address the challenges of global social–ecological change and sustainable development. In summary, the conceptualisation of EASES in Chapter 6 provides a way of looking at multilevel adaptive governance architecture for maritime regional sustainability through the lenses of complex adaptive SES theory (see Chapter 2) and SES resilience (see Chapter 3), which together constitute a single conceptual framework. This answers the first research question (RQ1): How can the concepts of maritime regional sustainability, sustainable development, SES resilience and multilevel adaptive governance be united in a single conceptual framework?

Revisiting the research problem

At EU level, policy makers must reconcile the aim of achieving sustainable economic growth and employment in the maritime economy with EU commitments to promote sustainable development and strengthen cohesion between Europe's regions and member states. This involves changing the way in which sea-related policy is made and decisions are taken. However, traditional forms of maritime governance have struggled to deal with the unprecedented global changes, complexity of interactions and pervasive uncertainties that challenge a transition towards marine and coastal sustainability in Europe's maritime macro-regions. Thus, new forms of governance are needed. This thesis argues that SES-based governance architecture is necessary.

My conclusion is that to achieve maritime regional sustainability actors at every level in maritime governance need to understand SES dynamics; they must work with rather than against fundamental characteristics of CAS including agents and interconnectedness, openness and fuzzy boundaries, nonlinearity, feedbacks, path dependence, self-organisation, emergent properties, scale and hierarchy, cross-scale linkages, adaptation, co-evolution and resilience (see Chapter 2). Many difficulties facing maritime governance result from a failure to understand and deal with such characteristics. Therefore, achieving effective maritime governance requires a paradigm shift towards CAS thinking.

Macro-regional level of governance

As outlined in Chapter 6 (section 6.5), actor networks such as the AAC perceive the need for a macro-regional level of competence to represent a coherent Atlantic Area territory, polity and social ecology within the EU multilevel governance system. At the time of writing, no formal governance arrangement yet exists that includes the Atlantic Europe macro-region in the multilevel system.

Regarding spatial aspects of governance, a correlation is apparent between the systems of multilevel governance envisaged in both the IMP and EU policy towards territorial cohesion (European Commission 2007c, 2008a; EU Presidency 2011). Both policy streams recognise the key functional and structural roles that the macro-regional level has in relation to the sustainable development of Europe's territory, but from different standpoints. Cohesion policy looks to assemblages of coastal regions and their inland maritime attributes, whereas the

IMP looks to coastal regions and their seaward attributes over extensive maritime spaces (including the marine regions and subregions designated under the MSFD).

In the case of the Atlantic Europe macro-region, I conclude that the integrative concept of EASES (a maritime SES encompassing Europe's Atlantic seaboard and adjacent ocean space) bridges these landward and seaward policy perspectives. EASES provides a macro-regional model with which to plug the land–sea governance gap. In this sense, EASES is relevant to ongoing efforts by stakeholders to explore some form of multilevel governance system that includes the Atlantic Europe macro-region under both EU cohesion policy and maritime policy objectives. In other words, a multilevel governance system that serves the objectives of the Atlantic Area 2014-2020 transnational programme[168] under EU cohesion policy and the Maritime Strategy for the Atlantic Ocean Area (European Commission 2011a, 2013b) under the IMP – both in the context of the Europe 2020 strategy for the 'smart, sustainable and inclusive growth' of the European economy (European Commission 2010b).

Theoretical and policy implications

The development of a European multilevel governance system for maritime affairs is fraught with difficulty, not least of which is the knowledge gap identified in Chapter 1 (section 1.2). That is, the gap between what is known about governance for sustainability in Europe's maritime macro-regions and what is known about CAS theory regarding SES. This has resulted in a significant disconnect between the EU's emerging maritime macro-regional and sea basin strategies, including the Atlantic Strategy, and a sound theoretical basis for them. The research undertaken for this thesis goes some way towards filling the knowledge gap.

To date, very little attention has been paid to integrated marine and coastal SES as opposed to individual marine or coastal SES. This is particularly so at the macro-regional level. The macro-regional approach to maritime and regional development is a rapidly emerging area of applied interest for researchers. But it

[168] http://www.coop-atlantico.com/

currently lacks a strong conceptual framework to guide the conceptualisation and analysis of maritime macro-regional SES with the aim of achieving more effective governance. Therefore, there is need for a coherent, integrative and interdisciplinary or transdisciplinary conceptual framework that rests on a sound theoretical basis. This research provides a conceptual framework that applies CAS theory and a SES approach, including a resilience perspective, to the conceptualisation and analysis of a maritime macro-region: in this case, the Atlantic Europe macro-region represented by EASES.

This research not only contributes a conceptual framework for understanding maritime macro-regions, but also contributes to an improved understanding of potential SES-based governance architecture. Implementation of the IMP, including the EU's Blue Growth strategy (economic pillar) and MSFD (environmental pillar), is already well advanced. The stakeholder-inclusive analysis and allocation of spatial and temporal distributions of maritime activities to achieve a balance of social, economic and ecological sustainable development objectives has begun to be facilitated by the MSP Directive (EU 2014a). The issue of decentralised regional governance continues to emerge (for fisheries) as a result of the 2013 CFP reform. Taken together, the development of a multilevel system of European maritime governance continues to progress. However, the EU has forged ahead in the absence of a strong theoretical foundation. This research provides some theoretical justification for the approach adopted by the EU towards maritime policy and governance. At the same time, a SES approach has yet to be adopted by actors engaged in maritime governance. Therefore, this thesis offers some general design guidelines for use in developing SES-based multilevel governance architecture for achieving maritime regional sustainability in Atlantic Europe and potentially other European macro-regions.

This SES-based approach could have significant implications for the evolving European maritime policy landscape. For example, the IMP is an umbrella framework that must strive, through multilevel governance, to integrate the socioeconomic pillar (represented by the Blue Growth strategy) with the environmental pillar (represented by the MSFD). A SES approach provides a strong rationale. But more than that, the IMP must integrate and coordinate

European maritime affairs with fisheries policy, that is, the reformed CFP. At present, the European Commission is moving towards further coordination between maritime affairs/fisheries and environmental protection by placing, for the first time, both policy areas under the joint political responsibility of a single European Commissioner, Karmenu Vella (2014-2019).[169] It is hoped (not least by environmental NGOs) that this EU-level co-management is the beginning of a truly integrated approach to policy making for sustainable maritime development. Despite the sidelining of ICZM, the MSP Directive nevertheless provides a policy instrument for spatial planning in the marine dimension. A suitable mechanism has still to be developed for integrating MSP with terrestrial spatial planning (Gazzola *et al.* 2015). Again, an SES-based perspective could underpin integration of spatial planning and territorial development across the land-sea 'divide'. It would appear that the nascent Atlantic Strategy and other EU sea basin macro-regional strategies offer a window of opportunity to develop, through adaptive experimentation, and implement an integrated spatial planning approach and multilevel governance architecture for maritime regional sustainability in Atlantic Europe and other macro-regions.

Arising from the convergent requirements of the EU territorial agenda and IMP, there is the prospect of creating and developing an integrated governance approach to European maritime affairs; one which spans the land-coast-ocean continuum and largely transcends the straitjacket of established jurisdictional and administrative boundaries. Regarding the Atlantic Area, many necessary institutional elements of governance already exist, particularly in the institutional form of the AAC. My conclusion is that if the complex adaptive SES characteristics of the Atlantic Europe maritime macro-region are adequately reflected in new institutional arrangements, then the macro-regional level will be a vital feature in a new maritime governance system for Europe.

Some of the findings of this research have general applicability to other maritime macro-regions in Europe. But the majority of findings are not generalisable to other situations or macro-regions because they are highly context specific.

[169] http://ec.europa.eu/commission/2014-2019/vella_en

Overall, this research adds to the existing body of knowledge in the field of social–ecological research for sustainability; more specifically, sustainability of the maritime dimension in the European context.

Chapter 8
Conclusion and outlook

> 'Sustainability [is] a process rather than an end-point'
>
> — Louis Lebel (2002: 7)

This chapter summarises the main themes and issues, reflects on the methodology and other aspects of the research, and makes suggestions for future research.

8.1 Main themes and issues

This thesis integrates complex adaptive systems (CAS) theory and a social–ecological systems (SES) approach (Chapter 2) with resilience thinking (Chapter 3) into a conceptual framework. The framework provides a robust foundation for the conceptualisation of a unit of analysis: the European Atlantic SES (EASES) (Chapter 6). This thesis also describes the context of the research problem and justification of the study of EASES (Chapter 4), and the research framework for addressing the research problem (Chapter 5). Insights drawn from Chapters 2 to 4 and 6 are used to link concepts, answer the research questions and arrive at a number of conclusions (Chapter 7).

A gap exists between what is known about governance for sustainability in Europe's maritime macro-regions in general, and the Atlantic Europe macro-region in particular, and what is known about CAS theory regarding SES. In other words, there is an apparent disconnect between the EU's emerging maritime macro-regional sustainable development strategies, including the Atlantic Strategy, and a sound theoretical basis for them. This thesis contributes to closing this knowledge gap.

I contend that the design of maritime or integrated ocean and coastal governance in the EU should be informed by the theory of complex adaptive SES (Chapter 2). SES-based governance architecture is necessary if the EU is to successfully meet the challenges of achieving sustainability in the maritime dimension (Chapter 4). I use the concept of SES resilience (Chapter 3) as a lens for analysis of the Atlantic Europe maritime macro-region (Chapter 7). The main aim of this research was to gain insight into a multilevel adaptive governance architecture that combines notions of sustainability and sustainable development in the context of European maritime macro-regions and sea basins in general, and Atlantic Europe in particular. The central research question asked whether it is possible to achieve this insight by using a maritime SES as a conceptual framework and analytical tool to relate governance to sustainability. To address this question, a study was undertaken to conceptualise EASES (Chapter 6) as both unit of analysis to represent and analytical tool to understand the Atlantic Europe macro-region. EASES provides a framework for relating governance architecture to maritime regional sustainability in Atlantic Europe (Chapter 7).

In Chapter 1 (section 1.2), I proposed that governance can be focused on building SES resilience to help achieve sustainability in the Atlantic Europe macro-region. The study of EASES and subsequent analysis leads me to conclude the following: Europe's seas and coastal regions comprise a number of identifiable maritime SES, including at macro-regional level (Proposition 1). In terms of a complex systems hierarchy and social–ecological dynamics, the macro-regional level of organisation is a key focal level regarding developing and implementing a multilevel adaptive governance framework for achieving maritime regional sustainability and sustainable development (Proposition 2). The related SES properties of resilience, adaptability and transformability determine the possible sustainable development trajectories and future identities of maritime SES (Proposition 3). A maritime SES that encompasses Europe's Atlantic seaboard and adjacent ocean space is conceivable: EASES is commensurate with the Atlantic Europe macro-region (the Atlantic Area in EU parlance) (Proposition 4). EASES has an identity in relation to various geographic, biogeographic, socioeconomic, political and institutional scales (Proposition 5). EASES is an appropriate unit of analysis with which to explore the concepts of SES resilience and governance architecture in relation to maritime regional sustainability (Proposition 6).

In summary, the five main themes addressed in this thesis are: (1) complex adaptive SES theory, (2) the multifaceted concept of SES resilience and (3) SES-based governance architecture, which are needed for shaping (4) a transition towards sustainability using insight based on analysis of (5) a maritime SES conceptualised to represent the Atlantic Europe macro-region.

The remainder of this chapter is organised as follows. Section 8.2 reflects on the research approach, conceptual framework, research design and strategy, methods and conceptualisation of EASES. Section 8.3 discusses methodological issues including bias, data quality, ethical considerations and reliability, validity and generalisability. Section 8.4 explains the limitations of the study. Section 8.5 summarises the overall contribution of the research. The chapter ends with some recommendations for future research (section 8.6).

8.2 Reflections

Research approach

There is growing recognition that the pursuit of sustainability requires new and more effective approaches to generating and applying science, technology and learning to solving complex, persistent problems of unsustainability. This thesis adopted a SES approach to sustainability research. It addressed society–nature relations through a framework based on social ecology and sustainability science, while incorporating CAS and resilience thinking (Chapter 5). Together, social ecology and sustainability science provided a philosophical and theoretical foundation: a logical structure for the integration of complementary components of different theories relevant to SES research. Overall, the SES approach to sustainability research provided a sound basis for guiding this research.

Conceptual framework

Investigating complex society–nature relations and interactions requires a conceptual framework to help organise and integrate different types of knowledge and reconcile different theoretical and analytical perspectives. However, integration of social and ecological knowledge is impeded by the lack of coherent, truly integrated and interdisciplinary (or transdisciplinary) frameworks to guide the conceptualisation of research concerning SES (Glaeser et al 2009: 183-188). This research required a conceptual framework to (1) accommodate concepts derived from different disciplines and perspectives; (2) allow relevant concepts and their (assumed) relationships to be identified, gathered and organised; and (3) provide a general, abstract explanation of key concepts and their relationships, which in turn served as the theoretical basis and justification for the conceptualisation and analysis of EASES (Chapters 6 and 7 respectively).

The conceptual framework developed during this research was not intended to be fully comprehensive or universally applicable. A balance was struck between general and specific applicability. The framework adequately linked the abstract theoretical level to the concrete and specific analytical level. It provided a coherent structure for relating, organising and synthesising a diversity of assumptions, concepts, models and other components of theory used to explain the things being studied. As mentioned above, the conceptual framework consists of two parts: complex adaptive SES theory (Chapter 2) and SES resilience (Chapter 3). It evolved through several iterations during the course of the research: modifications and refinements were made, reflecting new information and understanding derived from ongoing literature review and feedback from the expert panel during the study of EASES.

From my (the researcher's) perspective, in general, the conceptual framework performed its function very satisfactorily. From a panellist's perspective, the main weakness of the framework appears to have been related to the second part concerning resilience. As one panellist commented: "In Round 2, it seems, you need to be a Resilience Alliance disciple. This was not the case in Round 1."

Research design and strategy

Research needs careful design and a strategy. In Chapter 5 (section 5.3), I located the design in the interpretivist, social constructivist paradigm of enquiry. Essentially, this worldview recognises that there are multiple socially constructed, continually changing realities (a relativist ontology). It recognises that knowledge is constructed individually and co-constructed in the interactions between the researcher (myself) and the participants during the research process (a subjectivist epistemology). In both cases, research is influenced by the system of values held by the researcher and other participants. It is important that this is made explicit.

Given that the research process is embedded in a normative social–ecological context, I adopted a qualitative research strategy. Qualitative methods are more suited to the study of complex issues, problems and systems involving human–environment interactions and society–nature relations. For this research, I selected a single case study of EASES, which was conceptualised to represent the Atlantic Europe maritime macro-region and serve as the unit of analysis for studying the macro-region as a SES. The study design focused on a methodology for eliciting expert opinion regarding EASES. A workbook method was developed and used to ask questions and gather information from a panel of geographically dispersed experts during two rounds of the study (see section 5.4).

This research involved constructing the research process, and my role as single researcher and participant in the process, in a way that transcends the boundaries of individual disciplines. Social–ecological realities and SES involve complex patterns and processes that cannot be studied from the perspective of any one discipline or single researcher. Therefore, this research considered EASES from multiple perspectives by eliciting expert opinion from across a range of fields. This loosely interdisciplinary approach provided a more holistic understanding that better reflects the complexity of EASES. Nevertheless, the small number of panellists involved in the study (19 in round one and only 7 continuing in round two) limited the interdisciplinary nature of the study. Overall, the research design and strategy performed adequately.

Methods

The research strategy relied on expert opinion as the source of information during the study of EASES. This entailed using three methods: First, a procedure for identifying and selecting suitable individuals with appropriate expertise. Second, developing a qualitative workbook method for data collection. Third, adopting an analytical strategy and method of data analysis. (See subsections 5.4.1 to 5.4.3 respectively.) The expert panel method resulted in 19 participants in round one of the study. However, the drop out rate between rounds was significant and only seven of these panellists continued to participate in round two, limiting the effectiveness of that part of the study (see section 8.4).

The workbook method for data collection, which was developed specifically for the study, was in general adequate to the task. The separate workbook used in each round contained a series of open-ended questions, background information, the researcher's suggestions and space to enter a response. Round one produced a large number and volume of responses, which were analysed and synthesised to produce a report for round two. The data collected in round one together with the panellists' feedback on the report were used successfully to modify and refine the initial conceptualisation of EASES, resulting in the final version presented in Chapter 6.

The advantages of the workbook method lay in their low cost to produce and distribute (by email) and their ability to be used by a panel of geographically-dispersed experts, at their own convenience, in circumstances that required methodological anonymity. The main disadvantages relate to time: the time required to develop and pilot the workbooks and supporting information; and the time and effort required by panellists to assimilate the supporting information and then answer the questions. Personal communications by email from several panellists clearly expressed a general opinion that the method was sound, but the extensive time commitment needed was a drawback. The adage that 'less is more' would, in retrospect, have been a useful guide when preparing the workbooks.

For this research, I adopted a variant of Yin's (2009: 130) 'relying on theoretical propositions' analytical strategy. This involved following the initial set of propositions (see section 1.2) that led to the study of EASES (see section 8.1 above). The actual method of data analysis consisted of five interdependent stages, as described in subsection 5.4.3. The fifth stage, verifying data, is addressed in section 8.3 below in terms of reliability, validity and quality.

Conceptualisation of EASES

The process of conceptualising EASES, from my (the researcher's) perspective, produced a robust unit of analysis (Chapter 6). The preparation of background material and inclusion of suggestions in the round one workbook helped to inform panellists who provided many detailed and useful responses to the questions. Given the quality of the conceptualisation of EASES that resulted, this approach proved to be successful. In hindsight, I could have evaluated this apparent success from the panellists' perspective by contacting them for their opinions. However, this was not built into the study design. In addition, I assumed that the high drop out of panellists between rounds one and two indicated a general unwillingness to participate in any unscheduled extra round of contact.

8.3 Methodological issues

As with any qualitative research, there are significant issues arising from the methodological choices made by the researcher (myself). These choices concern the research design and strategy for acquiring knowledge, and the methods (rules and practices) adopted. They are choices that reflect my understanding the nature of reality (ontology) and knowledge (epistemology). They lead to a number of challenges, which I call 'methodological issues'. Some issues were pre-empted during the planning stage prior to engaging in the study of EASES. Others emerged from reflection during the research process. All of them affect how the findings of this research can (or cannot) be used by others, whether they be researchers and academics or decision makers and practitioners. Key methodological issues include the researcher's assumptions, role in the research process, bias and data quality. They also include issues regarding ethical considerations, reliability, validity and generalisability. My assumptions as a researcher are grounded in the interpretivist, social constructivist paradigm previously mentioned; space precludes a discussion of it here (see Bradley 1993). I have already mentioned my role as researcher in the research process. The remaining issues are discussed in the following paragraphs.

Bias

Bradley (1993: 433) places the researcher as interpreter. All humans, including researchers, interpret. That is, they assign meaning to experience and view that meaning as objective. I recognise that my own background of personal, social, cultural and historical experiences shape my interpretation of the empirical material. In other words, my role as researcher is to interpret the interpretations of others (panellists). Therefore, it is important to reflect on my role throughout the research process, the meaning of the data, and the subjectivity inherent in collecting and analysing data.

In addition to my role as interpreter, I am also an observer. As Levin (1992) points out, the 'observer imposes a perceptual bias, a filter through which the system is viewed' (p. 1943). I chose (prescribed) the scale at which things are studied and defined the limits of the focal system in the form of the macro-regional level. The dependence of pattern and scale on the observer's perspective is recognised in theories concerning hierarchy (Allen and Starr 1982). This issue manifests in my initial conceptualisation of EASES, which was presented to the panellists in round one of the consultation.

There is a risk of other forms of bias arising from a single researcher approach. There is my geographical bias in selecting the study area based on my familiarity and personal association with the Atlantic Europe area. This had an effect in terms of applying geographical selection criteria when identifying candidates to form the expert panel. For example, there were no panellists from Asia, Australasia, South America or Africa. This was deliberate, as the study was designed to elicit expert opinion specific to the Atlantic Europe macro-region. In addition, there is some degree of personal bias based on my former experience of working with mainly ecological rather than social issues. However, during the course of the research my knowledge and understanding of fields such as sociology improved. This went some way towards countering early-stage bias in favour of ecology. Furthermore, I accept that there are inevitably unconscious biases and preconceptions that I am unaware of, for example, linked to my worldview. However, by practicing reflexivity or explicit self-aware analysis of my own role (Finlay 2002a, 2002b), I aimed to minimise bias and increase the integrity and trustworthiness of this research. This, of course, included minimising bias specifically in data collection and analysis.

Data quality

There were issues around data quality. In this research the data is information in the form of panellists' responses recorded in the workbooks. High quality data refers to responses that are fit for the purpose of analysis. That is, responses that are complete and unambiguous, accurate and timely.

The quality of the responses across both rounds ranged from high to low quality. In some cases, responses were incomplete. Some were ambiguous, presenting a challenge to the interpretation of their meaning. In other cases, accuracy was poor, such as where a panellist used the response box to make a general comment or opinion. (The workbooks provided response boxes at the end of each section for any additional comments, but some panellists tended to include additional comments as an adjunct to specific questions.) Although inaccurate, it was often the case that such comments contained important and useful points of benefit in the analysis. Nevertheless, many of the responses were high quality.

Overall, the depth and detail of panellists' responses exceeded my expectations. This led to the challenge of dealing with a large amount of data. It took significantly more time than anticipated to prepare then analyse the information. The amount of usable information raised the issue of making full use of it in the space available. This trade-off amounts to an issue of representation.

Ethical considerations

This research involved participants: the expert panellists. Informed consent, confidentiality and data protection are cornerstones of research ethics. Therefore, when inviting candidates to participate on the expert panel, the 19 who agreed were required to provide a written consent form (Appendix C) before being accepted.[170] The list of panellists who participated in the study is presented in Appendix D.

[170] By signing the form, each panellist gave explicit permission to the researcher (myself) to use the data gathered. In addition to assuring confidentiality, the form advised the panellist that they

Reliability, validity and generalisability

The issue of trustworthiness is an important challenge in qualitative research. A principle of sustainability science is the need for high quality research, 'in terms of standards of evidence and argument and in their interpretation for policy and public awareness' (Lebel 2002: 28). This research aims to contribute to the body of knowledge concerning sustainability. For that to happen the quality of the research will be assessed and the knowledge generated has to be accepted as legitimate. It is assumed that the primary audience will consist of researchers from across different fields of enquiry. A secondary audience will consist of educators and practitioners such as managers and policy makers. These audiences will assess validity of the findings (new knowledge) from different community of practice perspectives based on knowledge already accepted as valid 'truth' in their particular community. Likewise, the quality of the data (evidence) and the research itself (study design and methods of collecting data and generating knowledge) will be assessed from different perspectives mainly within the academic community. The subject of what constitutes good or high quality research and valid knowledge in qualitative research is contentious (Golafshani 2003). Here, space limits me to a brief discussion of the issues of reliability, internal validity (credibility), external credibility (generalisability) and the means to deal with them.

Reliability

Is the research reliable? Is the information on which findings are based precise? Is there consistency of interpretation? For qualitative researchers, these are not easy questions to answer. I have attempted to demonstrate methodological consistency and reliability of the research process by precisely documenting the procedures followed. Unlike in quantitative research, qualitative information (i.e. panellists' one-off responses) cannot be checked for their measurable accuracy. Instead, they are assumed to be precise representations of panellists' opinions (on the proviso that collected information is properly managed and prepared for analysis by the researcher).

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would remain anonymous to other participants during the study; it sought permission to disclose their identity (including the name of the organisation to which they are affiliated, but not their email address) on completion of the study, on the condition that their identity would not be linked with any responses they provided.

The consistency of interpretations is essentially grounded in the use of a strong conceptual framework. The consistency of the findings is linked to the use of information collected from multiple sources, that is, different panellists in the study. This strategy of triangulation of information sources (as opposed to triangulation of methods) is a fundamental aspect of the study design. When several panellists respond to the same question, even if individual responses diverge, the reliability of findings is strengthened; where relatively few or only one panellist responds to a question, reliability is weakened. Furthermore, as part of round two, panellists were provided with a comprehensive report of the panel's round one responses and asked for feedback on them in the form of additions, revisions or comments. Following this strategy allowed the conceptualisation of EASES (Chapter 6) to be strengthened, which provided a reliable basis for the analysis in Chapter 7.

The strategy for achieving reliability in round two was different. It depended on providing panellists with the resilience theory components of the conceptual framework (Chapter 3). This provided a strong framework with which to consider their responses to the questions. However, due to drop-out between rounds, only seven of the original panellists participated in round two. Therefore, the reliability of the findings based on round two is weakened compared to round one.

If time and resources had permitted, I would have liked to have conducted a series of follow-up interviews with panellists to comment on and evaluate the findings. This would have strengthened the overall reliability of the study and its findings. A major reason for not attempting an additional stage in the study process was the apparent participant fatigue indicated by the high drop out between rounds. I judged that interviews with maybe two or three panellists would not significantly improve the reliability.

Where information or findings are inconsistent, divergent, contradictory or run counter to assumptions, they have been acknowledged or addressed. Given the interpretivist, constructivist approach and the deliberate involvement of individual experts with fundamentally different perspectives, this is to be expected. As stated in the invitation to participate: ‘Although a confluence of ideas is sought during the consultation, a panel consensus is not required. Any significantly divergent views will be represented in the reports’.

Validity

Is the research convincing? Is it truthful? Validity deals with the essential question: Why should I believe this? The ontological and epistemological meaning of ‘validity’ varies between the different sciences, disciplines and schools of thought (Angen 2000). There are numerous typologies, definitions, criteria and standards concerning validity (Creswell and Miller 2000: 124). It is the subject of philosophical discourse including in relation to the social construction of validity (Kvale 1995). The concept is used in both quantitative and qualitative research and is central to social science methodology (Golafshani 2003). Though accepted among quantitative researchers, validity remains a contentious issue among qualitative researchers (Onwuegbuzie and Leech 2007: 246).

It is important to address the question of validation (the assessment of validity) because following a qualitative research strategy means, as Scholz *et al.* (2006) put it, ‘there is no controlled repetition under the same constraints as postulated in the theory of statistical hypothesis testing’ (p. 245). Likewise, Sullivan *et al.* (2006: 7) state that the most direct method of assessing the validity of a study and verifying its findings – by redoing the study and getting the same results and interpretations – is not always possible for non-experimental studies. Freeman *et al.* (2007: 27) portray validity in terms of the standards of evidence. It can be understood as ‘the trustworthiness of inferences drawn from data’ (Eisenhart and Howe 1992: 644, cited in Freeman *et al.* 2007: 27). Validity approves the correlation between reality and the descriptive statements, evaluations, conclusions and recommendations made by researchers (Scholz *et al.* 2006: 245).

Generalisability

Generalisability concerns whether research findings can be applied beyond the specific focus and context of the study. More specifically, generalisability refers to whether findings generated in one instance can be applied more generally and widely across a range of instances; whereas transferability refers to whether findings from one instance can be applied to another more or less analogous instance. However, in qualitative research, as well as ‘can findings be generalised?’, the key question is ‘should findings be generalised?’ The answers to research questions, interpretations and knowledge generated may not apply in other instances, in which case the findings are not generalisable. But in some cases, even though findings can be generalised it may not be desirable or ethically acceptable to do so.

Qualitative researchers do not necessarily assume an either/or choice. Very often, understanding gained in one study may have potential for transferability or relevance to other studies; the knowledge generated may be useful to other researchers or practitioners in similar contexts or settings, even though general statements and other generalisations cannot be made. In effect, transferability is the purview of the end user. It is they who must judge whether a similar research process or set of findings could apply in their own case or situation. It is my role, as researcher, to present the information – this thesis – in a form that enables the end user to make an informed decision.

8.4 Limitations of the study

First of all, as a single researcher, I determined the boundaries of the study of EASES within the constraints of budget and time. I decided the problem to be addressed, macro-regional scope and focus of the study, research questions, research approach, qualitative research strategy, study design, unit of analysis and choice of methods.

As with all research, there are limitations specific to this particular study, which have an impact on reliability and validity. Some of these limitations were anticipated during planning, while others were encountered during the course of the study.

The main anticipated limitation is that imposed by scale. The fields of sustainability and governance are vast areas of scholarship not easily applied to empirical studies. In order to deal with such large topics, even when the study is clearly focused on the maritime dimension and a single unit of analysis, the individual researcher inevitably has to forgo some degree of depth and comprehensiveness. This involves a trade-off between the research questions and the information needed to answer them and the means to acquire that information. This trade-off is evident in the difference between the number of questions asked in rounds one and two of the study (49 and 12 questions respectively). Although each round had a different substantive focus, I decided that fewer questions were warranted in round two for two reasons. First, the focus of round two was much more theoretical than round one, which could have resulted in panellists giving responses that lacked sufficient focus on EASES. Second, there was an obvious risk of attrition, that is, of panellists dropping out or losing interest due to fatigue. This was critical given that only seven of the 19 panellists who participated in round one agreed to continue to round two.

Clearly, the lower than anticipated number of panellists participating in round two had the effect of limiting data collection. This limitation was offset to some degree by the detailed responses provided by many of the panellists. It became apparent from the round one responses and, subsequently, the round two responses that there was an unequal distribution of data quality (i.e. depth and relevance) across the panellists. Responses ranged from unanswered questions to detailed responses. Some responses failed to address the specific question; however, some of these provided useful information. This unequal distribution of data quality is a methodological weakness in the workbook method. It is plausible that an alternative method such as individual interviews might provide a more equal spread of data quality among experts. This is a potential area for future research.

During round two, panellists' feedback on the round one responses report was limited, both by the number of panellists taking the opportunity to respond and the usefulness of their responses. Therefore, the expert panellists' validation of my round one analysis and interpretation was of limited benefit.

A potential alternative approach and solution to this limitation might be to adopt the same basic approach but in a workshop setting. This would, of course, lose the benefit of anonymity and involve a different set of methodological justifications. It would also involve a significant financial cost and time commitment involved in travel to and from a venue, with possible accommodation issues depending workshop duration. These were not an option in this research.

Despite the limitations, the workbook method provided richer data than had been anticipated. Needless to say, each expert provided an individual perspective, complete with biases. A different set of experts would have provided a different set of responses. This and the inherent difficulty of dealing with subjectivity in expert opinion mean that the findings of this study can only be generalised with caution and applied with the understanding that they are specific to the case (EASES) and limited by the relatively small panel size (19 in round one and 7 in round two).

8.5 Contributions of this research

In addition to closing the knowledge gap previously mentioned, this research contributes to the existing body of academic knowledge in the field of social–ecological research for sustainability. More specifically, it contributes to knowledge concerning sustainability in the maritime dimension in the European context. The research demonstrates that CAS theory and a SES approach, including resilience thinking, can be used for the analysis of a maritime macro-region. As such, it contributes a conceptual framework for SES analysis and understanding of the Atlantic Europe maritime macro-region (represented by EASES). Some of the findings have broader applicability, at an abstract level, to other maritime macro-regions in Europe. However, the majority of findings are not generalisable to other situations or macro-regions because they are highly context specific.

This research also contributes to an improved understanding of potential SES-based architecture for maritime governance. The EU is already far advanced in implementing the IMP and developing a multilevel system of European maritime governance. This research contributes some theoretical justification for the EU approach towards maritime policy and governance. It also contributes some general design guidelines for the development of SES-based multilevel adaptive governance architecture. Therefore, the research has produced knowledge that is potentially useful to governance actors at all levels that have an interest in achieving maritime regional sustainability in Atlantic Europe and potentially other European macro-regions.

Methodologically, this research contributes to the development of a workbook method for eliciting expert opinion. Conceptually, it contributes two new insights: a reconceptualisation of the processes of adaptation and transformation as constituting a continuum as an alternative to the dichotomous view; and a new model of multiphase, multilevel transformation in SES (see Chapter 7, section 7.6).

8.6 Recommendations for future research

The ideas presented in this research are intended to be useful to policy actors concerned with achieving sustainable regional development and multilevel governance in Atlantic Europe. However, in order to bring these ideas to a wider audience, a number of further steps are required. First, a more succinct version of the conceptual framework (Chapters 2 and 3) needs to be developed. Second, a robust tool for SES analysis at the macro-regional focal level should be developed as a resource for governance actors. Third, the conceptual model of EASES requires refinement through additional research and alternative methodologies, for example, individual interviews or participatory workshops. Fourth, additional case studies of maritime macro-regions other than Atlantic Europe (e.g. the North Sea) are needed for comparison and for validation of the approach.

Although in its infancy, the SES approach to sustainability research has the potential to guide the design and development of governance architecture for maritime regional sustainability in Europe. The theory of complex adaptive SES offers a framework for linking concepts and guiding understanding society–nature relations. The general design guidelines for SES-based multilevel adaptive architecture for integrated maritime governance presented in this thesis are a starting point, for debate and for future research. Much work remains to be done to strengthen the argument and facilitate incorporation of complex adaptive SES thinking into governance frameworks for sustainable macro-regional development in Europe.

There are, of course, many remaining questions for future research. It behoves me to mention those that I consider to be important new topics for research. To begin with, I consider the SES approach to be too often disconnected from the philosophical (ontological and epistemological) foundations for it. Work is required to strengthen SES analysis from its philosophical foundations. Second, there is macro-regional gap in knowledge in general. This needs addressing from many different angles, including an SES approach to governance for sustainability. A whole new research area concerning 'macro-regional thinking' is needed. Many conceptual problems remain in relation to the notion of governance architecture: the macro-regional level is, in effect, the 'missing level'. There is potentially much work to be done regarding hybrid governance architectures that are designed along the lines of the experimentalist and interactive governance approaches outlined in Chapter 4. There is also further research to be done to refine and advance the reconceptualisation of the processes of adaptation and transformation as a continuum (see Chapter 7, section 7.6).

This thesis is predominantly conceptual in its approach. I believe it provides a sound basis for future research into social–ecological sustainability in the Atlantic Europe macro-region. I will end this thesis with one very important question: Building resilience, can it be done?

References

AAC. (2008) Basse-Normandie Region's Programme for the Presidency of the Atlantic Arc Commission for 2008-2010. 22 September 2008. Rennes: Atlantic Arc Commission. Online at: http://www.arcatlantique.org/pdf/doc_travail/159_en.pdf [accessed on 23/11/2015].

AAC. (2009a) Response to the EC consultation on the Green Paper on Territorial Cohesion: turning territorial diversity into strength. Opinion of the Political Bureau of the CPMR Atlantic Arc Commission, 7/5/2009. Rennes: Conference of Peripheral Maritime Regions of Europe (CPMR), Atlantic Arc Commission (AAC). Online at: http://ec.europa.eu/regional_policy/archive/consultation/terco/pdf/4_organisation/95_cpmr_atlantic_en.pdf [accessed 23/11/2015].

AAC. (2009b) General Assembly of the Atlantic Arc Commission, 15 May 2009, Santander (Cantabria, Spain). Final declaration. Rennes: Conference of Peripheral Maritime Regions of Europe (CPMR), Atlantic Arc Commission (AAC). Online at: http://arcatlantique.org/pdf/doc_travail/281_en.pdf [accessed on 23/11/2015].

AAC. (2009c) Atlantic Arc Commission Coordination Committee. 30 March 2009, Paris. Rennes: Conference of Peripheral Maritime Regions of Europe (CPMR), Atlantic Arc Commission (AAC). Online at: http://arcatlantique.org/pdf/doc_travail/227_en.pdf [accessed on 10/7/2016].

AAC. (2010) The Atlantic Arc Commission's response to the public consultation on the Integrated Maritime Policy for the Atlantic Ocean sea basin. Rennes: Conference of Peripheral Maritime Regions of Europe (CPMR), Atlantic Arc Commission (AAC). Online at: http://arcatlantique.org/pdf/doc_travail/369_en.pdf [accessed on 23/11/2015].

AAC. (2012) Position and proposals of the Atlantic Arc Commission on the EC Communication establishing a Strategy for the Atlantic. Document adopted by the Political Bureau of the Atlantic Arc Commission on 22 March 2012 in Caen (Basse-Normandie). Rennes: Conference of Peripheral Maritime Regions of Europe (CPMR), Atlantic Arc Commission (AAC). Online at: http://arcatlantique.org/pdf/doc_travail/492_en.pdf [accessed on 23/11/2015].

AAC. (2013) Contribution from the CPMR Atlantic Arc Commission to the European Commission's call for suggestions concerning the priorities of the Atlantic Strategy Action Plan: Approved by the Atlantic Arc Commission Political Bureau held in Nantes (Pays de la Loire-France) on 13 February 2013. Rennes: Conference of Peripheral Maritime Regions of Europe (CPMR), Atlantic Arc Commission (AAC). Online at: http://arcatlantique.org/pdf/doc_travail/588_en.pdf [accessed on 23/11/2015].

AAC. (2014a) Minutes/record of conclusions: Atlantic Strategy Working Group. 20 November 2014, Brussels. Rennes: Conference of Peripheral Maritime Regions of Europe (CPMR), Atlantic Arc Commission (AAC). Online at: http://www.arcatlantique.org/pdf/doc_travail/705_en.pdf [accessed 10/7/2016].

AAC. (2014b) CPMR Atlantic Arc Commission: a new step for the Atlantic Strategy? Atlantic Strategy Working Group presentation, 19 November 2014, Brussels. Rennes: Conference of Peripheral Maritime Regions of Europe (CPMR), Atlantic Arc Commission (AAC). Online at: http://www.arcatlantique.org/pdf/doc_travail/703_en.pdf [accessed 10/7/2016].

AAC. (2015) Working Group on «Innovation»: Draft Road Map for 2015-2016. Rennes: Conference of Peripheral Maritime Regions of Europe (CPMR), Atlantic Arc Commission (AAC). Online at: http://www.arcatlantique.org/pdf/doc_travail/746_en.pdf [accessed 25/7/2016].

AAC. (2016) Activity Report 2015-2016. Rennes: Conference of Peripheral Maritime Regions of Europe (CPMR), Atlantic Arc Commission (AAC). Online at: http://arcatlantique.org/pdf/doc_travail/831_en.pdf [accessed 10/7/2016].

Abel, N., Cumming, D.H.M. and Anderies, J.M. (2006) Collapse and reorganization in social-ecological systems: questions, some ideas, and policy implications. *Ecology and Society*, 11(1): 17.

Ackoff, R.L. (with the collaboration of Gupta, S.K. and Minas, J.S) (1962) *Scientific method: optimizing applied research decisions*. New York: Wiley.

Ackoff, R.L. (1999) *Re-Creating the Corporation: A Design of Organizations for the 21st Century*. New York: Oxford University Press.

Adger, W.N. (2003) Social capital, collective action, and adaptation to climate change. *Economic Geography*, 79(4): 387-404.

Adger, W.N. (2006) Vulnerability. *Global Environmental Change*, 16(3): 268-281.

Adger, W.N., Agrawala, S., Mirza, M.M.Q., Conde, C., O'Brien, K., Pulhin, J., Pulwarty, R., Smit, B. and Takahashi, K. (2007) Assessment of adaptation practices, options, constraints and capacity. Pages 717-743 in Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J. and Hanson, C.E. (eds.) *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press.

Adger, W.N., Brown, K. and Tompkins, E.L. (2005) The political economy of cross-scale networks in resource co-management. *Ecology and Society*, 10(2): 9.

Adger, W.N. and Jordan, A. (eds.) (2009a) *Governing Sustainability*. Cambridge: Cambridge University Press.

Adger, W.N. and Jordan, A. (2009b) Sustainability: exploring the processes and outcomes of governance. Pages 3-31 in: Adger, W.N. and Jordan, A. (eds.) *Governing Sustainability*. Cambridge: Cambridge University Press.

Adler, M. and Ziglio, E. (1996) *Gazing Into the Oracle: The Delphi Method and Its Application to Social Policy and Public Health*. London: Jessica Kingsley.

Alberti, M., Asbjornsen, H., Baker, L.A., Brozovic, N., Drinkwater, L.E., Drzyzga, S.A., Jantz, C.A., Fragoso, J., Holland, D.S., Kohler, T.A., Liu, J., McConnell, W.J., Maschner, H.D.G., Millington, J.D.A., Monticino, M., Podestá, G., Pontius, R.G., Redman, C.L., Reo, N.J., Sailor, D. and Urquhart, G. (2011) Research on coupled human and natural systems (CHANS): approach, challenges, and strategies. *Bulletin of the Ecological Society of America*, 92(2): 218-228.

Allen, C.R. and Garmestani, A.S. (2015) Adaptive management. Pages 1-10 in: Allen, C.R. and Garmestani, A.S. (eds.) *Adaptive Management of Social-Ecological Systems*. Dordrecht: Springer.

Allen, C.R., Gunderson, L. and Johnson, A.R. (2005) The use of discontinuities and functional groups to assess relative resilience in complex systems. *Ecosystems*, 8(8): 958-966.

Allen, C.R. and Holling, C. (2010) Novelty, adaptive capacity, and resilience. *Ecology and Society*, 15(3): 24.

Allen, P. (2001) What is complexity science? Knowledge of the limits to knowledge. *Emergence*, 3(1): 24-42.

Allen, T.F.H. and Hoekstra, T.W. (1993) Toward a definition of sustainability. Pages 98-107 in: Covington, W.W. and Debano, L.F. (eds.) *Sustainable ecological systems: implementing an ecological approach to land management*. Gen. Tech. Rep. RM-247. Fort Collins, CO: Rocky Mountain Forest and Range Experiment Station.

Allen, T.F.H. and Starr, T.B. (1982) *Hierarchy: Perspectives for Ecological Complexity*. Chicago: University of Chicago Press.

Alrøe, H.F. and Kristensen, E.S. (2002) Towards a systemic research methodology in agriculture: rethinking the role of values in science. *Agriculture and Human Values*, 19(1): 3-23.

Anderies, J.M., Carpenter, S.R., Steffen, W. and Rockström, J. (2013) The topology of non-linear global carbon dynamics: from tipping points to planetary boundaries. *Environmental Research Letters*, 8(4): 044048. DOI: 10.1088/1748-9326/8/4/044048.

Anderies, J.M., Janssen, M.A. and Ostrom, E. (2004) A framework to analyze the robustness of social-ecological systems from an institutional perspective. *Ecology and Society*, 9(1): 18.

Anderies, J.M., Walker, B.H. and Kinzig, A.P. (2006) Fifteen weddings and a funeral: case studies and resilience-based management. *Ecology and Society*, 11(1): 21.

Anderson, R.M. and May, R.M. (1982) Coevolution of hosts and parasites. *Parasitology*, 85(2): 411-426.

Andersson, K., Burns, M., Bursztyn, M., Henry, A.D., Laudati, A., Matus, K. and McNie, E. (2008) The Ruffolo Curriculum on Sustainability Science: 2008 Edition. CID Graduate Student and Research Fellow Working Paper No. 32. Center for International Development at Harvard University, December 2008. Online at: http://www.hks.harvard.edu/centers/cid/publications/fellow-graduate-student-working-papers/cid-graduate-student-and-postdoctoral-fellow-working-paper-no.-32 [accessed on 23/11/2015].

Andersson, K.P. and Ostrom, E. (2008) Analyzing decentralized resource regimes from a polycentric perspective. *Policy Sciences*, 41(1): 71-93.

Andonova, L.B. and Mitchell, R.B. (2010) The rescaling of global environmental politics. *Annual Review of Environment and Resources*, 35: 255-282.

Angen, M.J. (2000) Evaluating interpretive inquiry: reviewing the validity debate and opening the dialogue. *Qualitative Health Research*, 10(3): 378-395.

Armitage, D., Marschke, M. and Plummer, R. (2008) Adaptive co-management and the paradox of learning. *Global Environmental Change*, 18(1): 86-98.

Armitage, D.R., Plummer, R., Berkes, F., Arthur, R.I., Charles, A.T., Davidson-Hunt, I.J., Diduck, A.P., Doubleday, N.C., Johnson, D.S., Marschke, M., McConney, P., Pinkerton, E.W. and Wollenberg, E.K. (2009) Adaptive co-management for social–ecological complexity. *Frontiers in Ecology and the Environment*, 7(2): 95-102.

Arnell, N.W., Tompkins, E.L. and Adger, W.N. (2005) Eliciting information from experts on the likelihood of rapid climate change. *Risk Analysis*, 25(6): 1419-1431.

Arnold, J.S., Koro-Ljungberg, M. and Bartels, W. (2012) Power and conflict in adaptive management: analyzing the discourse of riparian management on public lands. *Ecology and Society*, 17(1): 19.

Assmann, A. (2008) Transformations between history and memory. *Social Research: An International Quarterly*, 75(1): 49-72.

Assmann, A. and Shortt, L. (eds.) (2012) *Memory and Political Change*. Basingstoke: Palgrave Macmillan.

Atlantic Networks. (2013) Atlantic Networks together to promote the good governance of the Atlantic Strategy. Common position document of the Atlantic Arc Commission (AAC), the Conference of Atlantic Arc Cities (CAAC), the Atlantic Transnational Network (ATN) and the Association of Chambers of Agriculture of the Atlantic Arc (AC3A). April 2013. Online at: http://arcatlantique.org/pdf/doc_travail/612_en.pdf [accessed 23/11/2015].

Aunger, R. (2007) Major transitions in 'big' history. *Technological Forecasting and Social Change*, 74(8): 1137-1163.

Ayers, A.L. and Kittinger, J.N. (2014) Emergence of co-management governance for Hawai'i coral reef fisheries. *Global Environmental Change*, 28: 251-262.

Ayres, R.U. (2007) On the practical limits to substitution. *Ecological Economics*, 61(1): 115-128.

Ayyub, B.M. (2001) *Elicitation of Expert Opinions for Uncertainty and Risks*. Boca Raton, FL: CRC Press.

Ayyub, B.M. (2010) On uncertainty in information and ignorance in knowledge. *International Journal of General Systems*, 39(4): 415-435.

Azadi, H., Shahvali, M., van den Berg, J. and Faghih, N. (2007) Sustainable rangeland management using a multi-fuzzy model: how to deal with heterogeneous experts' knowledge. *Journal of Environmental Management*, 83(2): 236-249.

Babiuch, W.M. and Farhar, B.C. (1994) *Stakeholder analysis methodologies resource book*. Golden, CO: National Renewable Energy Laboratory. DOI: 10.2172/10159593.

Bache, I. and Flinders, M. (eds.) (2004) *Multi-level Governance*. New York: Oxford University Press.

Bammer, G. (2005) Integration and implementation sciences: building a new specialization. *Ecology and Society*, 10(2): 6.

Bak, P. (1996) *How nature works: the science of self-organized criticality*. New York: Copernicus.

Bak, P., Tang, C. and Wiesenfeld, K. (1988) Self-organized criticality. *Physical Review A*, 38(1): 364-374.

Balsiger, J. (2012) New environmental regionalism and sustainable development in the European Alps. *Global Environmental Politics*, 12(3): 58-78.

Bar-Yam, Y. (1997) *Dynamics of Complex Systems*. Reading, MA: Addison-Wesley.

Barange, M. and Perry, R.I. (2009) Physical and ecological impacts of climate change relevant to marine and inland capture fisheries and aquaculture. Pages 7-106 in: Cochrane, K., De Young, C., Soto, D. and Bahri, T. (eds.) *Climate change implications for fisheries and aquaculture: Overview of current scientific knowledge*. FAO Fisheries and Aquaculture Technical Paper, No. 530. Rome: Food and Agriculture Organization of the United Nations (FAO).

Barca, F. (2009) An agenda for a reformed cohesion policy: a place-based approach to meeting European Union challenges and expectations. Independent Report prepared at the request of Danuta Hübner, Commissioner for Regional Policy. Rome: Ministry of Economy and Finance. Online at: http://ec.europa.eu/regional_policy/archive/policy/future/pdf/report_barca_v0306.pdf [accessed 23/11/2015].

Barnett-Page, E. and Thomas, J. (2009) Methods for the synthesis of qualitative research: a critical review. *BMC Medical Research Methodology*, 9(1): Article 59. DOI: 10.1186/1471-2288-9-59.

Barnosky, A.D., Hadly, E.A., Bascompte, J., Berlow, E.L., Brown, J.H., Fortelius, M., Getz, W.M., Harte, J., Hastings, A., Marquet, P.A., Martinez, N.D., Mooers, A., Roopnarine, P., Vermeij, G., Williams, J.W., Gillespie, R., Kitzes, J., Marshall, C., Matzke, N., Mindell, D.P., Revilla, E. and Smith, A.B. (2012) Approaching a state shift in Earth's biosphere. *Nature*, 486(7401): 52-58.

Barroso, J.M.D. (2012a) Speech by President Barroso: "A strong maritime pillar for the Europe 2020 strategy". Informal Ministerial meeting on EU Integrated Maritime Policy, Limassol, 8 October 2012. SPEECH/12/696. Brussels: European Commission. Online at: http://europa.eu/rapid/press-release_SPEECH-12-696_en.htm [accessed 21/5/2016].

Barthel, S., Colding, J., Elmqvist, T. and Folke, C. (2005) History and local management of a biodiversity-rich, urban cultural landscape. *Ecology and Society*, 10(2): 10.

Barthel, S., Folke, C. and Colding, J. (2010) Social–ecological memory in urban gardens—retaining the capacity for management of ecosystem services. *Global Environmental Change*, 20(2): 255-265.

Baumgartner, F.R. (2006) Punctuated equilibrium theory and environmental policy. Pages 24-46 in: Repetto, R. (ed.) *Punctuated Equilibrium and the Dynamics of U.S. Environmental Policy*. New Haven, CT: Yale University Press.

Baumgärtner, S. and Quaas, M. (2010) Sustainability economics — general versus specific, and conceptual versus practical. *Ecological Economics*, 69(11): 2056-2059.

Baxter, P. and Jack, S. (2008) Qualitative cCase study methodology: study design and implementation for novice researchers. *The Qualitative Report*, 13(4): 544-559.

Beck, U. (1992) *Risk Society: Towards a New Modernity*. Translated by Ritter, M. London: Sage. [Originally published in German in 1986 as *Risikogesellschaft: Auf dem Weg in eine andere Moderne*. Frankfurt am Main: Suhrkamp.]

Becker, E. (2012) Social-ecological systems as epistemic objects. Pages 37-59 in: Glaser, M., Krause, G., Ratter, B.M.W. and Welp, M. (eds.) *Human-Nature Interactions in the Anthropocene: Potentials of Social-Ecological Systems Analysis*. New York: Routledge.

Becker, E. and Breckling, B. (2011) Border zones of ecology and systems theory. Pages 385-403 in: Schwarz, A. and Jax, K. (eds.) *Ecology Revisited: Reflecting on Concepts, Advancing Science*. Dordrecht: Springer.

Becker, E., Hummel, D. and Jahn, T. (2011) Societal relations to nature as a common frame of reference for integrated environmental research. [Unpublished English translation. Originally published in German in 2011 as: *Gesellschaftliche naturverhältnisse als rahmenkonzept*. Pages 75-96 in: Groß, M. (ed.) *Handbuch Umweltsoziologie*. Wiesbaden: Springer VS.] Online at: http://www.isoe.de/fileadmin/redaktion/Downloads/Soziale_Oekologie/becker-hummel-jahn-soc-rel-nat-en-2012.pdf [accessed 23/11/015].

Becker, E. and Jahn, T. (2001) Social-ecological research - Conceptual framework for a new funding policy: synopsis of the report for the German Federal Ministry of Education and Research. Translated from German by Faust, R.D. *Nature Sciences Sociétés*, 9(1): 73-77.

Becker, E. and Jahn, T. (2003) Societal relations to nature: outline of a critical theory in the ecological crisis. Frankfurt am Main: Institute for Social-Ecological Research (ISOE). Online at: http://www.isoe.de/ftp/darmstadttext_engl.pdf [accessed 23/11/2015].

Becker, E. and Jahn, T. (2005) Societal relations to nature: outline of a critical theory in the ecological crisis. Frankfurt am Main: Institute for Social-Ecological Research (ISOE). [Originally published in German in 2003 as: *Umrisse einer kritischen Theorie gesellschaftlicher Naturverhältnisse*. Pages 91-112 in: Böhme, G. and Manzei, A. (eds.) *Kritische Theorie der Technik und der Natur*. München: Wilhelm Fink.] Online at: http://www.isoe.de/fileadmin/redaktion/Downloads/Soziale_Oekologie/becker-jahn-gnv-2003-en.pdf [accessed 23/11/2015].

Becker, E. and Jahn, T. (eds.) (2006) *Soziale Ökologie: Grundzüge einer Wissenschaft von den gesellschaftlichen Naturverhältnissen*. Frankfurt am Main: Campus.

Becker, E., Jahn, T., Stiess, I. and Wehling, P. (1997) Sustainability: a cross-disciplinary concept for social transformations. Management of Social Transformations (MOST) Policy Paper No. 6. Paris: United Nations Educational, Scientific and Cultural Organization (UNESCO) & Frankfurt am Main: Institute for Social-Ecological Research (ISOE).

Beisner, B.E., Haydon, D.T. and Cuddington, K. (2003) Alternative stable states in ecology. *Frontiers in Ecology and the Environment*, 1(7): 376-382.

Bergold, J. and Thomas, S. (2012) Participatory research methods: a methodological approach in motion. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, 13(1): Art. 30. Online at: http://www.qualitative-research.net/index.php/fqs/article/view/1801.

Bergseth, B.J., Russ, G.R. and Cinner, J.E. (2015) Measuring and monitoring compliance in no-take marine reserves. *Fish and Fisheries*, 16(2): 240-258.

Berkes, F. (2007) Understanding uncertainty and reducing vulnerability: lessons from resilience thinking. *Natural Hazards*, 41(2): 283-295.

Berkes, F. (2009) Evolution of co-management: role of knowledge generation, bridging organizations and social learning. *Journal of Environmental Management*, 90(5): 1692-1702.

Berkes, F. (2011a) Restoring unity: the concept of marine social-ecological systems. Pages 9-28 in: Ommer, R.E., Perry, R.I., Cochrane, K. and Cury, P. (eds.) *World Fisheries: A Social-Ecological Analysis*. Oxford: Wiley-Blackwell.

Berkes, F. (2011b) Implementing ecosystem-based management: evolution or revolution? *Fish and Fisheries*, 13(4): 465-476.

Berkes, F., Colding, J. and Folke, C. (eds.) (2003a) *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change*. Cambridge: Cambridge University Press.

Berkes, F., Colding, J. and Folke, F. (2003b) Introduction. Pages 1-29 in: Berkes, F., Colding, J. and Folke, C. (eds.) *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change*. Cambridge: Cambridge University Press.

Berkes, F. and Folke, C. (1998a) Linking social and ecological systems for resilience and sustainability. Pages 1-25 in: Berkes, F. and Folke, C. (eds.) *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience*. Cambridge: Cambridge University Press.

Berkes, F. and Folke, C. (eds.) (1998b) *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience*. Cambridge: Cambridge University Press.

Berkes, F. and Seixas, C. (2005) Building resilience in lagoon social–ecological systems: a local-level perspective. *Ecosystems*, 8(8): 967-974.

Beumer, C. and Martens, P. (2010) Noah's ark or world wild web? Cultural perspectives in global scenario studies and their function for biodiversity conservation in a changing world. *Sustainability*, 2(10): 3211-3238.

Biermann, F. (2007) 'Earth system governance' as a crosscutting theme of global change research. *Global Environmental Change*, 17(3-4): 326-337.

Biermann, F. (2010) Beyond the intergovernmental regime: recent trends in global carbon governance. *Current Opinion in Environmental Sustainability*, 2(4): 284-288.

Biermann, F., Abbott, K., Andresen, S., Bäckstrand, K., Bernstein, S., Betsill, M.M., Bulkeley, H., Cashore, B., Clapp, J., Folke, C., Gupta, A., Gupta, J., Haas, P.M., Jordan, A., Kanie, N., 16,17, Kluvánková-Oravská, T., Lebel, L., Liverman, D., Meadowcroft, J., Mitchell, R.B., Newell, P., Oberthür, S., Olsson, L., Pattberg, P., Sánchez-Rodríguez, R., Schroeder, H., Underdal, A., Camargo Vieira, S., Vogel, C., Young, O.R., Brock, A., and Zondervan, R. (2012) Transforming governance and institutions for global sustainability: key insights from the Earth System Governance Project. *Current Opinion in Environmental Sustainability*, 4(1): 51-60.

Biermann, F. and Pattberg, P. (2008) Global environmental governance: taking stock, moving forward. *Annual Review of Environment and Resources*, 33: 277-294.

Biermann, F., Pattberg, P., van Asselt, H. and Zelli, F. (2009) The fragmentation of global governance architectures: a framework for analysis. *Global Environmental Politics*, 9(4): 14-40.

Biggs, R., Westley, F.R. and Carpenter, S.R. (2010) Navigating the back loop: fostering social innovation, and transformation in ecosystem management. *Ecology and Society*, 15(2): 9.

Birks, M., Chapman, Y. and Francis, K. (2008) Memoing in qualitative research: probing data and processes. *Journal of Research in Nursing*, 13(1): 68-75.

Bissonette, J.A. (2013) Scale in wildlife management: the difficulty with extrapolation. Pages 73-83 in: Krausman, P.R. and Cain, III, J.W. (eds.) *Wildlife Management and Conservation: Contemporary Principles and Practices*. Baltimore, MA: John Hopkins University Press.

Blackman, T. (2013) Rethinking policy-related research: charting a path using qualitative comparative analysis and complexity theory. *Contemporary Social Science*, 8(3): 333-345.

Blackstock, K.L., Kelly, G.J. and Horsey, B.L. (2007) Developing and applying a framework to evaluate participatory research for sustainability. *Ecological Economics*, 60(4): 726-742.

Blount, B., Jacob, S., Weeks, P. and Jepson, M. (2015) Testing cognitive ethnography: mixed-methods in developing indicators of well-being in fishing communities. *Human Organization*, 74(1): 1-15.

Bodin, Ö. and Tengö, M. (2012) Disentangling intangible social–ecological systems. *Global Environmental Change*, 22(2): 430-439.

Bohensky, E., Stone-Jovicich, S., Larson, S. and Marshall, N. (2010) Adaptive capacity in theory and reality: implications for governance in the Great Barrier Reef region. Pages 23-41 in Armitage, D. and Plummer, R. (eds.) *Adaptive Capacity and Environmental Governance*. Berlin Heidelberg: Springer.

Bohle, H.-G., Etzold, B. and Keck, M. (2009) Resilience as agency. Reframing resilience: from systems-oriented to people-centred perspectives. Pages 8-13 in IHDP Update, 2/2009. Bonn: International Human Dimension Programme on Global Environmental Change (IHDP). Online at: https://www.geographie.uni-bonn.de/forschung/wissenschafliche-bereiche/geographische-entwicklungsforschung-1/staff/1bohle-etzold-keck-2009-resilience-as-agency-ihdp-update-2009.2.pdf [accessed 23/11/2015].

Bonabeau, E. (1998) Social insect colonies as complex adaptive systems. *Ecosystems*, 1(5): 437-443.

Bondarenko, D.M., Grinin, L.E. and Korotayev, A.V. (2002) Alternative pathways of social evolution. *Social Evolution & History*, 1(1): 54-79.

Borja, A., Elliot, M., Carstensen, J., Heiskanen, A.-S. and van de Bund, W. (2010) Marine management – towards an integrated implementation of the European Marine Strategy Framework and the Water Framework Directives. *Marine Pollution Bulletin*, 60(12): 2175-2186.

Bosselmann, K. (2008) *The Principle of Sustainability: Transforming Law and Governance*. Aldershot: Ashgate.

Bossomaier, T.R.J. and Green, D.G. (eds.) (2007) *Complex Systems*. Cambridge: Cambridge University Press. [Originally published in 2000].

Boyes, S.J. and Elliott, M. (2014) Marine legislation – the ultimate 'horrendogram': international law, European directives & national implementation. *Marine Pollution Bulletin*, 86(1-2): 39-47.

Bradley, E.H., Curry, L.A. and Devers, K.J. (2007) Qualitative data analysis for health services research: developing taxonomy, themes, and theory. *Health Services Research*, 42(4): 1758-1772.

Bradley, J. (1993) Methodological issues and practices in qualitative research. *Library Quarterly*, 63(4): 431-449.

Brand, F.S. and Jax, K. (2007) Focusing the meaning(s) of resilience: resilience as a descriptive concept and a boundary object. *Ecology and Society*, 12(1): 23.

Brand, U. and Görg, C. (2013) Regimes in global environmental governance and the internationalization of the state: the case of biodiversity politics. *International Journal of Social Science Studies*, 1(1): 110-122.

Brand, U. and Wissen, M. (2013) Crisis and continuity of capitalist society-nature relationships: the imperial mode of living and the limits to environmental governance. *Review of International Political Economy*, 20(4): 687-711.

Bray, D. and von Storch, H. (1999) Climate science: an empirical example of postnormal science. *Bulletin of the American Meteorological Society*, 80(3): 439-455.

Brock, W.A. and Carpenter, S.R. (2010) Interacting regime shifts in ecosystems: implication for early warnings. *Ecological Monographs*, 80(3): 353-367.

Brown, K. (2009) Human development and environmental governance: a reality check. Pages 32-51 in: Adger, W.N. and Jordan, A. (eds.) *Governing Sustainability*. Cambridge: Cambridge University Press.

Brown, L.D. (1991) Bridging organizations and sustainable development. *Human Relations*, 44(8): 807-831.

Bruckmeier, K. (2013) *Natural Resource Use and Global Change: New Interdisciplinary Perspectives in Social Ecology*. Basingstoke: Palgrave Macmillan.

Brunckhorst, D.J. (2002) Institutions to sustain ecological and social systems. *Ecological Management & Restoration*, 3(2): 108-116.

Brunckhorst, D.J. (2005) Integration research for shaping sustainable regional landscapes. *Journal of Research Practice*, 1(2): Article M7. Online at: http://jrp.icaap.org/content/v1.2/brunckhorst.html.

Bryman, A. (1988) *Quantity and Quality in Social Research*. London: Routledge.

Bryman, A. (2012) *Social Research Methods*. Fourth Edition. Oxford: Oxford University Press.

Bull, J.W., Jobstvogt, N., Böhnke-Henrichs, A., Mascarenhas, A., Sitas, N., Baulcomb, C., Lambini, C.K., Rawlins, M., Baral, H., Zähringer, J., Carter-Silk, E., Balzan, M.V., Kenter, J.O., Häyhä, T., Petz, K. and Koss, R. (2016) Strengths, weaknesses, opportunities and threats: a SWOT analysis of the ecosystem services framework. *Ecosystem Services*, 17: 99-111.

Burnard, P., Gill, P., Stewart, K., Treasure, E. and Chadwick, B. (2008) Analysing and presenting qualitative data. *British Dental Journal*, 204(8): 429-432.

Burstein, P. (1991) Policy domains: organization, culture, and policy outcomes. *Annual Review of Sociology*, 17: 327-350.

Bäckstrand, K., Khan, J., Kronsell, A. and Lövbrand, E. (eds.) (2010) *Environmental Politics and Deliberative Democracy: Examining the Promise of New Modes of Governance*. Cheltenham: Edward Elgar.

Cairns, J., Jr. (2007) Sustainable co-evolution. *International Journal of Sustainable Development & World Ecology*, 14(1): 103-108.

Campbell, S.M., Braspenning, J., Hutchinson, A. and Marshall, M. (2002) Research methods used in developing and applying quality indicators in primary care. *Quality & Safety in Health Care*, 11(4): 358-364.

Campbell, S.M. and Cantrill, J.A. (2001) Consensus methods in prescribing research. *Journal of Clinical Pharmacy and Therapeutics*, 26(1): 5-14.

Cañas, A.J., Coffey, J.W., Carnot, M.J., Feltovich, P., Hoffman, R.R., Feltovich, J. and Novak, J.D. (2003) A summary of literature pertaining to the use of concept mapping techniques and technologies for education and performance support. Pensacola, FL: Institute for Human and Machine Cognition.

Cañas, A.J., Hill, G., Carff, R., Suri, N., Lott, J., Gómez, G., Eskridge, T.C., Arroyo, M. and Carvajal, R. (2004) CmapTools: a knowledge modeling and sharing environment. Paper in: Cañas, A.J., Novak, J.D. and González, F.M. (eds.) Concept Maps: Theory, Methodology, Technology. Proceedings of the First International Conference on Concept Mapping, Pamplona, Spain 2004. Pensacola, FL: Institute for Human & Machine Cognition (IHMC).

Carpenter, S.R. and Brock, W.A. (2008) Adaptive capacity and traps. *Ecology and Society*, 13(2): 40.

Carpenter, S.R., Cole, J.J, Pace, M.L., Batt, R., Brock, W.W., Cline, T., Coloso, J., Hodgson, J.R., Kitchell, J.F., Seekell, D.A., Smith, L. and Weidel, B. (2011) Early warnings of regime shifts: a whole-ecosystem experiment. *Science*, 332(6033): 1079-1082.

Carpenter, S.R., DeFries, R., Dietz, T., Mooney, H.A., Polasky, S., Reid, W.V. and Scholes, R.J. (2006) Millennium Ecosystem Assessment: research needs. *Science*, 314(5797): 257-258.

Carpenter, S.R. and Gunderson, L.H. (2001) Coping with collapse: ecological and social dynamics in ecosystem management. *BioScience*, 51(6): 451-457.

Carpenter, S., Walker, B., Anderies, J.M. and Abel, N. (2001) From metaphor to measurement: resilience of what to what? *Ecosystems*, 4(8): 765-781.

Cash, D.W., Adger, W.N., Berkes, F., Garden, P., Lebel, L., Olsson, P., Pritchard, L. and Young, O. (2006) Scale and cross-scale dynamics: governance and information in a multilevel world. *Ecology and Society*, 11(2): 8.

Cash, D.W. and Moser, S.C. (2000) Linking global and local scales: designing dynamic assessment and management processes. *Global Environmental Change*, 10(2): 109-120.

Castree, N. (2001) Socializing nature: theory, practice, and politics. Pages 1-21 in: Castree, N. and Braun, B. (eds.) *Social Nature: Theory, Practice, and Politics*. Oxford: Blackwell.

CCDR-N. (2007) European Territorial Cooperation Operational Programme: Atlantic Area – Transnational Cooperation 2007-2013. Final version approved by European Commission. Porto: Comissão de Coordenação e Desenvolvimento Regional do Norte (CCDR-N). Online at: http://atlanticarea.ccdr-n.pt/documentation/operational-programme/atlantic-area-transnational-programme-2007-2013 [accessed 23/11/2015].

Cetin, C.K. and Cerit, A.G. (2010) Organizational effectiveness at seaports: a systems approach. *Maritime Policy & Management*, 37(3): 195-219.

Chapin, III, F.S., Carpenter, S.R., Kofinas, G.P., Folke, C., Abel, N., Clark, W.C., Olsson, P., Stafford Smith, D.M., Walker, B., Young, O.R., Berkes, F., Biggs, R., Grove, J.M., Naylor, R.L., Pinkerton, E., Steffen, W. and Swanson, F.J. (2010) Ecosystem stewardship: sustainability strategies for a rapidly changing planet. *Trends in Ecology & Evolution*, 25(4): 241-249.

Chapin, III, F.S., Folke, C. and Kofinas, G.P. (2009b) A Framework for understanding change. Pages 3-28 in: Chapin, III, F.S., Kofinas, G.P. and Folke, C. (eds.) *Principles of Ecosystem Stewardship: Resilience-Based Natural Resource Management in a Changing World*. New York: Springer.

Chapin, III, F.S., Kofinas, G.P. and Folke, C. (eds.) (2009a) *Principles of Ecosystem Stewardship: Resilience-Based Natural Resource Management in a Changing World*. New York: Springer.

Chapin, III, F.S., Kofinas, G.P., Folke, C., Carpenter, S.R., Olsson, P., Abel, N., Biggs, R., Naylor, R.L., Pinkerton, E., Stafford Smith, D.M., Steffen, W., Walker, B. and Young, O.R. (2009c) Resilience-based stewardship: strategies for navigating sustainable pathways in a changing world. Pages 319-337 in: Chapin, III, F.S., Kofinas, G.P. and Folke, C. (eds.) *Principles of Ecosystem Stewardship: Resilience-Based Natural Resource Management in a Changing World*. New York: Springer.

Chapin III, F.S., Lovecraft, A.L., Zavaleta, E.S., Nelson, J., Robards, M.D., Kofinas, G.P., Trainor, S.F., Peterson, G.D., Huntington, H.P. and Naylor, R.L. (2006) Policy strategies to address sustainability of Alaskan boreal forests in response to a directionally changing climate. *Proceedings of the National Academy of Sciences of the United States of America*, 103(45): 16637-16643.

Christensen, P.P. (2001) Early links between sciences of nature and economics: historical perspectives for ecological and social economics. Pages 15-33 in: Cleveland, C.J., Stern, D.I. and Costanza, R. (eds.) *The Economics of Nature and the Nature of Economics*. Cheltenham: Edward Elgar.

Christopherson, R.W. (1997) *Geosystems: An Introduction to Physical Geography*. Upper Saddle River, NJ: Prentice Hall.

Christopherson, S., Michie, J. and Tyler, P. (2010) Regional resilience: theoretical and empirical perspectives. *Cambridge Journal of Regions, Economy and Society*, 3(1): 3-10.

Chuenpagdee, R. (2011) Interactive governance for marine conservation: an illustration. *Bulletin of Marine Science*, 87(2): 197-211.

Chuenpagdee, R. and Jentoft, S. (2009) Governability assessment for fisheries and coastal systems: a reality check. *Human Ecology*, 37(1): 109-120.

Cinnirella, S., Sardà, R., de Vivero, J.L.S., Brennan, R., Barausse, A., Icely, J., Luisetti, T., March, D., Murciano, C., Newton, A., O'Higgins, T., Palmeri, L., Palmieri, M.G., Raux, P., Rees, S., Albaigés, J., Pirrone, N. and Turner, K. (2014) Steps toward a shared governance response for achieving good environmental status in the Mediterranean Sea. *Ecology and Society*, 19(4): 47.

Clark, W.C. (2007) Sustainability science: a room of its own. *Proceedings of the National Academy of Sciences of the United States of America*, 104(6): 1737-1738.

Clark, W.C., Buizer, J., Cash, D., Corell, R., Dickson, N., Dowdeswell, E., Doyle, H., Gallopín, G., Glaser, G., Goldfarb, L., Gupta, A.K., Hall, J.M., Hassan, M., Imevbore, A., Iwu, M.M., Jäger, J., Juma, C., Kates, R., Krömker, D., Kurushima, M., Lebel, L., Lee, Y.C., Lucht, W., Mabogunje, A., Malpede, D., Matson, P., Moldan, B., Montenegro, G., Nakicenovic, N., Ooi, L.G., O'Riordan, T., Pillay, D., Rosswall, T., Sarukhán, J. and Wakhungu, J. (2002) Science and Technology for Sustainable Development: Consensus Report and Background Document, Mexico City Synthesis Conference, 20-23 May 2002. ICSU Series on Science for Sustainable Development No. 9. Paris: International Council for Science (ICSU). Online at: http://www.icsu.org/publications/reports-and-reviews/science-and-technology-at-the-world-summit-on-sustainable-development-2002/rainbow-series-vol9.pdf [accessed 23/11/2015].

Clark, W.C., Crutzen, P.J. and Schellnhuber, H.J. (2004) Science for global sustainability: toward a new paradigm. Pages 1-28 in: Schellnhuber, H.J., Crutzen, P.J., Clark, W.C., Claussen, M. and Held, H. (eds.) *Earth System Analysis for Sustainability*. Cambridge, MA: MIT Press.

Clark, W.C. and Dickson, N.M. (2003) Sustainability science: the emerging research program. *Proceedings of the National Academy of Sciences of the United States of America*, 100(14): 8059-8061.

Claxton, J.D., Ritchie, J.R.B. and Zaichkowsky, J. (1980) The nominal group technique: its potential for consumer research. *Journal of Consumer Research*, 7(3): 308-313.

Cochrane, K., De Young, C., Soto, D. and Bahri, T. (eds.) (2009) Climate change implications for fisheries and aquaculture: Overview of current scientific knowledge. FAO Fisheries and Aquaculture Technical Paper, No. 530. Rome: Food and Agriculture Organization of the United Nations (FAO).

Colding, J. (2013) Local assessment of Stockholm: revisiting the Stockholm Urban Assessment. Pages 313-335 in: Elmqvist, T., Fragkias, M., Goodness, J., Güneralp, B., Marcotullio, P.J., McDonald, R.I., Parnell, S., Schewenius, M., Sendstad, M., Seto, K.C. and Wilkinson, C. (eds.) *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities – A Global Assessment*. Dordrecht: Springer.

Cole, A. and Flenley, J. (2007) Human settlement of Easter Island – a competing hypothesis. *Earth and Environmental Science Transactions of the Royal Society of Edinburgh*, 98(1): 101-116.

Coleman, C.A., Hudson, S. and Maine, L.L. (2013) Health literacy practices and educational competencies for health professionals: a consensus study. *Journal of Health Communication: International Perspectives*, 18(sup1): 82-102.

Collins Dictionary. (2015). Collins English Dictionary. Online at: http://www.collinsdictionary.com/dictionary/english [accessed 23/11/2015].

Collins, S.L., Carpenter, S.R., Swinton, S.M., Orenstein, D.E., Childers, D.L., Gragson, T.L., Grimm, N.B., Grove, J.M., Harlan, S.L., Kaye, J.P., Knapp, A.K., Kofinas, G.P., Magnuson, J.J., McDowell, W.H., Melack, J.M., Ogden, L.A., Robertson, G.P., Smith, M.D. and Whitmer, A.C. (2011) An integrated conceptual framework for long-term social–ecological research. *Frontiers in Ecology and the Environment*, 9(6): 351-357.

Committee of the Regions. (2012) Opinion of the Committee of the Regions. Building a European culture of multilevel governance: follow-up to the Committee of the Regions' White Paper. Opinion No. CdR 273/2011. 94th plenary session, 15-16 February 2012. CIVEX-V-020. Brussels: Commission for Citizenship, Governance, Institutional and External Affairs (CIVEX), Committee of the Regions. Online at: http://www.toad.cor.europa.eu/Viewdoc.aspx?doc=cdr/civex-v/dossiers/civex-v-020/EN/CDR273-2011_FIN_AC_EN.doc [accessed 23/11/2015].

Conversi, A., Dakos, V., Gårdmark, A., Ling, S., Folke, C., Mumby, P.J., Greene, C., Edwards, M., Blenckner, T., Casini, M., Pershing, A. and Möllmann, C. (2015) A holistic view of marine regime shifts. *Philosophical Transactions of the Royal Society B*, 370: 20130279.

Cooke, R.M. and Goossens, L.H.J. (2004) Expert judgement elicitation for risk assessments of critical infrastructures. *Journal of Risk Research*, 7(6): 643-656.

Corbetta, P. (2003) *Social Research: Theory, Methods and Techniques*. London: Sage.

Cornelissen, A.M.G., van den Berg, J., Koops, W.J. and Kaymak, U. (2003) Elicitation of expert knowledge for fuzzy evaluation of agricultural production systems. *Agriculture, Ecosystems and Environment*, 95(1): 1-18.

Cornell, S., Berkhout, F., Tuinstra, W., Tàbara, J.D., Jäger, J., Chabay, I., de Wit, B., Langlais, R., Mills, D., Moll, P., Otto, I.M., Petersen, A., Pohl, C. and van Kerkhoff, L. (2013) Opening up knowledge systems for better responses to global environmental change. *Environmental Science & Policy*, 28: 60-70.

Cornwall, A. and Jewkes, R. (1995) What is participatory research? *Social Science & Medicine*, 41(12): 1667-1676.

Costanza, R. (1996) Ecological economics: reintegrating the study of humans and nature. *Ecological Applications*, 6(4): 978-990.

Costanza, R. (2001) Visions, values, valuation, and the need for an ecological economics. *BioScience*, 51(6): 459-468.

Costanza, R. (2003) A vision of the future of science: reintegrating the study of humans and the rest of nature. *Futures*, 35(6): 651-671.

Costanza, R. (2011) Changing the way we view humanity and the rest of nature. *Solutions*, 2(6): 1. Online at: http://www.thesolutionsjournal.com/node/1010 [accessed 27/5/2012].

Costanza, R., Alperovitz, G., Daly, H.E., Farley, J., Franco, C., Jackson, T., Kubiszewski, I., Schor, J. and Victor, P. (2012a) Building a Sustainable and Desirable Economy-in-Society-in-Nature. New York: United Nations Department of Economic and Social Affairs, Division for Sustainable Development. Online at: http://www.un.org/esa/dsd/dsd_sd21st/21_pdf/Building_a_Sustainable_and_Desirable_Economy-in-Society-in-Nature.pdf [accessed 23/11/2015].

Costanza, R., Andrade, F., Antunes, P., van den Belt, M., Boersma, D., Boesch, D.F., Catarino, F., Hanna, S., Limburg, K., Low, B., Molitor, M., Pereira, J.G., Rayner, S., Santos, R., Wilson, J. and Young, M. (1998) Principles for sustainable governance of the oceans. *Science*, 281(5374): 198-199.

Costanza, R. and Daly, H.E. (1992) Natural capital and sustainable development. *Conservation Biology*, 6(1): 37-46.

Costanza, R., de Groot, R., Sutton, P., van der Ploeg, S., Anderson, S.J., Kubiszewski, I., Farber, S. and Turner, R.K. (2014) Changes in the global value of ecosystem services. *Global Environmental Change*, 26: 152-158.

Costanza, R., Graumlich, L.J. and Steffen, W. (eds.) (2005) *Sustainability or Collapse? An Integrated History and Future of People on Earth*. Cambridge, MA: MIT Press.

Costanza, R., Graumlich, L., Steffen, W., Crumley, C., Dearing, J., Hibbard, K., Leemans, R., Redman, C. and Schimel, D. (2007a) Sustainability or collapse: what can we learn from integrating the history of humans and the rest of nature? *Ambio*, 36(7): 522-527.

Costanza, R., Low, B.S., Ostrom, E. and Wilson, J.A. (2001) Ecosystems and human systems: a framework for exploring the linkages. Pages 3-20 in: Costanza, R., Low, B., Ostrom, E. and Wilson, J. (eds.) *Institutions, Ecosystems, and Sustainability*. Boca Raton, FL: CRC Press.

Costanza, R., van der Leeuw, S., Hibbard, K., Aulenbach, S., Brewer, S., Burek, M., Cornell, S., Crumley, C., Dearing, J., Folke, C., Graumlich, L., Hegmon, M., Heckbert, S., Jackson, S.T., Kubiszewski, I., Scarborough, V., Sinclair, P., Sörlin, S. and Steffen, W. (2012b) Developing an integrated history and future of people on Earth (IHOPE). *Current Opinion in Environmental Sustainability*, 4(1): 106-114.

Costanza, R., Wainger, L., Folke, C. and Mäler, K.-G. (1993) Modeling complex ecological economic systems: toward an evolutionary, dynamic understanding of people and nature. *BioScience*, 43(8): 545-555.

Council of the EU. (2006) Renewed EU Sustainable Development Strategy as adopted by the European Council on 15/16 June 2006. Annex to Document 10917/06. 26/6/2006. Brussels: Council of the European Union. Online at: http://register.consilium.europa.eu/pdf/en/06/st10/st10917.en06.pdf [accessed 23/11/2015].

Council of the EU. (2008a) Presidency Conclusions of the Brussels European Council, 14 December 2007 (revised 14/2/2008). Doc. 16616/1/07 REV 1. Online at: http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/97669.pdf [accessed 23/11/2015].

Council of the EU. (2011) Council conclusions on the European Union Strategy for the Danube Region. 3083rd General Affairs Council meeting, Brussels, 13 April 2011. Online at: http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/EN/genaff/121511.pdf [accessed 23/11/2015].

CPMR. (2005) Atlantic Spatial Development Perspective. Rennes: Conference of Peripheral Maritime Regions of Europe (CPMR) and Porto: Forward Studies Unit for the Maritime Peripheries (FSU). Online at: http://atlanticarea.ccdr-n.pt/documentation/other-useful-documents/asdp-atlantic-spatial-development-perspective [accessed 23/11/2015].

CPMR. (2009) Draft manifesto "Emerging stronger from the crisis: a European Territorial Pact". Technical paper from the CPMR General Secretariat. Ref. CRPMNTP090016 A0, 23/4/2009. Rennes: Conference of Peripheral Maritime Regions of Europe (CPMR) Online at: http://www.crpm.org/pub/news/166_draft_manifesto_-_emerging_stronger_from_the_crisis.pdf [accessed on 23/11/2015].

CPMR. (2013a) Information on the proposal for a Directive of the European Parliament and of the Council establishing a framework for maritime spatial planning and integrated coastal zone management. Technical paper from the CPMR General Secretariat. Ref. CRPMNTP130021 A1, 22/5/2013. Rennes: Conference of Peripheral Maritime Regions of Europe (CPMR). Online at: http://www.crpm.org/pub/docs/399_tp_iczm_msp.pdf [accessed 10/7/2016].

CPMR. (2013b) Regions at the core of a new deal for Europe. Rennes: Conference of Peripheral Maritime Regions of Europe (CPMR). Online at: http://www.crpm.org/pub/agenda/2726_regions_at_the_core_of_a_new_deal-europe.pdf [accessed 10/7/2016].

Creswell, J.W. (2007) *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*. Second Edition. Thousand Oaks, CA: Sage.

Creswell, J.W. (2009) *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Third Edition. Thousand Oaks, CA: SAGE.

Creswell, J.W. (2012) *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research*. Fourth Edition. Boston, MA: Pearson.

Creswell, J.W. and Miller, D.L. (2000) Determining validity in qualitative inquiry. *Theory Into Practice*, 39(3): 124-130.

Crona, B.I. and Parker, J.N. (2012) Learning in support of governance: theories, methods, and a framework to assess how bridging organizations contribute to adaptive resource governance. *Ecology and Society*, 17(1): 32.

Crutzen, P.J. (2002) Geology of mankind. *Nature*, 415(6867): 23.

Cumming, G.S. (2011a) *Spatial Resilience in Social-Ecological Systems*. Dordrecht: Springer.

Cumming, G.S., Bodin, Ö., Ernstson, H. and Elmqvist, T. (2010) Network analysis in conservation biogeography: challenges and opportunities. *Diversity and Distributions*, 16(3): 414-425.

Cumming, G.S. and Collier, J. (2005) Change and identity in complex systems. *Ecology and Society*, 10(1): 29.

Cumming, G.S., Cumming, D.H.M. and Redman, C.L. (2006) Scale mismatches in social-ecological systems: causes, consequences, and solutions. *Ecology and Society*, 11(1): 14.

Cumming, G.S. and Norberg, J. (2008) Scale and complex systems. Pages 246-276 in Norberg, J. and Cumming, G.S. (eds.) *Complexity Theory for a Sustainable Future*. New York: Columbia University Press.

Cumming, G.S., Olsson, P., Chapin, III, F.S. and Holling, C.S. (2013) Resilience, experimentation, and scale mismatches in social-ecological landscapes. *Landscape Ecology*, 28(6): 1139-1150.

Cunliffe, B. (2001) *Facing the Ocean: The Atlantic and Its Peoples, 8000 BC to AD 1500*. Oxford: Oxford University Press.

Curtin, R. and Prellezo, R. (2010) Understanding marine ecosystem based management: a literature review. *Marine Policy*, 34(5): 821-830.

Dakos, V., Kéfi, S., Rietkerk, M., van Nes, E.H. and Scheffer, M. (2011) Slowing down in spatially patterned ecosystems at the brink of collapse. *The American Naturalist*, 177(6): E153-E166.

Dakos, V., van Nes, E.H., Donangelo, R., Fort, H. and Scheffer, M. (2010) Spatial correlation as leading indicator of catastrophic shifts. *Theoretical Ecology*, 3(3): 163-174.

Dalkey, N. and Helmer, O. (1963) An experimental application of the Delphi method to the use of experts. *Management Science*, 9(3): 458-467.

Daly, K.J. (2007) *Qualitative Methods for Family Studies and Human Development*. Thousand Oaks, CA: Sage.

Damanaki, M. (2013a) Europe in the global maritime economy. Speech by Maria Damanaki, European Commissioner for Maritime Affairs and Fisheries, at the Euromaritime Fair, Paris, 7 February 2013. SPEECH/13/109. Brussels: European Commission. Online at: http://europa.eu/rapid/press-release_SPEECH-13-109_en.htm [accessed 21/5/2016].

Darnhofer, I., Bellon, S., Dedieu, B. and Milestad, R. (2010) Adaptiveness to enhance the sustainability of farming systems. A review. *Agronomy for Sustainable Development*, 30(3): 545-555.

David, P.A. (2005) Path dependence in economic processes: implications for policy analysis in dynamical system contexts. Pages 151-194 in: Dopfer, K. (ed.) *The Evolutionary Foundations of Economics*. Cambridge: Cambridge University Press.

David, P.A. (2007) Path dependence: a foundational concept for historical social science. *Cliometrica*, 1(2): 91-114.

Davidson-Hunt, I.J. and Berkes, F. (2003) Nature and society through the lens of resilience: toward a human-in-ecosystem perspective. Pages 53-82 in: Berkes, F., Colding, J. and Folke, C. (eds.) *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change*. Cambridge: Cambridge University Press.

Davies, P. (2004) The Magenta Book: Guidance Notes for Policy Evaluation and Analysis - Chapter 8: Qualitative Research and Evaluation. How Do You Know Why (and How) Something Works? London: Government Chief Social Researcher's Office, Prime Minister's Strategy Unit, Cabinet Office.

Davis, A. and Wagner, J.R. (2003) Who knows? On the importance of identifying "experts" when researching local ecological knowledge. *Human Ecology*, 31(3): 463-489.

Davoudi, S. (2012) Resilience: a bridging concept or a dead end? Pages 299-307 in: Davoudi, S. and Porter, L. (eds.) Applying the resilience perspective to planning: critical thoughts from theory and practice. *Planning Theory & Practice*, 13(2): 299-333.

Daw, T., Adger, W.N., Brown, K. and Badjeck, M.-C. (2009) Climate change and capture fisheries: potential impacts, adaptation and mitigation. Pages 107-150 in: Cochrane, K., De Young, C., Soto, D. and Bahri, T. (eds.) Climate change implications for fisheries and aquaculture: Overview of current scientific knowledge. FAO Fisheries and Aquaculture Technical Paper, No. 530. Rome: Food and Agriculture Organization of the United Nations (FAO).

Daw, T. and Gray. T. (2005) Fisheries science and sustainability in international policy: a study of failure in the European Union's Common Fisheries Policy. *Marine Policy*, 29(3): 189-197.

Day, J. and Bobeva, M. (2005) A generic toolkit for the successful management of Delphi studies. *Electronic Journal of Business Research Methodology*, 3(2): 103-116.

de Búrca, G. (2003) The constitutional challenge of new governance in the European Union. *European Law Review*, 28(6): 814-839.

de Búrca, G. and Scott, J. (eds.) (2006) *Law and New Governance in the EU and the US*. Oxford: Hart.

de Jager, A.L. and Vogt, J.V. (2010) Development and demonstration of a structured hydrological feature coding system for Europe. *Hydrological Sciences Journal*, 55(5): 661-675.

de Loe, R.C. (1995) Exploring complex policy questions using the policy Delphi. *Applied Geography*, 15(1): 53-68.

de Ruyter, K. (1996) Focus versus nominal group interviews: a comparative analysis. *Marketing Intelligence & Planning*, 14(6): 44-50.

de Vivero, J.L.S. and Mateos, J.C.R. (2004) New factors in ocean governance. From economic to security-based boundaries. *Marine Policy*, 28(2): 185-188.

de Vivero, J.L.S. and Mateos, J.C.R. (2012) The Spanish approach to marine spatial planning. Marine Strategy Framework Directive vs. EU Integrated Maritime Policy. *Marine Policy*, 36(1): 18-27.

de Vos, M.G., Janssen, P.H.M., Kok, M.T.J., Frantzi, S., Dellas, E., Pattberg, P., Petersen, A.C. and Biermann, F. (2013) Formalizing knowledge on international environmental regimes: a first step towards integrating political science in integrated assessments of global environmental change. *Environmental Modelling & Software*, 44: 101-112.

De Young, C., Soto, D., Bahri, T. and Brown, D. (2012) Building resilience for adaptation to climate change in the fisheries and aquaculture sector. Pages 103-116 in: Meybeck, A., Lankoski, J., Redfern, S., Azzu, N. and Gitz, V. (eds.) Building resilience for adaptation to climate change in the agriculture sector. Proceedings of a Joint FAO/OECD Workshop, 23-24 April 2012, FAO headquarters, Rome. Rome: Food and Agriculture Organization of the United Nations (FAO) & Organisation for Economic Co-operation and Development (OECD).

Dekker, S. (2011) *Drift into Failure: From Hunting Broken Components to Understanding Complex Systems*. Farnham, UK: Ashgate.

Delbecq, A.L., Van de Ven, A.H. and Gustafson, D.H. (1975) *Group Techniques for Program Planning: a guide to nominal group and delphi processes*. Glenview, IL: Scott, Foresman and Company.

Denscombe, M. (2010) *The Good Research Guide: For small-scale social research projects*. Fourth Edition. Maidenhead: Open University Press.

Denzin, N.K. and Lincoln, Y.S. (eds.) (2005a) *The SAGE Handbook of Qualitative Research*. Third Edition. Thousand Oaks, CA: Sage.

Denzin, N.K. and Lincoln, Y.S. (2005b) Introduction: the discipline and practice of qualitative research. Pages 1-32 in: Denzin, N. and Lincoln, Y.S. (eds.) *The SAGE Handbook of Qualitative Research*. Third Edition. Thousand Oaks, CA: Sage.

Derissen, S., Quaas, M.F. and Baumgärtner, S. (2011) The relationship between resilience and sustainability of ecological-economic systems. *Ecological Economics*, 70(6): 1121-1128.

Deutsch, L., Folke, C. and Skånberg, K. (2003) The critical natural capital of ecosystem performance as insurance for human well-being. *Ecological Economics*, 44(2-3): 205-217.

Dietz, T. and Henry, A.D. (2008) Context and the commons. *Proceedings of the National Academy of Sciences of the United States of America*, 105(36): 13189-13190.

Dietz, T., Ostrom, E. and Stern, P.C. (2003) The struggle to govern the commons. *Science*, 302: 1902-1912.

Dinter, W.P. (2001) *Biogeography of the OSPAR Maritime Area: a synopsis and synthesis of biogeographical distribution patterns described for the North-East Atlantic*. Bonn: Federal Agency for Nature Conservation, Germany.

Dirnböck, T., Bezák, P., Dullinger, S., Haberl, H., Lotze-Campen, H., Mirtl, M., Peterseil, J., Redpath, S., Singh, S.J., Travis, J. and Wijdeven, S.M.J. (2008) Scaling issues in long-term socio-ecological biodiversity research: a review of European cases. Social Ecology Working Paper No. 100. Vienna: Institute of Social Ecology, Klagenfurt University. Online at: http://www.uni-klu.ac.at/socec/downloads/WP100Webversion.pdf [accessed 23/11/2015].

Dorussen, H., Lenz, H. and Blavoukos, S. (2005) Assessing the reliability and validity of expert interviews. *European Union Politics*, 6(3): 315-337.

Douvere, F. (2008) The importance of marine spatial planning in advancing ecosystem-based sea use management. *Marine Policy*, 32(5): 762-771.

Douvere, F. and Ehler, C.N. (2009) New perspectives on sea use management: initial findings from European experience with marine spatial planning. *Journal of Environmental Management*, 90(1): 77-88.

Drexhage, J. and Murphy, D. (2010) Sustainable Development: From Brundtland to Rio 2012. Background Paper [GSP1-6] prepared for consideration by the [UN Secretary-General's] High Level Panel on Global Sustainability at its first meeting, 19 September 2010, United Nations Headquarters, New York. Online at: http://www.un.org/wcm/webdav/site/climatechange/shared/gsp/docs/GSP1-6_Background%20on%20Sustainable%20Devt.pdf [accessed 23/11/2015].

Drolet, D., Locke, A., Lewis, M.A. and Davidson, J. (2015) Evidence-based tool surpasses expert opinion in predicting probability of eradication of aquatic nonindigenous species. *Ecological Applications*, 25(2): 441-450.

Dubois, A., Hedin, S., Schmitt, P. and Sterling, J. (2009) EU macro-regions and macro-regional strategies – a scoping study. Nordregio Electronic Working Paper 2009:4. Online at: http://www.nordregio.se/Publications/Publications-2009/EU-macro-regions-and-macro-regional-strategies/ [accessed 23/11/2015].

Duggan, E.W. and Thachenkary, C.S. (2004) Integrating nominal group technique and joint application development for improved systems requirements determination. *Information & Management*, 41(4): 399-411.

Duit, A. and Galaz, V. (2008) Governance and complexity—emerging issues for governance theory. *Governance: An International Journal of Policy, Administration, and Institutions*, 21(3): 311-335.

Duit, A., Galaz, V., Eckerberg, K. and Ebbesson, J. (2010) Governance, complexity, and resilience. Global Environmental Change, 20(3): 363-368.

Dul, J. and Hak, T. (2008) *Case Study Methodology in Business Research*. Oxford: Butterworth-Heinemann.

Duménil, G. and Lévy, D. (2011) *The Crisis of Neoliberalism*. Cambridge, MA: Harvard University Press.

Dunsire, A. (1993) Modes of governance. Pages 21-34 in: Kooiman, J. (ed.) (1993) *Modern Governance: New Government-Society Interactions*. London: Sage.

Eakin, H. and Luers, A.L. (2006) Assessing the vulnerability of social-environmental systems. *Annual Review of Environment and Resources*, 31: 365-394.

Ecorys. (2014) Study on Deepening Understanding of Potential Blue Growth in the EU Member States on Europe's Atlantic Arc. Sea basin report - FWC MARE/2012/06 – SC C1/2013/02. 7/3/2013. Client: European Commission, DG MARE. Rotterdam: Ecorys Nederland BV. Online at: https://webgate.ec.europa.eu/maritimeforum/sites/maritimeforum/files/Blue%20Growth%20Atlantic_Seabasin%20report%20FINAL%2007Mar14.pdf [accessed 14/7/2016].

Ecorys, Deltares and Oceanic Développement. (2012) Blue Growth: Scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts – Final Report. 13/8/2012. Client: European Commission, DG MARE. Rotterdam/Brussels: Ecorys Nederland BV. Online at: https://webgate.ec.europa.eu/maritimeforum/en/node/2946 [accessed 21/5/2016].

EEA. (2006) The changing faces of Europe's coastal areas. Report No. 6/2006. European Environment Agency, Copenhagen, Denmark & Luxembourg: Office for Official Publications of the European Communities.

EEA. (2007a) Europe's environment — The fourth assessment. State of the environment report No 1/2007. Copenhagen: European Environment Agency (EEA). Online at: http://www.eea.europa.eu/publications/state_of_environment_report_2007_1 [accessed 23/11/2015].

EEA. (2013) Balancing the future of Europe's coasts – knowledge base for integrated management. Copenhagen: European Environment Agency (EEA).

EEA. (2014) Marine messages: our seas, our future – moving towards a new understanding. Copenhagen: European Environment Agency.

Ehler, C. and Douvere, F. (2009) Marine spatial planning: a step-by-step approach toward ecosystem-based management. UNESCO Intergovernmental Oceanographic Commission (IOC) Manual and Guides No. 53, Integrated Coastal Area Management (ICAM) Programme Dossier No. 6. UNESCO IOC and Man and the Biosphere Programme. Paris: UNESCO. Online at: http://unesdoc.unesco.org/images/0018/001865/186559e.pdf [accessed 21/5/2016].

Ehrlich, P.R. and Ehrlich, A.H. (2013a) Can a collapse of global civilization be avoided? *Proceedings of the Royal Society B*, 280(1754): 20122845.

Ehrlich, P.R. and Ehrlich, A.H. (2013b) Future collapse: how optimistic should we be? *Proceedings of the Royal Society B*, 280(1767): 20131373.

Ehrlich, P.R. and Raven, P.H. (1964) Butterflies and plants: a study in coevolution. *Evolution*, 18(4): 586-608.

Eigenbrod, F., Hecnar, S.J. and Fahrig, L. (2009) Quantifying the road-effect zone: threshold effects of a motorway on anuran populations in Ontario, Canada. *Ecology and Society*, 14(1): 24.

Eisenhardt, K.M. (1989) Building theories from case study research. *Academy of Management Review*, 14(4): 532-550.

Eisenhart, M.A. and Howe, K.R. (1992) Validity in educational research. Pages 644-680 in: LeCompte, M.D., Millroy, W.L. and Preissle, J. (eds.) The handbook of qualitative research in education. San Diego, CA: Academic Press. Cited in: Freeman, M., deMarrais, K., Preissle, J., Roulston, K. and St. Pierre, E.A. (2007) Standards of evidence in qualitative research: an incitement to discourse. *Educational Researcher*, 36(1): 25-32.

Ekins, P., Dresner, S. and Dahlström, K. (2008) The four-capital method of sustainable development evaluation. *European Environment*, 18(2): 63-80.

Engels, T.C.E. and Powell Kennedy, H. (2007) Enhancing a Delphi study on family-focused prevention. *Technological Forecasting & Social Change*, 74(4): 433-451.

Engle, N.L. (2011) Adaptive capacity and its assessment. *Global Environmental Change*, 21(2): 647-656.

Ernstson, H., Barthel, S., Andersson, E. and Borgström, S.T. (2010) Scale-crossing brokers and network governance of urban ecosystem services: the case of Stockholm. *Ecology and Society*, 15(4): 28.

Espineira, T.G. (2014) The Atlantic Arc: new translations for an old identity. *Debater a Europa*, 11: 309-326. DOI: 10.14195/1647-6336_11_16.

ESPON. (2013a) ESaTDOR: European Seas and Territorial Development, Opportunities and Risks. Applied Research 2013/1/5. Final Report, Version 15/4/2013. Executive Summary. Luxembourg: European Observation Network for Territorial Development and Cohesion (ESPON). Online at: http://www.espon.eu/export/sites/default/Documents/Projects/AppliedResearch/ESaTDOR/FR_160413/ESaTDOR_Executive_Summary.pdf [accessed 10/7/2016].

ESPON. (2013b) ESaTDOR: European Seas and Territorial Development, Opportunities and Risks. Annex 3 to the Scientific Report: Atlantic Ocean Regional Profile. Applied Research 2013/1/5. Version 16/1/2013. Luxembourg: European Observation Network for Territorial Development and Cohesion (ESPON). Online at: http://www.espon.eu/export/sites/default/Documents/Projects/AppliedResearch/ESaTDOR/FR_160413/20130417_annexes/ESaTDOR_FR_Annex_3_Atlantic_Profile.pdf [accessed 10/7/2016].

ESPON. (2013c) ESaTDOR: European Seas and Territorial Development, Opportunities and Risks. Annex 9 to the Scientific Report, Governance Case Studies: Atlantic Ocean. Applied Research 2013/1/5. Version 16/1/2013. Luxembourg: European Observation Network for Territorial Development and Cohesion (ESPON). Online at: http://www.espon.eu/export/sites/default/Documents/Projects/AppliedResearch/ESaTDOR/FR_160413/20130417_annexes/ESaTDOR_FR_Annex_9_Atlantic_CS.pdf [accessed 10/7/2016].

EU. (1992) Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. Official Journal of the European Communities, L 206, 22/7/1992, pages 7-50.

EU. (2000) Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. Official Journal of the European Communities, L 327, 22/12/2000, pages 1-73.

EU. (2002a) Recommendation of the European Parliament and of the Council of 30 May 2002 concerning the implementation of Integrated Coastal Zone Management in Europe (2002/413/EC). Official Journal of the European Communities, L 148, 6/6/2002, pages 24-27.

EU. (2002b) Council regulation (EC) No 2371/2002 of 20 December 2002 on the conservation and sustainable exploitation of fisheries resources under the Common Fisheries Policy. Official Journal of the European Communities, L 358, 31/12/2002, pages 59-807.

EU. (2008) Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). Official Journal of the European Union, L 164, 25/6/2008, pages 19-40.

EU. (2009) Protocol on Integrated Coastal Zone Management in the Mediterranean. Official Journal of the European Union, L 34, 4/2/2009, pages 19-28.

EU. (2010) Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds. Official Journal of the European Union, L 20, 26/1/2010, pages 128-146.

EU. (2011) Regulation (EU) No 1255/2011 of the European Parliament and of the Council of 30 November 2011 establishing a Programme to support the further development of an Integrated Maritime Policy. Official Journal of the European Union, L 321, 5/12/2011, pages 1-10.

EU. (2012) Consolidated versions of the Treaty on European Union and the Treaty on the Functioning of the European Union. Notice No 2012/C 326/01. Official Journal of the European Union, C 326, 26/10/2012, pages 1-390.

EU. (2013) Regulation (EU) No 1380/2013 of the European Parliament and of the Council of 11 December 2013 on the Common Fisheries Policy, amending Council Regulations (EC) No 1954/2003 and (EC) No 1224/2009 and repealing Council Regulations (EC) No 2371/2002 and (EC) No 639/2004 and Council Decision 2004/585/EC. Official Journal of the European Union, L 354, 28/12/2013, pages 22-61.

EU. (2014a) Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning. Official Journal of the European Union, L 257, 28/8/2014, pages 135-145.

EU. (2014b) Regulation (EU) No 508/2014 of the European Parliament and of the Council of 15 May 2014 on the European Maritime and Fisheries Fund and repealing Council Regulations (EC) No 2328/2003, (EC) No 861/2006, (EC) No 1198/2006 and (EC) No 791/2007 and Regulation (EU) No 1255/2011 of the European Parliament and of the Council. Official Journal of the European Union, L 149, 20/5/2014, pages 1-66.

EU. (2014c) Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning. Official Journal of the European Union, L 257, 28/8/2014, pages 135-145.

EU Presidency. (2002a) Conclusions from the conference working session on policy – framework for integration, co-ordination and coherence. 'Towards a strategy to protect and conserve the marine environment', Stakeholder Conference, Køge, Denmark, 4-6 December 2002. Danish EU Presidency and the European Commission.

EU Presidency. (2002b) Conclusions from the conference working session on an ecosystem approach to assessment and management. 'Towards a strategy to protect and conserve the marine environment', Stakeholder Conference, Køge, Denmark, 4-6 December 2002. Danish EU Presidency and the European Commission.

EU Presidency. (2011) Territorial Agenda of the European Union 2020: Towards an Inclusive, Smart and Sustainable Europe of Diverse Regions. Agreed at the Informal Ministerial Meeting of Ministers responsible for Spatial Planning and Territorial Development on 19th May 2011 Gödöllő, Hungary. Hungarian Presidency of the Council of the European Union. Online at: http://ec.europa.eu/regional_policy/sources/policy/what/territorial-cohesion/territorial_agenda_2020.pdf [accessed 10/7/2016].

European Commission. (1991) Europe 2000: Outlook for the Development of the Community's Territory. COM(91) 452 final, 7/11/1991. Brussels: Commission of the European Communities (European Commission).

European Commission. (1999) ESDP, European Spatial Development Perspective: Towards Balanced and Sustainable Development of the Territory of the European Union. Agreed at the Informal Council of Ministers responsible for Spatial Planning in Potsdam, May 1999. Online at: http://www.espon-usespon.eu/dane/web_usespon_library_files/1228/esdp_european_spatial_development_perspective.pdf [accessed 25/7/2016].

European Commission. (2001a) European Governance – A White Paper. COM(2001) 428 final, 25/7/2001. Brussels: Commission of the European Communities (European Commission).

European Commission. (2002) Communication from the Commission to the Council and the European Parliament. Towards a strategy to protect and conserve the marine environment. COM(2002) 539 final, 2/10/2002. Brussels: Commission of the European Communities (European Commission).

European Commission. (2004) Thematic Strategy for the Protection and Conservation of the European Marine Environment. Discussion document. 'Second Stakeholder Conference on the Development of a European Marine Strategy', Rotterdam, The Netherlands, 10-12 November 2004. Brussels: European Commission, Directorate-General Environment, Directorate D – Water & Environmental Programmes (European Marine Strategy).

European Commission. (2005a) Strategic Objectives 2005–2009. Europe 2010: A Partnership for European Renewal, Prosperity, Solidarity and Security – Communication from the President in agreement with Vice-President Wallström. COM(2005) 12 final, 26/1/2005. Brussels: Commission of the European Communities (European Commission).

European Commission. (2005b) Communication to the Commission from the President and Mr Borg. Towards a future Maritime Policy for the Union: A European vision for the oceans and seas. SEC(2005) 290, 2/3/2005. Brussels: Commission of the European Communities (European Commission).

European Commission. (2005c) Communication from the Commission to the Council and the European Parliament. Thematic Strategy on the Protection and Conservation of the Marine Environment. COM(2005) 504 final, 24/10/2005. Brussels: Commission of the European Communities (European Commission).

European Commission. (2005d) Proposal for a Directive of the European Parliament and of the Council establishing a Framework for Community Action in the field of Marine Environmental Policy (Marine Strategy Directive). COM(2005) 505 final, 24/10/2005. Brussels: Commission of the European Communities (European Commission).

European Commission. (2006a) Green Paper. Towards a future Maritime Policy for the Union: A European vision for the oceans and seas. COM(2006) 275 final, Volume II – Annex, 7/6/2006. Brussels: Commission of the European Communities (European Commission).

European Commission. (2006b) EU Marine Strategy: The story behind the Strategy. Luxembourg: Office for Official Publications of the European Communities. Online at: http://ec.europa.eu/environment/marine/pdf/eumarinestrategy_storybook.pdf [accessed 10/6/2016].

European Commission. (2007a) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. An Integrated Maritime Policy for the European Union. COM(2007) 575 final, 10/10/2007. Brussels: Commission of the European Communities (European Commission).

European Commission. (2007b) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Conclusions from the Consultation on a European Maritime Policy. COM(2007) 574 final, 10/10/2007. Brussels: Commission of the European Communities (European Commission).

European Commission. (2007c) Commission Staff Working Document. Accompanying document to the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. An Integrated Maritime Policy for the European Union. SEC(2007) 1278, 10/10/2007. Brussels: Commission of the European Communities (European Commission).

European Commission. (2007d) Commission Staff Working Document. Accompanying document to the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. An Integrated Maritime Policy for the European Union. Impact Assessment. SEC(2007) 1279, 10/10/2007. Brussels: Commission of the European Communities (European Commission).

European Commission. (2008a) Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions. Guidelines for an Integrated Approach to Maritime Policy: Towards best practice in integrated maritime governance and stakeholder consultation. COM(2008) 395 final, 26/6/2008. Brussels: Commission of the European Communities (European Commission).

European Commission. (2008b) Communication from the Commission. Roadmap for Maritime Spatial Planning: Achieving Common Principles in the EU. COM(2008) 791 final, 25/11/2008. Brussels: Commission of the European Communities (European Commission).

European Commission. (2009a) Report from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions. Progress Report on the EU's Integrated Maritime Policy. COM(2009) 540 final, 15/10/2009. Brussels: Commission of the European Communities (European Commission).

European Commission. (2009b) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Mainstreaming sustainable development into EU policies: 2009 Review of the European Union Strategy for Sustainable Development. COM(2009) 400 final, 24/7/2009. Brussels: Commission of the European Communities (European Commission).

European Commission. (2009c) Commission Staff Working Document. Accompanying document to the Report from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions. Progress Report on the EU's Integrated Maritime Policy. SEC(2009) 1343 final, 15/10/2009. Brussels: Commission of the European Communities (European Commission).

European Commission. (2009d) From the Baltic Sea to the Danube Basin – a macro-regional strategy for the EU: Commissioner Samecki to present new type of EU cooperation at Ministerial conference (Stockholm). Press release IP/09/1326. 16/9/2009. Brussels: Commission of the European Communities (European Commission). Online at: http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/1326&format=HTML&aged=0&language=EN&guiLanguage=en [accessed 23/11/2015].

European Commission. (2009e) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions concerning the European Union Strategy for the Baltic Sea Region. COM(2009) 248 final, 10/6/2009. Brussels: Commission of the European Communities.

European Commission. (2009f) Commission Staff Working Document. Accompanying the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions concerning the European Union Strategy for the Baltic Sea Region. Action Plan. SEC(2009) 712. Commission of the European Communities, Brussels, 10/6/2009. Updated version: SEC(2009) 712/2. Brussels, May 2010. Online at: http://ec.europa.eu/regional_policy/sources/docoffic/official/communic/baltic/action0520102010.doc [accessed 23/11/2015].

European Commission. (2009g) Green Paper. Reform of the Common Fisheries Policy. COM(2009) 163 final, 22/4/2009. Brussels: Commission of the European Communities (European Commission).

European Commission. (2010a) Commission Staff Working Document. Ex-Ante Evaluation for establishing a Programme to support further development towards an Integrated Maritime Policy. Accompanying document to the Proposal for a Regulation of the European Parliament and of the Council concerning the establishment of a Programme to support the Integrated Maritime Policy. SEC(2010) 1097 final, 29/9/2010. Brussels: European Commission.

European Commission. (2010b) Communication from the Commission. Europe 2020: A strategy for smart, sustainable and inclusive growth. COM(2010) 2020 final, 3/3/2010. Brussels: European Commission.

European Commission. (2010c) Roadmap (Initial impact assessment screening & planning of further work). Initiative: Proposal from the Commission for a Regulation of the European Parliament and of the Council concerning the establishment of a Programme to support further development towards an Integrated Maritime Policy. Brussels: Directorate-General for Maritime Affairs and Fisheries (DG MARE), European Commission. Online at: http://ec.europa.eu/governance/impact/planned_ia/docs/67_mare_imp_financing_programme_en.pdf [accessed 23/11/2015].

European Commission. (2010d) Proposal for a Regulation of the European Parliament and of the Council establishing a Programme to support the further development of an Integrated Maritime Policy. COM(2010) 494 final, 29/9/2010. Brussels: European Commission.

European Commission. (2010e) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. European Union Strategy for Danube Region. COM(2010) 715 final, 8/12/2010. Brussels: European Commission.

European Commission. (2010f) Maritime Spatial Planning for the EU's seas and oceans: what's it all about? Directorate-General for Maritime Affairs and Fisheries, European Commission. Luxembourg: Publications Office of the European Union.

European Commission. (2011a) Proposal for a Regulation of the European Parliament and of the Council on the European Maritime and Fisheries Fund [repealing Council Regulation (EC) No 1198/2006 and Council Regulation(EC) No 861/2006 and Council Regulation No XXX/2011 on integrated maritime policy. COM(2011) 804 final, 2/12/2011. Brussels: European Commission.

European Commission. (2011b) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Developing a Maritime Strategy for the Atlantic Ocean Area. COM(2011) 782 final, 21/11/2011. Brussels: European Commission.

European Commission. (2011c) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Our life insurance, our natural capital: an EU biodiversity strategy to 2020. COM(2011) 244 final, 3/5/2011. Brussels: European Commission.

European Commission. (2012a) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A Maritime Strategy for the Adriatic and Ionian Seas. COM(2012) 713 final, 30/11/2012. Brussels: European Commission.

European Commission. (2012b) Blue Growth: sustainable growth from the oceans, seas and coasts - Summary Report of the Online Public Consultation Results. Brussels: European Commission, DG Maritime Affairs and Fisheries. Online at: http://ec.europa.eu/dgs/maritimeaffairs_fisheries/consultations/blue_growth/blue-growth-consultation-report_en.pdf [accessed 23/11/2015].

European Commission. (2012e) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Blue Growth: opportunities for marine and maritime sustainable growth. COM(2012) 494 final, 13/9/2012. Brussels: European Commission.

European Commission. (2013a) Proposal for a Directive of the European Parliament and of the Council establishing a framework for maritime spatial planning and integrated coastal management. COM(2013) 133 final, 12/3/2013. Brussels: European Commission.

European Commission, (2013b) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Action Plan for a Maritime Strategy in the Atlantic area: Delivering smart, sustainable and inclusive growth. COM(2013) 279 final, 13/5/2013. Brussels: European Commission.

European Commission. (2013c) Questions and answers on the new, reformed Common Fisheries Policy (webpage). MEMO/13/482, 30/5/2013. Brussels: European Commission. Online at: http://europa.eu/rapid/press-release_MEMO-13-482_en.htm [accessed 11/6/2016].

European Commission. (2013d) Research & Innovation and Atlantic Ports – Workshop Atlantic Forum (Cork, 4-5 March 2013). Brussels: European Commission, DG Maritime Affairs and Fisheries.

European Commission. (2014a) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Innovation in the Blue Economy: realising the potential of our seas and oceans for jobs and growth. COM(2014) 254 final/2, 13/5/2014. Brussels: European Commission.

European Commission. (2014b) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions concerning the European Union Strategy for the Adriatic and Ionian Region. COM(2014) 357 final, 17/6/2014. Brussels: European Commission.

European Commission. (2015a). Key actors 2014-2015 (webpage). Brussels: Directorate-General for Maritime Affairs and Fisheries (DG MARE), European Commission. Online at: http://ec.europa.eu/maritimeaffairs/policy/sea_basins/atlantic_ocean/key-actors/index_en.htm [accessed 23/11/2015].

European Commission. (2015b) Integrated maritime policy (webpage). Brussels: Directorate-General for Maritime Affairs and Fisheries (DG MARE), European Commission. Online at: http://ec.europa.eu/maritimeaffairs/policy/index_en.htm [accessed 23/11/2015].

European Commission. (2016a) The Common Fisheries Policy (CFP): Management of EU fisheries (webpage). Brussels: Directorate-General for Maritime Affairs and Fisheries (DG MARE), European Commission. Online at: http://ec.europa.eu/fisheries/cfp/index_en.htm [accessed 10/6/2016].

European Commission. (2016b) EU coastal and marine policy (webpage). Brussels: Directorate-General for Environment (DG ENV), European Commission. Online at: http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/index_en.htm [accessed 10/6/2016].

European Commission. (2016c) Interaction with other policies (webpage). Brussels: Directorate-General for Environment (DG ENV), European Commission. Online at: http://ec.europa.eu/environment/marine/interaction-with-other-policies/index_en.htm [accessed 10/6/2016].

European Council. (2013) Conclusions of the European Council 19/20 December 2013. EUCO 217/13, 20/12/2013. Brussels: European Council.

European Parliament. (2008a) An Integrated Maritime Policy for the European Union. European Parliament resolution of 20 May 2008 on an integrated maritime policy for the European Union (2008/2009(INI)). P6_TA(2008)0213. Strasbourg, 20/5/2008. Online at: www.europarl.europa.eu/sides/getDoc.do?type=TA&reference=P6-TA-2008-0213&language=EN&ring=A6-2008-0163 [accessed 23/11/2015].

European Parliament. (2016) The Common Fisheries Policy: origins and development (webpage). Fact sheets on the European Union. Online at: http://www.europarl.europa.eu/atyourservice/en/displayFtu.html?ftuId=FTU_5.3.1.html [accessed 11/6/2016].

Eurostat. (2016) Maritime economy statistics - coastal regions and sectoral perspective (webpage, last modified 25/2/2016). Data extracted in July 2015. Brussels: Eurostat. Online at: http://ec.europa.eu/eurostat/statistics-explained/index.php/Maritime_economy_statistics_-_coastal_regions_and_sectoral_perspective [accessed 21/5/2016].

Evers, J.C, and van Staa, A. Qualitative data analysis. Pages 749-757 in: Mills, A.J., Durepos, G. and Wiebe, E. (eds.) *Encyclopedia of Case Study Research*. Thousand Oaks, CA: Sage.

Ewert, A.W., Baker, D.C. and Bissix, G.C. (2004) *Integrated Resource and Environmental Management: the Human Dimension*. Wallingford: CABI Publishing.

Fabricius, C. and Currie, B. (2015) Adaptive co-management. Pages 147-179 in: Allen, C.R. and Garmestani, A.S. (eds.) *Adaptive Management of Social-Ecological Systems*. Dordrecht: Springer.

Falk, I. and Kilpatrick, S. (2000) What is social capital? A study of interaction in a rural community. *Sociologia Ruralis*, 40(1): 87-110.

FAO. (2012) The State of World Fisheries and Aquaculture 2012. Rome: Food and Agriculture Organization of the United Nations (FAO).

FAO. (2016) The State of World Fisheries and Aquaculture 2016: Contributing to food security and nutrition for all. Rome: Food and Agriculture Organization of the United Nations (FAO).

Farole, T., Rodríguez-Pose, A. and Storper, M. (2011) Human geography and the institutions that underlie economic growth. *Progress in Human Geography*, 35(1): 58-80.

Farthing, S. and Carrière, J.-P. (2007) Reflections on policy-oriented learning in transnational visioning processes: the case of the Atlantic Spatial Development Perspective (ASDP). *Planning, Practice and Research*, 22(3): 329-345.

Felt, U. (ed.) (2009) *Knowing and Living in Academic Research: Convergences and heterogeneity in research cultures in the European context*. Prague: Institute of Sociology of the Academy of Sciences of the Czech Republic.

Fernandes, P.G. and Cook, R.M. (2013) Reversal of fish stock decline in the Northeast Atlantic. *Current Biology*, 23(15): 1432-1437.

Fernandez-Gimenez, M.E., Ballard, H.L. and Sturtevant, V.E. (2008) Adaptive management and social learning in collaborative and community-based monitoring: a study of five community-based forestry organizations in the western USA. *Ecology and Society*, 13(2): 4.

Fiksel, J. (2006) Sustainability and resilience: toward a systems approach. *Sustainability: Science, Practice, & Policy*, 2(2): 14-21.

Finlay, L. (2002a) "Outing" the researcher: the provenance, process, and practice of reflexivity. *Qualitative Health Research*, 12(4): 531-545.

Finlay, L. (2002b) Negotiating the swamp: the opportunity and challenge of reflexivity in research practice. *Qualitative Research*, 2(2): 209-230.

Fischer, J., Gardner, T.A., Bennett, E.M., Balvanera, P., Biggs, R., Carpenter, S., Daw, T., Folke, C., Hill, R., Hughes, T.P., Luthe, T., Maass, M., Meacham, M., Norström, A.V., Peterson, G., Queiroz, C., Seppelt, R., Spierenburg, M. and Tenhunen, J. (2015) Advancing sustainability through mainstreaming a social–ecological systems perspective. *Current Opinion in Environmental Sustainability*, 14: 144-149.

Fischer-Kowalski, M. and Haberl, H. (1993) Metabolism and colonization. Modes of production and the physical exchange between societies and nature. *Innovation in Social Sciences Research*, 6(4): 415-442.

Fischer-Kowalski, M. and Haberl, H. (1997) Tons, joules, and money: modes of production and their sustainability problems. *Society & Natural Resources: An International Journal*, 10(1): 61-85.

Fischer-Kowalski, M. and Haberl, H. (1998) Sustainable development: socio-economic metabolism and colonization of nature. *International Social Science Journal*, 50(158): 573-587.

Fischer-Kowalski, M. and Haberl, H. (eds.) (2007) *Socioecological Transitions and Global Change: Trajectories of Social Metabolism and Land Use*. Cheltenham: Edward Elgar.

Fischer-Kowalski, M. and Rotmans, J. (2009) Conceptualizing, observing, and influencing social–ecological transitions. *Ecology and Society*, 14(2): 3.

Flannery, W., Ellis, G., Ellis, G., Flannery, W., Nursey-Bray, M., van Tatenhove, J.P.M., Kelly, C., Coffen-Smout, S., Fairgrieve, R., Knol, M., Jentoft, S., Bacon, D. and O'Hagan, A.M. (2016) Exploring the winners and losers of marine environmental governance/Marine spatial planning: Cui bono?/"More than fishy business": epistemology, integration and conflict in marine spatial planning/Marine spatial planning: power and scaping/Surely not all planning is evil?/Marine spatial planning: a Canadian perspective/Maritime spatial planning – "ad utilitatem omnium"/Marine spatial planning: "it is better to be on the train than being hit by it"/Reflections from the perspective of recreational anglers and boats for hire/Maritime spatial planning and marine renewable energy. *Planning Theory & Practice*, 17(1): 121-151.

Fleischman, F.D., Boenning, K., Garcia-Lopez, G.A., Mincey, S., Schmitt-Harsh, M., Daedlow, K., Lopez, M.C., Basurto, X., Fischer, B. and Ostrom, E. (2010) Disturbance, response, and persistence in self-organized forested communities: analysis of robustness and resilience in five communities in southern Indiana. *Ecology and Society*, 15(4): 9.

Fletcher, A.J. and Marchildon, G.P. (2014) Using the Delphi method for qualitative, participatory action research in health leadership. *International Journal of Qualitative Methods*, 13(1): 1-18.

Flyvbjerg, B. (2006) Five misunderstandings about case-study research. *Qualitative Inquiry*, 12(2): 219-245.

Flyvbjerg, B. (2011) Case study. Pages 301-316 in: Denzin, N.K. and Lincoln, Y.S. (eds.) *The SAGE Handbook of Qualitative Research*. Fouth Edition. Thousand Oaks, CA: Sage.

Folke, C. (2006) Resilience: the emergence of a perspective for social–ecological systems analyses. *Global Environmental Change*, 16(3): 253-267.

Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C.S., Walker, B., Bengtsson, J., Berkes, F., Colding, J., Danell, K., Falkenmark, M., Moberg, F., Gordon, L., Kaspersson, R., Kautsky, N., Kinzig, A., Levin, S.A., Mäler, K.-G., Ohlsson, L., Olsson, P., Ostrom, E., Reid, W., Rockström, J., Savenije, H. and Svedin, U. (2002) Resilience and sustainable development: building adaptive capacity in a world of transformations. ICSU Series on Science for Sustainable Development, No. 3. Paris: International Council for Scientific Unions.

Folke, C., Carpenter, S.R., Walker, B., Scheffer, M., Chapin, T. and Rockström, J. (2010). Resilience thinking: integrating resilience, adaptability and transformability. *Ecology and Society*, 15(4): 20.

Folke, C., Carpenter, S., Walker, B., Scheffer, M., Elmqvist, T., Gunderson, L. and Holling, C.S. (2004) Regime shifts, resilience, and biodiversity in ecosystem management. *Annual Review of Ecology, Evolution, and Systematics*, 35: 557-581.

Folke, C., Chapin, III, F.S. and Olsson, P. (2009) Transformations in ecosystem stewardship. Pages 103-125 in Chapin, III, F.S., Kofinas, G.P. and Folke, C. (eds.) *Principles of Ecosystem Stewardship: Resilience-Based Natural Resource Management in a Changing World*. New York: Springer.

Folke, C., Colding, J. and Berkes, F. (2003) Synthesis: building resilience and adaptive capacity in social-ecological systems. Pages 352-387 in Berkes, F., Colding, J. and Folke, C. (eds.) *Navigating Social–Ecological Systems: Building Resilience for Complexity and Change*. Cambridge: Cambridge University Press.

Folke, C. and Gunderson, L. (2006) Facing global change through social-ecological research. *Ecology and Society*, 11(2): 43.

Folke, C., Hahn, T., Olsson, P. and Norberg, J. (2005) Adaptive governance of social-ecological systems. *Annual Review of Environment and Resources*, 30: 441-473.

Folke, C., Jansson, Å., Rockström, J., Olsson, P., Carpenter, S.R., Chapin III, F.S., Crépin, A.-S., Daily, G., Danell, K., Ebbesson, J., Elmqvist, T., Galaz, V., Moberg, F., Nilsson, M., Österblom, H., Ostrom, E., Persson, Å., Peterson, G., Polasky, S., Steffen, W., Walker, B. and Westley, F. (2011a) Reconnecting to the biosphere. *Ambio*, 40(7): 719-738.

François, L. and Isaacs, A.K. (eds.) (2001) *The Sea in European History*. Pisa: Edizioni Plus – Pisa University Press.

Franklin, K.K. and Hart, J.K. (2007) Idea generation and exploration: benefits and limitations of the policy Delphi research method. *Innovation in Higher Education*, 31(4): 237-246.

Frechtling, J. (2002) *The 2002 User-Friendly Handbook for Project Evaluation*. Arlington, VA: National Science Foundation. Online at: http://www.nsf.gov/pubs/2002/nsf02057/nsf02057.pdf [accessed 25/6/2016].

Frechtling, J. and Sharp, L. (eds.) (1997) *User-Friendly Handbook for Mixed Method Evaluation*. Arlington, VA: National Science Foundation. Online at: https://www.nsf.gov/pubs/1997/nsf97153/start.htm [accessed 5/7/2016].

Freeman, M., deMarrais, K., Preissle, J., Roulston, K. and St. Pierre, E.A. (2007) Standards of evidence in qualitative research: an incitement to discourse. *Educational Researcher*, 36(1): 25-32.

Frid, C., Hammer, C., Law, R., Loeng, H., Pawlak, J.F., Reid, P.C. and Tasker, M. (2003). Environmental status of the European seas. Copenhagen: International Council for the Exploration of the Sea (ICES). Online at: http://archimer.ifremer.fr/doc/00040/15135/12473.pdf [accessed 23/11/2015].

Galaz, V., Biermann, F., Crona, B., Loorbach, D., Folke, C., Olsson, P., Nilsson, M., Allouche, J., Persson, Å. and Reischl, G. (2012a) 'Planetary boundaries' — exploring the challenges for global environmental governance. *Current Opinion in Environmental Sustainability*, 4(1): 80-87.

Galaz, V., Crona, B., Österblom, H., Olsson, P. and Folke, C. (2012b) Polycentric systems and interacting planetary boundaries — emerging governance of climate change–ocean acidification–marine biodiversity. *Ecological Economics*, 81: 21-32.

Galaz, V., Moberg, F., Olsson, E.-K., Paglia, E. and Parker, C. (2011) Institutional and political leadership dimensions of cascading ecological crises. *Public Administration*, 89(2): 361-380.

Gallopín, G.C. (1991) Human dimensions of global change: linking the global and local processes. *International Social Science Journal*, 43(4): 707-718.

Gallopín, G.C. (2006) Linkages between vulnerability, resilience, and adaptive capacity. *Global Environmental Change*, 16(3): 293-303.

Gallopín, G. (2007) Linkages between vulnerability, resilience, and adaptive capacity. Presentation to 'Formal Approach to Vulnerability' workshop, Potsdam Institute for Climate Impact Research, Potsdam, Germany, 13-14 September 2007. Online at: http://www.pik-potsdam.de/research/research-domains/transdisciplinary-concepts-and-methods/project-archive/favaia/presentations_vul_ws/gallopin.pdf [accessed 23/11/2015].

Gallopín, G.C., Funtowicz, S., O'Connor, M., Ravetz, J. (2001) Science for the twenty-first century: from social contract to the scientific core. *International Social Science Journal*, 53(168): 219-229.

Gallopín, G.C., Gutman, P. and Maletta, H. (1989) Global impoverishment, sustainable development and the environment: a conceptual approach. *International Social Science Journal*, 41(3): 375-397.

Gallopín, G.C. and Modvar, C. (2005) Sustainable development: epistemological challenges to science and technology. Division of Sustainable Development and Human Settlements, United Nations Economic Commission for Latin America and the Caribbean. CEPAL Series Seminarios y Conferencias (LC/L.2273-P) No. 44. Santiago, Chile, February 2005.

Galparsoro, I., Borja, A. and Uyarra, M.C. (2014) Mapping ecosystem services provided by benthic habitats in the European North Atlantic Ocean. *Frontiers in Marine Science*, 1. DOI: 10.3389/fmars.2014.00023.

Gardner, J.S. and Dekens, J. (2007) Mountain hazards and the resilience of social–ecological systems: lessons learned in India and Canada. *Natural Hazards*, 41(2): 317-336.

Garmestani, A.S., Allen, C.R. and Bessey, K.M. (2008a) Discontinuities in urban systems: comparison of regional city-size structure in the United States. Pages 136-164 in: Allen, C.R. and Holling, C.S. (eds.) *Discontinuities in Ecosystems and Other Complex Systems*. New York: Columbia University Press.

Garmestani, A.S., Allen, C.R. and Cabezas, H. (2008-2009) Panarchy, adaptive management and governance: policy options for building resilience. *Nebraska Law Review*, 87: 1036-1054.

Garmestani, A.S., Allen, C.R. and Gallagher, C.M. (2008b) Power laws, discontinuities and regional city size distributions. *Journal of Economic Behavior & Organization*, 68(1): 209-216.

Garmestani, A.S., Allen, C.R., Gallagher, C.M. and Mittelstaedt, J.D. (2007) Departures from Gibrat's law, discontinuities and city size distributions. *Urban Studies*, 44(10): 1997-2007.

Garmestani, A.S., Allen, C.R. and Gunderson, L. (2009) Panarchy: discontinuities reveal similarities in the dynamic system structure of ecological and social systems. *Ecology and Society*, 14(1): 15.

Garmestani, A.S., Allen, C.R., Mittelstaedt, J.D., Stow, C.A. and Ward, W.A. (2006) Firm size diversity, functional richness, and resilience. *Environment and Development Economics*, 11(4): 533-551.

Garrod, B. (2003) Defining marine ecotourism: a Delphi study. Pages 17-36 in: Garrod, B. and Wilson, J.C. (eds.) *Marine Ecotourism: Issues and Experiences*. Clevedon: Channel View Publications.

Gasparski, W.W. (1991) Systems approach as a style: a hermeneutics of systems. Pages 15-27 in: Jackson, M.C., Mansell, G.J., Flood, R.L., Blackham, R.B. and Probert, S.V.E. (eds.) *Systems Thinking in Europe*. New York: Springer.

Gazzola, P., Roe, M.H. and Cowie, P.J. (2015) Marine spatial planning and terrestrial spatial planning: reflecting on new agendas. *Environment and Planning C: Government and Policy*, 33(5): 1156-1172.

Geels, F.W. (2006) Co-evolutionary and multi-level dynamics in transitions: the transformation of aviation systems and the shift from propeller to turbojet (1930–1970). *Technovation*, 26(9): 999-1016.

Geels, F.W. (2010) Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective. *Research Policy*, 39(4): 495-510.

Geels, F.W. (2011) The multi-level perspective on sustainability transitions: responses to seven criticisms. *Environmental Innovation and Societal Transitions*, 1(1): 24-40.

Geels, F.W. and Schot, J. (2007) Typology of sociotechnical transition pathways. *Research Policy*, 36(3): 399-417.

Gelcich, S., Hughes, T.P., Olsson, P., Folke, C., Defeo, O., Fernándeza, M., Foale, S., Gunderson, L.H., Rodríguez-Sickert, C., Scheffer, M., Steneck, R.S. and Castilla, J.C. (2010) Navigating transformations in governance of Chilean marine coastal resources. *Proceedings of the National Academy of Sciences of the United States of America*, 107(39): 16794-16799.

Gell-Mann, M. (1994) *The Quark and the Jaguar: adventures in the simple and the complex*. New York: W.H. Freeman.

Gell-Mann, M. (1995) What is complexity? *Complexity*, 1(1): 16-19.

Genus, A. and Coles, A.-M. (2008) Rethinking the multi-level perspective of technological transitions. *Research Policy*, 37(9): 1436-1445.

Gerring, J. (2007) *Case Study Research: Principles and Practices*. Cambridge: Cambridge University Press.

Gersick, C.J.G. (1991) Revolutionary change theories: a multi-level exploration of the punctuated equilibrium paradigm. *The Academy of Management Review*, 16(1): 10-36.

Gibson, C.C., Ostrom, E. and Ahn, T.K. (2000) The concept of scale and the human dimensions of global change: a survey. *Ecological Economics*, 32(2): 217-239.

Gilbert, A.J., Alexander, K., Sardá, R., Brazinskaite, R., Fischer, C., Gee, K., Jessopp, M., Kershaw, P., Los, H.J., March Morla, D., O'Mahony, C., Pihlajamäki, M., Rees, S. and Varjopuro, R. (2015) Marine spatial planning and good environmental status: a perspective on spatial and temporal dimensions. *Ecology and Society*, 20(1): 64.

Gilbert, A., Bacher, C., d'Hernoncourt, J., Fernandes, T., Konstantinou, Z., Lowe, C., McFadden, L., Mette, A., Priest, S., Raux, P., Salomons, W., Tett, P., Tunstall, S., and Stojanovic, T. (2011) Coastal SAF Glossary. Science and Policy Integration for Coastal Systems Assessment (SPICOSA) project report, 3/2011. Online at: http://www.coastal-saf.eu/introduction/glossintro.shtml [accessed 23/11/2015].

Gilek, M., Hassler, B. and Jentoft, S. (2015) Marine environmental governance in Europe: problems and opportunities. Pages 249-264 in: Gilek, M. and Kern, K. (eds.) *Governing Europe's Marine Environment: Europeanization of Regional Seas or Regionalization of EU Policies?* Farnham: Ashgate.

Given, L.M. (ed.) (2008) *The SAGE Encyclopedia of Qualitative Research Methods*. Volumes 1 & 2. Thousand Oaks, CA: Sage.

Glaeser, B. (2002) The changing human–nature relationships (HNR) in the context of global environmental change. Pages 11-24 in: Timmerman, P. (vol. ed.) *Encyclopedia of Global Environmental Change*, Vol. 5: Social and economic dimensions of global environmental change. Munn, T. (ed.-in-chief). Chichester: John Wiley & Sons.

Glaeser, B. (2010) *Environment, Development, Agriculture: Integrated Policy Through Human Ecology*. Abingdon: Routledge. [First published in 1995. London: UCL Press.]

Glaeser, B., Bruckmeier, K., Glaser, M. and Krause, G. (2009) Social-ecological systems analysis in coastal and marine areas: a path toward integration of interdisciplinary knowledge. Pages 180-200 in: Lopes, P. and Begossi, A. (eds.) *Current Trends in Human Ecology*. Newcastle upon Tyne: Cambridge Scholars.

Glaeser, B. and Glaser, M. (2010) Global change and coastal threats: the Indonesian case. An attempt in multi-level social-ecological research. *Human Ecology Review*, 17(2): 135-147.

Glaser, B.G. and Strauss, A.L. (1967) *The Discovery of Grounded Theory: Strategies for Qualitative Research*. Piscataway, NJ: AldineTransaction.

Glaser, M. (2006) The social dimension in ecosystem management: strengths and weaknesses of human-nature mind maps. *Human Ecology Review*, 13(2): 122-142.

Glaser, M., Krause, G., Ratter, B. and Welp, M. (2008) Human/nature interaction in the Anthropocene: potential of social-ecological systems analysis. *Gaia*, 17(1): 77-88.

Glaser, M., Krause, G., Ratter, B.M.W. and Welp, M. (eds.) (2012a) *Human-Nature Interactions in the Anthropocene: Potentials of Social-Ecological Systems Analysis*. New York: Routledge.

Glaser, M., Ratter, B.M.W., Krause, G., and Welp, M. (2012b) New approaches to the analysis of human-nature relations. Pages 3-12 in: Glaser, M., Krause, G., Ratter, B.M.W. and Welp, M. (eds.) *Human-Nature Interactions in the Anthropocene: Potentials of Social-Ecological Systems Analysis*. New York: Routledge.

Glavovic, B.C. (2013a) Coastal innovation paradox. *Sustainability*, 5(2): 912-933.

Glavovic, B.C. (2013b) Coastal innovation imperative. *Sustainability*, 5(3): 934-954.

Golafshani, N. (2003) Understanding reliability and validity in qualitative research. *The Qualitative Report*, 8(4): 597-607. Online at: http://www.nova.edu/ssss/QR/QR8-4/golafshani.pdf [accessed 23/11/2015].

Goldman, M. and Schurman, R.A. (2000) Closing the "great divide": new social theory on society and nature. *Annual Review of Sociology*, 26: 563-584.

Gonzalès, R. and Parrott, L. (2012) Network theory in the assessment of the sustainability of social–ecological systems. *Geography Compass*, 6(2): 76-88.

Gordon, L., Torrens, J. and Fremier, A. (2014) Do not lose sight of resilience thinking in the pursuit of resilience metrics. CGIAR Agriculture and Ecosystems Blog, 2/5/2014. CGIAR Research Program on Water, Land and Ecosystems. Online at: http://wle.cgiar.org/blogs/2014/05/02/lose-sight-resilience-thinking-pursuit-resilience-metrics/ [accessed 23/11/2015].

Gordon, T.J. (2003) The Delphi method. In: Glenn, J.C. and Gordon, T.J. (eds.) *Futures Research Methodology Version 2.0* [CD-ROM]. Washington, DC: American Council for the United Nations University. ISBN: 0-9722051-1-X.

Gordon, T.J. (2009) The Delphi method. Chapter 4 in: Glenn, J.C. and Gordon, T.J. (eds.) *Futures Research Methodology Version 3.0* [CD-ROM]. Washington, DC: The Millennium Project. ISBN: 978-0-9818941-1-9.

Gotts, N.M. (2007) Resilience, panarchy, and world-systems analysis. *Ecology and Society*, 12(1): 24.

Grafton, R.Q., Adamowicz, W., Dupont, D., Nelson, H., Hill, R.J. and Renzetti, S. (2004) *The Economics of the Environment and Natural Resources*. Oxford: Blackwell.

Gray, S.A., Gray, S., De Kok, J.L., Helfgott, A.E.R., O'Dwyer, B., Jordan, R. and Nyaki, A. (2015) Using fuzzy cognitive mapping as a participatory approach to analyze change, preferred states, and perceived resilience of social-ecological systems. *Ecology and Society*, 20(2): 11.

Griffin, L. (2012) Where is power in governance? Why geography matters in the theory of governance. *Political Studies Review*, 10(2): 208-220.

Grinin, L. and Korotayev, A. (2009) Social macroevolution: growth of the World System integrity and a system of phase transitions. *World Futures*, 65(7): 477-506.

Grinin, L.E., Korotayev, A.V., Carneiro, R.L. and Spier, F. (2011) Introduction. Evolutionary megaparadigms: potential, problems, perspectives. Pages 5-29 in Grinin, L.E., Korotayev, A.V., Carneiro, R.L. and Spier, F. (eds.) *Evolution: Cosmic, Biological, and Social*. Volgograd: 'Uchitel' Publishing House.

Grothmann, T. and Siebenhüner, B. (2012) Reflexive governance and the importance of individual competencies: the case of adaptation to climate change in Germany. Pages 299-314 in: Brousseau, E., Dedeurwaerdere, T. and Siebenhüner, B. (eds.) *Reflexive Governance for Global Public Goods*. Cambridge, MA: MIT Press.

Grove, J.M. (2009) Cities: managing densely settled social–ecological systems. Pages 281-294 in: Chapin, III, F.S., Kofinas, G.P. and Folke, C. (eds.) *Principles of Ecosystem Stewardship: Resilience-Based Natural Resource Management in a Changing World*. New York: Springer.

Gruber, J.S. (2010) Key principles of community-based natural resource management: a synthesis and interpretation of identified effective approaches for managing the commons. *Environmental Management*, 45(1): 52-66.

Grunwald, A. (2007) Working towards sustainable development in the face of uncertainty and incomplete knowledge. *Journal of Environmental Policy & Planning*, 9(3-4): 245-262.

Gual, M.A. and Norgaard, R.B. (2010) Bridging ecological and social systems coevolution: a review and proposal. *Ecological Economics*, 69(4): 707-717.

Gualini, E. (2006) The rescaling of governance in Europe: new spatial and institutional rationales. *European Planning Studies*, 14(7): 881-904.

Guba, E.G. (1990) The alternative paradigm dialog. Pages 17-27 in: Guba, E.G. (ed.) *The Paradigm Dialog*. Newbury Park, CA: Sage.

Gunderson, L.H. (2000) Ecological resilience – in theory and application. *Annual Review of Ecology and Systematics*, 31: 425-439.

Gunderson, L. (2010) Ecological and human community resilience in response to natural disasters. *Ecology and Society*, 15(2): 18.

Gunderson, L. and Folke, C. (2005) Resilience—now more than ever. *Ecology and Society*, 10(2): 22.

Gunderson, L.H. and Holling, C.S. (eds.) (2002) *Panarchy: Understanding Transformations in Human and Natural Systems*. Washington, DC: Island Press.

Gunderson, L.H., Holling, C.S. and Allen, C.R. (2010) The evolution of an idea — the past, present, and future of ecological resilience. Pages 423-444 in Gunderson, L.H., Allen, C.R. and Holling, C.S. (eds.) *Foundations of Ecological Resilience*. Washington, DC: Island Press.

Gunderson, L.H., Holling, C.S. and Light, S.S. (1995) Barriers broken and bridges built: a synthesis. Pages 489-532 in: Gunderson, L.H., Holling, C.S. and Light, S.S. (eds.) *Barriers and Bridges to the Renewal of Ecosystems and Institutions*. New York: Columbia University Press.

Gunderson, L. and Light, S.S. (2006) Adaptive management and adaptive governance in the everglades ecosystem. *Policy Sciences*, 39(4): 323-334.

Gunderson, L.H., Pritchard, Jr., L., Holling, C.S., Folke, C. and Peterson, G.D. (2002) A summary and synthesis of resilience in large-scale systems. Pages 249-266 in: Gunderson, L.H. and Pritchard, Jr., L. (eds.) *Resilience and the Behavior of Large-Scale Systems*. Washington, DC: Island Press.

Gupta, U.G. and Clarke, R.E. (1996) Theory and applications of the Delphi technique: a bibliography (1975-1994). *Technological Forecasting and Social Change*, 53: 185-211.

Gutiérrez, F.M. and Fernández, R.M. (2010) The development strategy in the Atlantic Europe: Spain in the SDEA project. *Boletín de la Asociación de Geógrafos Españoles*, 52: 395-397.

Haas, P.M. (1992) Introduction: epistemic communities and international policy coordination. *International Organization*, 46(1): 1-35.

Haas, P.M., Kanie, N. and Murphy, C.N. (2004) Conclusion: institutional design and institutional reform for sustainable development. Pages 263-281 in: Kanie, N. and Haas, P.M. (eds.) (2004) *Emerging Forces in Environmental Governance*. Tokyo: United Nations University Press.

Haber, W. (2004) Landscape ecology as a bridge from ecosystems to human ecology. *Ecological Research*, 19(1): 99-106.

Haberl, H., Fischer-Kowalski, M., Krausmann, F., Martinez-Alier, J. and Winiwarter, V. (2011) A socio-metabolic transition towards sustainability? Challenges for another great transformation. *Sustainable Development*, 19(1): 1-14.

Haberl, H., Fischer-Kowalski, M., Krausmann, F., Weisz, H. and Winiwarter, V. (2004) Progress towards sustainability? What the conceptual framework of material and energy flow accounting (MEFA) can offer. *Land Use Policy*, 21(3): 199-213.

Haberl, H., Gaube, V., Díaz-Delgado, R., Krauze, K., Neuner, A., Peterseil, J., Plutzar, C., Singh, S.J. and Vadineanu, A. (2009) Towards an integrated model of socioeconomic biodiversity drivers, pressures and impacts. A feasibility study based on three European long-term socio-ecological research platforms. *Ecological Economics*, 68(6): 1797-1812.

Haberl, H., Winiwarter, V., Andersson, K., Ayres, R.U., Boone, C., Castillo, A., Cunfer, G., Fischer-Kowalski, M., Freudenburg, W.R., Furman, E., Kaufmann, R., Krausmann, F., Langthaler, E., Lotze-Campen, H., Mirtl, M., Redman, C.L., Reenberg, A., Wardell, A., Warr, B. and Zechmeister, H. (2006) From LTER to LTSER: conceptualizing the socioeconomic dimension of long-term socioecological research. *Ecology and Society*, 11(2): 13.

Habibi, A., Sarafrazi, A. and Izadyar, S. (2014) Delphi technique theoretical framework in qualitative research. International Journal of Engineering and Science, 3(4): 8-13.

Hagedorn, K. (2008) Particular requirements for institutional analysis in nature-related sectors. *European Review of Agricultural Economics*, 35(3): 357-384.

Hall, A.D. and Fagen, R.E. (1956) Definition of system. Pages 18-28 in: von Bertalanffy, L. and Rappoport, A. (eds.) *General Systems: Yearbook of the Society for the Advancement of General Systems Theory* [SAGST], Vol.1. Ann Arbor, MI: SAGST.

Halpern, B.S, McLeod, K.L., Rosenberg, A.A. and Crowder, L.B. (2008) Managing for cumulative impacts in ecosystem-based management through ocean zoning. *Ocean & Coastal Management*, 51(3): 203-211.

Hamilton, D.M. and Breslawski, S. (1996) Knowledge acquisition for multiple site, related domain expert systems: Delphi process and application. *Expert Systems with Applications*, 11(3): 377-389.

Hammer, M. (2016) The ecosystem management approach: implications for marine governance. Pages 75-92 in: Gilek, M. and Kern, K. (eds.) *Governing Europe's Marine Environment: Europeanization of Regional Seas Or Regionalization of EU Policies?* Abingdon: Routledge.

Hasson, F., Keeney, S. and McKenna, H. (2000) Research guidelines for the Delphi survey technique. *Journal of Advanced Nursing*, 32(4): 1008-1015.

Hastings, A. (2004) Transients: the key to long-term ecological understanding? *Trends in Ecology & Evolution*, 19(1): 39-45.

Hastings, A. and Gross, L.J. (eds.) (2012) *Encyclopedia of Theoretical Ecology*. Berkeley, CA: University of California Press.

Hauser, C., Tappeiner, G. and Walde, J. (2007) The learning region: the impact of social capital and weak ties on innovation. *Regional Studies*, 41(1): 75-88.

Hediger, W. (2000) Sustainable development and social welfare. *Ecological Economics*, 32(3): 481-492.

Helliwell, J.F. and Putnam, R.D. (1995) Economic growth and social capital in Italy. *Eastern Economic Journal*, 21(3): 295-307.

Helmer, O. and Rescher, N. (1959) On the epistemology of the inexact sciences. *Management Science*, 6(1): 25-52.

Héritier, A. and Rhodes, M. (2011) Conclusion – New modes of governance: emergence, execution, evolution and evaluation. Pages 163-174 in: Héritier, A. and Rhodes, M. (eds.) *New Modes of Governance in Europe: Governing in the Shadow of Hierarchy*. Basingstok: Palgrave Macmillan.

HERO (2001) The HERO e-Delphi system: overview and implementation. Human-Environment Regional Observatory (HERO), Pennsylvania State University, USA. October 2001. Online at: http://hero.geog.psu.edu/products/Delphi_white_paper.pdf [accessed 23/11/2015].

Hesse-Biber, S.N. (2010) *Mixed Methods Research: Merging Theory with Practice*. New York: Guilford Press.

Hesse-Biber, S.N. and Leavy, P. (eds.) (2008) *Handbook of Emergent Methods*. New York: Guilford Press.

Hewitt, J.E. and Thrush, S.F. (2010) Empirical evidence of an approaching alternate state produced by intrinsic community dynamics, climatic variability and management actions. *Marine Ecology Progress Series*, 413: 267-276.

Heynen, N., Kaika, M. and Swyngedouw, E. (2006) Urban political ecology: politicizing the production of urban natures. Pages 1-19 in: Heynen, N., Kaika, M. and Swyngedouw, E. (eds.) *In the Nature of Cities: Urban political ecology and the politics of urban metabolism*. Abingdon: Routledge.

Heynen, N., McCarthy, J., Prudham, S. and Robbins, P. (eds.) (2007) *Neoliberal Environments: False promises and unnatural consequences*. Abingdon: Routledge.

Hilt, S., Köhler, J., Kozerski, H.-P., van Nes, E.H. and Scheffer, M. (2011) Abrupt regime shifts in space and time along rivers and connected lake systems. *Oikos*, 120(5): 766-775.

Hinkel, J. (2011) "Indicators of vulnerability and adaptive capacity": towards a clarification of the science–policy interface. *Global Environmental Change*, 21(1): 198-208.

Hirota, M., Holmgren, M., van Nes, E.H. and Scheffer, M. (2011) Global resilience of tropical forest and savanna to critical transitions. *Science*, 334(6053): 232-235.

Hishamunda, N., Poulain, F. and Ridler, N. (2009) Prospective analysis of aquaculture development: the Delphi method. FAO Fisheries and Aquaculture Technical paper No. 521. Rome: FAO Fisheries and Aquaculture Department, Food and Agriculture Organization of the United Nations (FAO).

Hisschemöller, M, Tol, R.S.J. and Vellinga, P. (2001) The relevance of participatory approaches in integrated environmental assessment. *Integrated Assessment*, 2(2): 57-72.

Hjorth, P. and Bagheri, A. (2006) Navigating towards sustainable development: a system dynamics approach. *Futures*, 38: 74-92.

Hodgson, G.M. (2010) Darwinian coevolution of organizations and the environment. *Ecological Economics*, 69(4): 700-706.

Holding, M.L., Biardi, J.E. and Gibbs, H.L. (2016) Coevolution of venom function and venom resistance in a rattlesnake predator and its squirrel prey. *Proceedings of the Royal Society B*, 283(1829). DOI: 10.1098/rspb.2015.2841.

Holdren, J.P. (2008) Science and technology for sustainable well-being. *Science*, 319(5862): 424-434.

Holland J.H. (1992a) *Adaptation in Natural and Artificial Systems: An Introductory Analysis with Applications to Biology, Control, and Artificial Intelligence*. Cambridge, MA: MIT Press. [Originally published in 1975. Ann Arbor, MI: University of Michigan Press].

Holland, J.H. (1992b) Complex adaptive systems. *Daedalus*, 121(1): 17-30.

Holland, J.H. (1995) *Hidden Order: How Adaptation Builds Complexity*. Reading, MA: Addison-Wesley.

Holland, J.H. (2002) Complex adaptive systems and spontaneous emergence. Pages 25-34 in: Quadrio Curzio, A. and Fortis, M. (eds.) *Complexity and Industrial Clusters: Dynamics and Models in Theory and Practice*. Heidelberg: Physica-Verlag.

Holland, J.H. (2006) Studying complex adaptive systems. *Journal of Systems Science and Complexity*, 19(1): 1-8.

Holland, J.H. (2012) *Signals and Boundaries: Building Blocks for Complex Adaptive Systems*. Cambridge, MA: MIT Press.

Holling, C.S. (1973) Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics*, 4: 1-23.

Holling, C.S. (1986) The resilience of terrestrial ecosystems: local surprise and global change. Pages 292-317 in Clark, W.C. and Munn, R.E. (eds.) *Sustainable Development of the Biosphere*. Cambridge: Cambridge University Press.

Holling, C.S. (1992) Cross-scale morphology, geometry, and dynamics of ecosystems. *Ecological Monographs*, 62(4): 447-502.

Holling, C.S. (1996) Engineering resilience versus ecological resilience. Pages 31-44 in Schulze, P.C. (ed.) *Engineering Within Ecological Constraints*. Washington, DC: National Academy Press.

Holling, C.S. (2001) Understanding the complexity of economic, ecological, and social systems. *Ecosystems*, 4(5): 390-405.

Holling, C.S. (2004) From complex regions to complex worlds. *Ecology and Society*, 9(1): 11.

Holling, B. (2006) A journey of discovery. Personal Memoir, December 2006. Online at: http://www.resalliance.org/files/Buzz_Holling_Memoir_2006_a_journey_of_discovery_buzz_holling.pdf [accessed 23/11/2015].

Holling, C.S. and Gunderson, L.H. (2002) Resilience and adaptive cycles. Pages 25-62 in: Gunderson, L.H. and Holling, C.S. (eds.) *Panarchy: Understanding Transformations in Human and Natural Systems*. Washington, DC: Island Press.

Holling, C.S., Gunderson, L.H. and Peterson, G.D. (2002) Sustainability and panarchies. Pages 63-102 in Gunderson, L.H. and Holling, C.S. (eds.) *Panarchy: Understanding Transformations in Human and Natural Systems*. Washington, DC: Island Press.

Holling, C.S. and Meffe, G.K. (1996) Command and control and the pathology of natural resource management. *Conservation Biology*, 10(2): 328-337.

Holling, C.S., Schindler, D.W., Walker, B.H. and Roughgarden, J. (1995) Biodiversity in the functioning of ecosystems. Pages 44-83 in: Perrings, C., Mäler, K.-G., Folke, C., Holling, C.S. and Jansson, B.-O. (eds.) *Biodiversity Loss: Economic and Ecological Issues*. Cambridge: Cambridge University Press.

Homer-Dixon, T. (2006) *The Upside of Down: Catastrophe, Creativity, and the Renewal of Civilization*. Washington, DC: Island Press.

Homer-Dixon, T., Walker, B., Biggs, R., Crépin, A.-S., Folke, C., Lambin, E.F., Peterson, G.D., Rockström, J., Scheffer, M., Steffen, W. and Troell, M. (2015) Synchronous failure: the emerging causal architecture of global crisis. *Ecology and Society*, 20(3): 6.

Hooghe, L. and Marks, G. (2001) *Multi-Level Governance and European Integration*. Lanham, MA: Rowman & Littlefield.

Hooghe, L. and Marks, G. (2003) Unravelling the central state, but how? Types of multi-level governance. *American Political Science Review*, 97(2): 233-243.

Hopkins , T.S., Bailly, D. and Støttrup, J.G. (2011) A systems approach framework for coastal zones. *Ecology and Society*, 16(4): 25.

Hoverman, S., Ross, H., Chan, T. and Powell, B. (2011) Social learning through participatory integrated catchment risk assessment in the Solomon Islands. *Ecology and Society*, 16(2): 17.

Huitric, M., Walker, B., Moberg, F., Österblom, H., Sandin, L., Grandin, U., Olsson, P. and Bodegård, J. (2009) Biodiversity, Ecosystem Services and Resilience – Governance for a Future with Global Changes. Background report for the scientific workshop ‘Biodiversity, ecosystem services and governance – targets beyond 2010’ in Tjärnö, Sweden, 4-6 September 2009. Stockholm: Albaeco.

Huggett, A.J. (2005) The concept and utility of ‘ecological thresholds’ in biodiversity conservation. *Biological Conservation*, 124(3): 301-310.

Hummel, D., Hertler, C., Niemann, S., Lux, A. and Janowicz, C. (2008a) The central analytical concept: supply systems. Pages 37-58 in: Hummel, D. (ed.) *Population Dynamics and Supply Systems: A Transdisciplinary Approach*. Frankfurt am Main: Campus.

Hurni, H., Wiesmann, U., Anton, P. and Messerli, P. (2004) Initiating research for mitigating syndromes of global change in different contexts. Pages 11-30 in Hurni, H., Wiesmann, U. and Schertenleib, R. (eds.) *Research for Mitigating Syndromes of Global Change: A Transdisciplinary Appraisal of Selected Regions of the World to Prepare Development-Oriented Research Partnerships. Perspectives*, Vol. 1. Swiss National Centre of Competence in Research (NCCR) North–South, University of Berne. Berne: Geographica Bernensia.

Hussen, A.M. (2004) *Principles of Environmental Economics*. Second edition. London: Routledge.

ICES. (2004) Information and advice about appropriate eco-regions for the implementation of an ecosystem approach in European waters [in response to request from DG Environment]. Report of the ICES Advisory Committee on Fishery Management and Advisory Committee on Ecosystems, 2004. Copenhagen: International Council for the Exploration of the Sea (ICES). *ICES Advice*, 1(2): 115-131.

ICSU. (2002) Science and Technology at the World Summit on Sustainable Development: 26 August to 4 September 2002, Johannesburg, South Africa. ICSU Series on Science for Sustainable Development No. 11. Paris: International Council for Science (ICSU). Online at: http://www.icsu.org/publications/reports-and-reviews/science-and-technology-at-the-world-summit-on-sustainable-development-2002/rainbow-series-vol11.pdf [accessed 23/11/2015].

ICSU. (2003) Science and Technology at the World Summit on Sustainable Development, 26 August to 4 September 2002, Johannesburg, South Africa. ICSU Series on Science for Sustainable Development No. 11. Paris: International Council for Science (ICSU). Online at: http://www.icsu.org/publications/reports-and-reviews/science-and-technology-at-the-world-summit-on-sustainable-development-2002/rainbow-series-vol11.pdf [accessed 23/11/2015].

ICSU. (2005) Strategic Plan 2006-2011. Paris: International Council for Science (ICSU). Online at: http://www.icsu.org/publications/reports-and-reviews/icsu-strategic-plan-2006-2011/icsu-strategic-plan-2006-2011.pdf [accessed 23/11/2015].

ICSU (2010). Earth System Science for Global Sustainability: The Grand Challenges. Paris: International Council for Science (ICSU). Online at: http://www.icsu.org/publications/reports-and-reviews/grand-challenges/GrandChallenges_Oct2010.pdf [accessed 23/11/2015].

IEEP. (2003) Assessing the 2002 CFP reforms. Briefing No. 10, January 2003. London: Institute for European Environmental Policy (IEEP). Online at: http://www.ieep.eu/assets/86/CFP10.pdf [accessed 11/6/2016].

IGBP. (2010) Developing an Integrated History and Future of People on Earth (IHOPE): Research Plan. IGBP Report No. 59. Stockholm: International Geosphere-Biosphere Programme (IGBP) Secretariat. Online at: http://www.ihdp.unu.edu/docs/Publications/IHOPE/IHOPE_ResearchPlan_2010.pdf [accessed 23/11/2015].

IHDP. (2007) Strategic Plan 2007-2015: Framing Worldwide Research on the Human Dimensions of Global Environmental Change. Bonn: International Human Dimensions Programme on Global Environmental Change (IHDP). Online at: http://www.ihdp.unu.edu/docs/Publications/Secretariat/Reports/IHDP_StrategicPlan_2007-15.pdf [accessed 23/11/2015].

INTERACT. (2014) EU Macro-Regional Strategies. INTERACT Programme co-financed by the European Regional Development Fund (ERDF). Bratislava: INTERACT Secretariat. Online at http://www.interact-eu.net/macro_regional_strategies/macro_regional_strategies/283/3921 [accessed 23/11/2015].

IPCC. (2014) Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects & Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC). Cambridge: Cambridge University Press. Online at: http://www.ipcc.ch/report/ar5/wg2/ [accessed 12/5/2016].

ISOE. (2015) Social ecology. Frankfurt am Main: Institute for Social-Ecological Research (ISOE). Online at: http://www.isoe.de/en/research/social-ecology/ [accessed 23/11/2015].

IUCN/UNEP/WWF. (1980) World Conservation Strategy: Living Resource Conservation for Sustainable Development. Gland, Switzerland: IUCN (International Union for Conservation of Nature). Online at: https://portals.iucn.org/library/efiles/html/WCS-004/cover.html [accessed 23/11/2015].

Jacobs, S., Burkhard, B., Van Daele, T., Staes, J. and Schneiders, A. (2015) 'The matrix reloaded': a review of expert knowledge use for mapping ecosystem services. *Ecological Modelling*, 295: 21-30.

Jäger, J. (2006) Sustainability science. Pages 19-26 in: Ehlers, E. and Krafft, T. (eds.) *Earth System Science in the Anthropocene*. Linguistic editing by Moss, C. Berlin Heidelberg: Springer.

Jäger, J. (2011) Risks and opportunities for sustainability science in Europe. Pages 187-203 in Jaeger, C.C., Tàbara, J.D. and Jaeger, J. (eds.) *European Research on Sustainable Development. Volume 1: Transformative Science Approaches for Sustainability*. Berlin Heidelberg: Springer.

Jäger, J., Pálsson, G., Goodsite, M., Pahl-Wostl, C., O'Brien, K., Hordijk, L., Avril, B., Cloetingh, S., Holm, P., Toonen, T., Reams, J. and Berkhout, F. (2012) Responses to Environmental and Societal Challenges for our Unstable Earth (RESCUE): ESF Forward Look – ESF-COST 'Frontier of Science' joint initiative. Strasbourg: European Science Foundation (ESF) and Brussels: European Cooperation in Science and Technology (COST). Online at: http://www.esf.org/uploads/media/rescue.pdf [accessed 23/11/2015].

Jahn, T. (2012) Transdisciplinarity as a research practice to approach sustainability challenges – a social-ecological perspective. Paper delivered at the Leuphana Sustainability Summit 2012, Lüneburg University, 29/2/2012-2/3/2012. Frankfurt am Main: Institute for Social-Ecological Research (ISOE). Online at: http://www.isoe.de/uploads/media/jahn-sustainability-summit-lueneburg-2012-en_01.pdf [accessed on 23/11/2015].

Jahn, T., Becker, E., Keil, F. and Schramm, E. (2009) Understanding social-ecological systems: frontier research for sustainable development – implications for European research policy. Paper presented at the 'Sustainable development - a challenge for European research' conference 26-28 May 2009, European Commission, Brussels, Belgium. Online at: http://www.isoe.de/uploads/media/jahn-sust-dev-bruss-2009-en1.pdf [accessed 23/11/2015].

Jamison, A. (2011) Knowledge making in transition: on the changing contexts of science and technology. Pages 93-105 in: Nordmann, A., Radder, H. and Schielmann, G. (eds.). *Science Transformed? Debating Claims of an Epochal Break*. Pittsburgh: University of Pittsburgh Press.

Janssen, M.A. and Anderies, J.M. (2007) Robustness trade-offs in social-ecological systems. *International Journal of the Commons*, 1(1): 43-65.

Janssen, M.A., Bodin, Ö., Anderies, J.M., Elmqvist, T., Ernstson, H., McAllister, R.R.J., Olsson, P. and Ryan, P. (2006) A network perspective on the resilience of social-ecological systems. *Ecology and Society*, 11(1): 15.

Janssen, M.A. and Osnas, E.E. (2005) Adaptive capacity of social-ecological systems: lessons from immune systems. *EcoHealth*, 2(2): 93-101.

Janssen, M.A. and Ostrom, E. (2006) Resilience, vulnerability, and adaptation: a cross-cutting theme of the International Human Dimensions Programme on Global Environmental Change. *Global Environmental Change*, 16(3): 237-239.

Jentoft, S. (2007) Limits of governability: institutional implications for fisheries and coastal governance. *Marine Policy*, 31(4): 360-370.

Jentoft, S. and Chuenpagdee, R. (2009) Fisheries and coastal governance as a wicked problem. *Marine Policy*, 33(4): 553-560.

Jentoft, S. and Chuenpagdee, R. (2015) (eds.) *Interactive Governance for Small-Scale Fisheries: Global Reflections*. Cham: Springer.

Jentoft, S. and Chuenpagdee, R. (2016) The 'new' marine governance: assessing governability. Pages 15-34 in: Gilek, M. and Kern, K. (eds.) *Governing Europe's Marine Environment: Europeanization of Regional Seas Or Regionalization of EU Policies?* Abingdon: Routledge.

Johnson, D.P. (2008) *Contemporary Sociological Theory: An Integrated Multi-Level Approach*. New York: Springer.

Johnson, T.R., Wilson, J.A., Cleaver, C. and Vadas, R.L. (2012) Social-ecological scale mismatches and the collapse of the sea urchin fishery in Maine, USA. *Ecology and Society*, 17(2): 15.

Jones, A.K., Jones, D.L., Edwards-Jones, G. and Cross, P. (2013) Informing decision making in agricultural greenhouse gas mitigation policy: a best–worst scaling survey of expert and farmer opinion in the sheep industry. *Environmental Science & Policy*, 29: 46-56.

Jones, K. (2004) Mission drift in qualitative research, or moving toward a systematic review of qualitative studies, moving back to a more systematic narrative review. *Qualitative Report*, 9(1): 95-112.

JRC-IPTS. (2013) Method. FOR-LEARN Online Foresight Guide. FOR-LEARN is a 6th Framework Programme project of the European Commission, developed by the Institute for Prospective Technological Studies (IPTS), part of the European Commission's Joint Research Centre (JRC). Online at: http://forlearn.jrc.ec.europa.eu/guide/A1_key-terms/method.htm [accessed 23/11/2015].

Juda, L. (1999) Considerations in developing a functional approach to the governance of large marine ecosystems. *Ocean Development & International Law*, 30(2): 89-125.

Juda, L. (2010) The European Union and the Marine Strategy Framework Directive: continuing the development of European ocean use management. *Ocean Development & International Law*, 41(1): 34-54.

Justice, V., Bhaskar, P., Pateman, H., Cain, P. and Cahoon, S. (2016) US container port resilience in a complex and dynamic world. *Maritime Policy & Management*, 43(2): 179-191.

Kaldaru, H. and Parts, E. (2008) Social and institutional factors of economic development: evidence from Europe. *Baltic Journal of Economics*, 8(1): 29-51.

Kallis, G. (2007) Socio-environmental co-evolution: some ideas for an analytical approach. *International Journal of Sustainable Development & World Ecology*, 14(1): 4-13.

Kallis, G. (2010) Coevolution in water resource development: the vicious cycle of water supply and demand in Athens, Greece. *Ecological Economics*, 69(4): 796-809.

Kallis, G. and Norgaard, R.B. (2010) Coevolutionary ecological economics. *Ecological Economics*, 69(4): 690-699.

Kates, R.W., Clark, W.C., Corell, R., Hall, J.M., Jaeger, C.C., Lowe, I., McCarthy, J.J., Schellnhuber, H.J., Bolin, B., Dickson, N.M., Faucheux, S., Gallopin, G.C., Grübler, A., Huntley, B., Jäger, J., Jodha, N.S., Kasperson, R.E., Mabogunje, A., Matson, P., Mooney, H., Moore III, B., O'Riordan, T. and Svedin, U. (2001) Sustainability science. *Science*, 292(5517): 641-642.

Kates, R.W. and Parris, T.M. (2003) Long-term trends and a sustainability transition. *Proceedings of the National Academy of Sciences of the United States of America*, 100(14): 8062-8067.

Kates, R.W., Parris, T.M. and Leiserowitz, A.A. (2005) What is sustainable development? Goals, indicators, values, and practice. *Environment: Science and Policy for Sustainable Development*, 47(3): 8-21.

Kato, S. and Ahern, J. (2011) The concept of threshold and its potential application to landscape planning. *Landscape and Ecological Engineering*, 7(2): 275-282.

Kauffman, S.A. (1993) *The Origins of Order: Self-Organization and Selection in Evolution*. New York: Oxford University Press.

Kauffman, S.A. (1995) *At Home in the Universe: The Search for the Laws of Self-Organization and Complexity*. New York: Oxford University Press.

Keiner, M. (2004) Re-emphasizing sustainable development — the concept of 'evolutionability'. *Environment, Development and Sustainability*, 6(4): 379-392.

Keiner, M. (2006) Rethinking sustainability—editor's introduction. Pages 1-15 in: Keiner, M. (ed.) *The Future of Sustainability*. Dordrecht: Springer.

Kelly, M.J. (2013) Why a collapse of global civilization will be avoided: a comment on Ehrlich & Ehrlich. *Proceedings of the Royal Society B*, 280(1767): 20131193.

Kemp, R., Loorbach, D. and Rotmans, J. (2007) Transition management as a model for managing processes of co-evolution towards sustainable development. *International Journal of Sustainable Development & World Ecology*, 14(1): 78-91.

Kemp, R. and Martens, P. (2007) Sustainable development: how to manage something that is subjective and never can be achieved? *Sustainability: Science, Practice, & Policy*, 3(2): 5-14.

Kennedy, H.P. (2004) Enhancing Delphi research: methods and results. *Journal of Advanced Nursing*, 45(5): 504-511.

Khalilian, S., Froese, R., Proelss, A. and Requate, T. (2010) Designed for failure: a critique of the Common Fisheries Policy of the European Union. *Marine Policy*, 24(6): 1178-1182.

Kim, J. (1999) Making sense of emergence. *Philosophical Studies*, 95(1-2): 3-36.

King, A.W. (1997) Hierarchy theory: a guide to system structure for wildlife biologists. Pages 185-212 in: Bissonette, J.A. (ed.) *Wildlife and Landscape Ecology: Effects of Pattern and Scale*. New York: Springer.

Kinzig, A.P., Ryan, P., Etienne, M., Allison, H., Elmqvist, T. and Walker, B.H. (2006) Resilience and regime shifts: assessing cascading effects. *Ecology and Society*, 11(1): 20.

Klein, C.J., Steinback, C., Watts, M., Scholz, A.J. and Possingham, H.P. (2010) Spatial marine zoning for fisheries and conservation. *Frontiers in Ecology and the Environment*, 8(7): 349-353.

Knowlton, N. (1992) Thresholds and multiple stable states in coral reef community dynamics. *American Zoologist*, 32(6): 674-682.

Knowlton, N. (2004) Multiple “stable” states and the conservation of marine ecosystems. *Progress in Oceanography*, 60(2-4): 387-396.

Koch, E.W., Barbier, E.B., Silliman, B.R., Reed, D.J., Perillo, G.M.E., Hacker, S.D., Granek, E.F., Primavera, J.H., Muthiga, N., Polasky, S., Halpern, B.S., Kennedy, C.J., Kappel, C.V. and Wolanski, E. (2009) Non-linearity in ecosystem services: temporal and spatial variability in coastal protection. *Frontiers in Ecology and the Environment*, 7(1): 29-37.

Kofinas, G.P. (2009) Adaptive co-management in social–ecological governance. Pages 77-101 in Chapin, III, F.S., Kofinas, G.P. and Folke, C. (eds.) *Principles of Ecosystem* Stewardship: Resilience-Based Natural Resource Management in a Changing World. New York: Springer.

Kofinas, G.P. and Chapin, III, F.S. (2009) Sustaining livelihoods and human well-being during social–ecological change. Pages 55-75 in Chapin, III, F.S., Kofinas, G.P. and Folke, C. (eds.) *Principles of Ecosystem Stewardship: Resilience-Based Natural Resource Management in a Changing World*. New York: Springer.

Kohler-Koch, B. and Rittberger, B. (2006) The governance turn in EU studies. *Journal of Common Market Studies*, 44 (Annual Review): 27-49.

Kok, K. and Veldkamp, T.(A.) (2011) Scale and governance: conceptual considerations and practical implications. *Ecology and Society*, 16(2): 23.

Kooiman, J. (1993a) Social-political governance: introduction. Pages 1-7 in: Kooiman, J. (ed.) (1993) *Modern Governance: New Government-Society Interactions*. London: Sage.

Kooiman, J. (1993b) Governance and governability: using complexity, dynamics and diversity. Pages 35-48 in: Kooiman, J. (ed.) *Modern Governance: New Government-Society Interactions*. London: Sage.

Kooiman, J. (1999) Social-political governance: overview, reflections and design. *Public Management: An International Journal of Research and Theory*, 1(1): 67-92.

Kooiman, J. (2003) *Governing as Governance*. London: Sage.

Kooiman, J. (2008) Exploring the concept of governability. *Journal of Comparative Policy Analysis: Research and Practice*, 10(2): 171-190.

Kooiman, J. (2010) Governance and governability. Pages 72-86 in: Osborne, S.P. (ed.) *The New Public Governance? Emerging perspectives on the theory and practice of public governance*. Abingdon: Routledge.

Kooiman, J. and Bavinck, M. (2005) The governance perspective. Pages 11-24 in: Kooiman, J., Bavinck, M,. Jentoft, S. and Pullin, R. (eds). *Fish for Life: Interactive Governance for Fisheries*. Amsterdam: Amsterdam University Press.

Kooiman, J. and Bavinck, M. (2013) Theorizing Governability – The Interactive Governance Perspective. Pages 9-30 in: Bavinck, M., Chuenpagdee, R., Jentoft, S. and Kooiman, J. (eds.) *Governability of Fisheries and Aquaculture: Theory and Applications*. MARE Publication Series, 7. Dordrecht: Springer.

Kooiman, J., Bavinck, M., Chuenpagdee, R., Mahon, R. and Pullin, R. (2008) Interactive governance and governability: an introduction. *The Journal of Transdisciplinary Environmental Studies*, 7(1): 2.

Kooiman, J., Bavinck, M., Jentoft, S. and Pullin, R. (eds.) (2005a) *Fish for Life: Interactive Governance for Fisheries*. Amsterdam: Amsterdam University Press.

Kooiman, J. and Jentoft, S. (2009) Meta-governance: values, norms and principles, and the making of hard choice. *Public Administration*, 87(4): 818-836.

Korotayev, A.V. and Tsirel, S.V. (2010) A spectral analysis of world GDP dynamics: Kondratieff waves, Kuznets swings, Juglar and Kitchin cycles in global economic development, and the 2008-2009 economic crisis. *Structure and Dynamics*, 4(1). Online at: http://www.escholarship.org/uc/item/9jv108xp [accessed 23/11/2015].

Kowalewski, S.A. (2004) The new past: from region to macroregion. *Social Evolution & History*, 3(1): 81-105.

Krausmann, F., Fischer-Kowalski, M., Schandl, H. and Eisenmenger, N. (2008a) The global sociometabolic transition: past and present metabolic profiles and their future trajectories. *Journal of Industrial Ecology*, 12(5-6): 637-656.

Krausmann, F., Schandl, H. and Sieferle, R.P. (2008b) Socio-ecological regime transitions in Austria and the United Kingdom. *Ecological Economics*, 65(1): 187-201.

Krueger, T., Page, T., Hubacek, K., Smith, L. and Hiscock, K. (2012) The role of expert opinion in environmental modelling. *Environmental Modelling & Software*, 36: 4-18.

Kueffer, C., Underwood, E., Hirsch Hadorn, G., Holderegger, R., Lehning, M., Pohl, C., Schirmer, M., Schwarzenbach, R., Stauffacher, M., Wuelser, G. and Edwards, P. (2012) Enabling effective problem-oriented research for sustainable development. *Ecology and Society*, 17(4): 8.

Kuhn, T.S. (1996) *The Structure of Scientific Revolutions*. Third Edition. Chicago: University of Chicago Press. [First edition published in 1962.]

Kumar, P. (2007) Variability, feedback, and cooperative process dynamics: elements of a unifying hydrologic theory. *Geography Compass*, 1(6): 1338-1360.

Kuznets, S. (1955) Economic growth and income inequality. *American Economic Review*, 45(1): 1-28.

Kvale, S. (1995) The social construction of validity. *Qualitative Inquiry*, 1(1): 19-40.

Lago, P.P., Beruvides, M.G., Jian, J.-Y., Canto, A.M., Sandoval, A. and Taraban, R. (2007) Structuring group decision making in a web-based environment by using the nominal group technique. *Computers & Industrial Engineering*, 52(2): 277-295.

Lähdesmäki, T., Hurme, P., Koskimaa, R., Mikkola, L. and Himberg, T. (2013) Philosophy of Science, Method Map, Mapping Research Methods. Jyväskylä: Faculty of Humanities, University of Jyväskylä. Online at: https://koppa.jyu.fi/avoimet/hum/menetelmapolkuja/en/methodmap/philosophy-of-science [accessed 23/11/2015].

Laland, K.N. and Boogert, N.J. (2010) Niche construction, co-evolution and biodiversity. *Ecological Economics*, 69(4): 731-736.

Landeta, J. (2006) Current validity of the Delphi method in social sciences. *Technological Forecasting and Social Change*, 73(5): 467-482.

Lane, D.E. (2010) Is the current fisheries management toolbox sufficient to address climate change? Pages 177-215 in: OECD (ed.) *The Economics of Adapting Fisheries to Climate Change*. Paris: OECD Publishing. [Organisation for Economic Co-operation and Development.] DOI: 10.1787/9789264090415-en.

Langmead, O., McQuatters-Gollop, A. and Mee, L.D. (eds.) (2007) European Lifestyles and Marine Ecosystems: Exploring challenges for managing Europe's seas. Plymouth: University of Plymouth Marine Institute. Online at: http://cordis.europa.eu/documents/documentlibrary/106255051EN6.pdf [accessed 23/11/2015].

Lansing, J.S. (2003) Complex adaptive systems. *Annual Review of Anthropology*, 32: 183-204.

Laszlo, A. and Krippner, S. (1998) Systems theories: their origins, foundations, and development. Pages 47-74 in: Jordan, J.S. (ed.) *Systems Theories and A Priori Aspects of Perception*. Amsterdam: Elsevier.

Latour, B. (1993) *We Have Never Been Modern*. Translated by Porter, C. Cambridge, MA: Harvard University Press.

Latour, B. (1999) *Pandora's Hope: Essays on the Reality of Science Studies*. Cambridge, MA: Harvard University Press.

Latour, B. (2004) *Politics of Nature: How to Bring the Sciences into Democracy*. Translated by Porter, C. Cambridge, MA: Harvard University Press.

Laws, D., Scholz, R.W., Shiroyama, H., Susskind, L., Suzuki, T. and Weber, O. (2004) Expert views on sustainability and technology implementation. *International Journal of Sustainable Development & World Ecology*, 11(3): 247-261.

Le Corbusier (a.k.a. Jeanneret-Gris, C.-É.) (2007) *Toward an Architecture*. Introduction by Cohen, J.-L. Translated by Goodman, J. Los Angeles, CA: Getty Research Institute. [Translation of 1928 printing of *Vers une architecture*, 2nd ed. Originally published in 1924. Paris: G. Crès].

Leal, J., Wordsworth, S., Legood, R. and Blair, E. (2007) Eliciting expert opinion for economic models: an applied example. *Value in Health*, 10(3): 195-203.

Lebel, L. (2002) Chiang Mai Workshop on Sustainability Science: knowledge, technology and institutions for sustainability transitions in Asia – Synthesis. 4-6 February 2002, Chiang Mai University, Thailand. Online at: http://sustsci.harvard.edu/ists/docs/ists_regws_chiangmai_synthesis.pdf [accessed on 23/11/2015].

Lebel, L., Anderies, J.M., Campbell, B., Folke, C., Hatfield-Dodds, S., Hughes, T.P. and Wilson, J. (2006) Governance and the capacity to manage resilience in regional social-ecological systems. *Ecology and Society*, 11(1): 19.

Lebel, L., Tri, N.H., Saengnoree, A., Pasong, S., Buatama, U. and Thoa, L.K. (2002) Industrial transformation and shrimp qquaculture in Thailand and Vietnam: pathways to ecological, social, and economic sustainability? *Ambio*, 1(4): 311-323.

Leemans R, Asrar, G., Busalacchi, A., Canadell, J., Ingram, J., Larigauderie, A., Mooney, H., Nobre, C., Patwardhan, A., Rice, M., Schmidt, F., Seitzinger, S., Virji, H., Vörösmarty, C. and Young, O. (2009) Developing a common strategy for integrative global environmental change research and outreach: the Earth System Science Partnership (ESSP). *Current Opinion in Environmental Sustainability*, 1(1): 4-13.

Lele, S.R. and Allen, K.L. (2006) On using expert opinion in ecological analyses: a frequentist approach. *Environmetrics*, 17(7): 683-704.

Lélé, S. and Norgaard, R.B. (1996) Sustainability and the scientist's burden. *Conservation Biology*, 10(2): 354-365.

Lenhard, J., Lücking, H. and Schwechheimer, H. (2006) Expert knowledge, Mode-2 and scientific disciplines: two contrasting views. *Science and Public Policy*, 33(5): 341-350.

Leslie, H.M. and Kinzig, A.P. (2009) Resilience science. Pages 55-73 in McLeod, K. and Leslie, H. (eds.) *Ecosystem-Based Management for the Oceans*. Washington, DC: Island Press.

Levin, S.A. (1992) The problem of pattern and scale in ecology: the Robert H. MacArthur Award Lecture. *Ecology*, 73(6): 1943-1967.

Levin, S.A. (1998) Ecosystems and the biosphere as complex adaptive systems. *Ecosystems*, 1(5): 431-436.

Levin, S.A. (1999) *Fragile Dominion: Complexity and the Commons*. Cambridge, MA: Perseus Publishing.

Levin, S.A. (2000) Multiple scales and the maintenance of biodiversity. *Ecosystems*, 3(6): 498-506.

Levin, S.A. (2003) Complex adaptive systems: exploring the known, the unknown and the unknowable. *Bulletin of the American Mathematical Society*, 40(1): 3-19.

Levin, S.A. (2005) Self-organization and the emergence of complexity in ecological systems. *BioScience*, 55(12): 1075-1079.

Levin, S.A. (2006) Learning to live in a global commons: socioeconomic challenges for a sustainable environment. *Ecological Research*, 21(3): 328-333.

Levin, S.A. (2010a) Complex adaptive systems and the challenge of sustainability. Pages 129-134 in Levin, S.A. and Clark, W.C. (eds.) Toward a Science of Sustainability: Report from Toward a Science of Sustainability Conference, Airlie Center, Warrenton, Virginia, USA, 29 November–2 December 2009. CID Working Paper No. 196. Cambridge, MA: Center for International Development at Harvard University. Online at: http://www.hks.harvard.edu/centers/cid/publications/faculty-working-papers/cid-working-paper-no.-196 [accessed 23/11/2015].

Levin, S. (2010b) Crossing scales, crossing disciplines: collective motion and collective action in the global commons. *Philosophical Transactions of the Royal Society B*, 365(1537): 13-18.

Levin, S. (2012) Epilogue: the challenge of sustainability: lessons from an evolutionary perspective. Pages 431-437 in: Weinstein, M.P. and Turner, R.E. (eds.) *Sustainability Science: The Emerging Paradigm and the Urban Environment*. New York: Springer.

Levin, S.A., Barrett, S., Aniyar, S., Baumol, W., Bliss, C., Bolin, B., Dasgupta, P., Ehrlich, P., Folke, C., Gren, I.-M., Holling, C.S., Jansson, A., Jansson, B.-O., Mäler, K.-G., Martin, D., Perrings, C. and Sheshinski, E. (1998) Resilience in natural and socioeconomic systems. *Environment and Development Economics*, 3(2): 222-235.

Levin, S.A. and Clark, W.C. (eds.) (2010) Toward a science of sustainability: report from Toward a Science of Sustainability Conference, Airlie Center, Warrenton, Virginia, November 29, 2009 – December 2, 2009. CID Working Paper No. 196. Cambridge, MA: Center for International Development, Harvard University. Online at: http://www.hks.harvard.edu/centers/cid/publications/faculty-working-papers/cid-working-paper-no.-196 [accessed 23/11/2015].

Levin, S.A., Dushoff, J. and Keymer, J.E. (2001) Community assembly and the emergence of ecosystem pattern. *Scientia Marina*, 65(S2): 171-179.

Levin, S.A. and Lubchenco, J. (2008) Resilience, robustness, and marine ecosystem-based management. *BioScience*, 58(1): 27-32.

Levin, S., Xepapadeas, T., Crépin, A.-S., Norberg, J., de Zeeuw, A., Folke, C., Hughes, T., Arrow, K., Barrett, S., Daily, G., Ehrlich, P., Kautsky, N., Mäler, K.-G., Polasky, S., Troell, M., Vincent, J.R. and Walker, B. (2013) Social-ecological systems as complex adaptive systems: modeling and policy implications. *Environment and Development Economics*, 18(2): 111-132.

Lewontin, R.C. (1969) The meaning of stability. *Brookhaven Symposia in Biology*, 22: 13-24.

Linde, C. (2009) *Working the Past: Narrative and Institutional Memory*. New York: Oxford University Press.

Linstone, H.A. and Turoff, M. (eds.) (2002) *The Delphi Technique: Techniques and Applications*. Newark, NJ: New Jersey Institute of Technology. Online at: http://is.njit.edu/pubs/delphibook/ [accessed 25/6/2016].

Liu, J., Dietz, T., Carpenter, S.R., Alberti, M., Folke, C., Moran, E., Pell, A.N., Deadman, P., Kratz, T., Lubchenco, J., Ostrom, E., Ouyang, Z., Provencher, W., Redman, C.L., Schneider, S.H. and Taylor, W.W. (2007a) Complexity of coupled human and natural systems. *Science*, 317(5844): 1513-1516.

Liu, J., Dietz, T., Carpenter, S.R., Folke, C., Alberti, M., Redman, C.L., Schneider, S.H., Ostrom, E., Pell, A.N., Lubchenco, J., Taylor, W.W., Ouyang, Z., Deadman, P., Kratz, T. and Provencher, W. (2007b) Coupled human and natural systems. *Ambio*, 36(8): 639-649.

Lockwood, M., Davidson, J., Curtis, A., Stratford, E. and Griffith, R. (2010) Governance principles for natural resource management. *Society & Natural Resources: An International Journal*, 23(10): 986-1001.

Löf, A. (2010) Exploring adaptability through learning layers and learning loops. *Environmental Education Research*, 16(5-6): 529-543.

Lombard, A.T., Cowling, R.M., Vlok, J.H.J. and Fabricius, C. (2010) Designing conservation corridors in production landscapes: assessment methods, implementation issues, and lessons learned. *Ecology and Society*, 15(3): 7.

Longstaff, P.H. (2009) Managing surprises in complex systems: multidisciplinary perspectives on resilience. *Ecology and Society*, 14(1): 49.

Loorbach, D. (2007) *Transition Management: New mode of governance for sustainable development*. Utrecht: International Books.

Loorbach, D. (2010) Transition management for sustainable development: a prescriptive, complexity-based governance framework. *Governance: An International Journal of Policy, Administration, and Institutions*, 23(1): 161-183.

Loring, P.A. (2007) The most resilient show on earth: the circus as a model for viewing identity, change, and chaos. *Ecology and Society*, 12(1): 9.

Low, B., Ostrom, E., Simon, C. and Wilson, J. (2003) Redundancy and diversity: do they influence optimal management? Pages 83-114 in Berkes, F., Colding, J. and Folke, C. (eds.) *Navigating Social–Ecological Systems: Building Resilience for Complexity and Change*. Cambridge: Cambridge University Press.

Low-Choy, S., Whittle, P. and Anderson, C. (2011) Quantitative approaches to designing plant biosecurity surveillance. In press in: McKirdy, S. (ed.) *Biosecurity in Agriculture and the Environment*. Wallingford: CABI.

Lowe, T.D. and Lorenzoni, I. (2007) Danger is all around: eliciting expert perceptions for managing climate change through a mental models approach. *Global Environmental Change*, 17(1): 131-146.

Lubchenco, J. (1998) Entering the century of the environment: a new social contract for science. *Science*, 279(5350): 491-497.

Ludwig, D., Walker, B. and Holling, C.S. (1997) Sustainability, stability, and resilience. *Conservation Ecology*, 1(1): 7.

Lüdeke, M.K.B., Petschel-Held, G. and Schellnhuber, H.-J. (2004) Syndromes of global change: the first panoramic view. *GAIA*, 13(1): 42-49.

Luks, F. and Siebenhüner, B. (2007) Transdisciplinarity for social learning? The contribution of the German socio-ecological research initiative to sustainability governance. *Ecological Economics*, 63: 418-426.

Lundgren, N.-G. (1996) Bulk trade and maritime transport costs: the evolution of global markets. *Resources Policy*, 22(1-2): 5-32.

Luthe, T. and Wyss, R. (2014) Assessing and planning resilience in tourism. *Tourism Management*, 44: 161-163.

Luthe, T. and Wyss, R. (2016) Resilience to climate change in a cross-scale tourism governance context: a combined quantitative-qualitative network analysis. *Ecology and Society*, 21(1):27.

Lyall, C. and Tait, J. (2005) Shifting policy debates and the implications for governance. Pages 3-17 in: Lyall, C. and Tait, J. (eds.) *New Modes of Governance: Developing an Integrated Policy Approach to Science, Technology, Risk and the Environment*. Aldershot: Ashgate.

MA. (2005) *Ecosystems and Human Well-being: Synthesis*. Millennium Ecosystem Assessment (MA). Washington, DC: Island Press.

Mahon, R., McConney, P. and Roy, R.N. (2008) Governing fisheries as complex adaptive systems. *Marine Policy*, 32(1): 104-112.

Makri, A. (2005) Connecting Health and Vulnerability to Environmental Stress. Stockholm: Stockholm Environment Institute (SEI). Online at: https://www.sei-international.org/mediamanager/documents/Publications/Risk-livelihoods/SEI_Makri_health_vulnerability_2005.pdf [accessed 8/5/2016].

Malloy, T.E., Butner, J., Dickerson, C. and Cooper, J.M. (2010) Fearless-evolution on Boolean landscapes: Boolean phase portraits reveal a new navigation strategy based on fearful symmetry. *Emergence: Complexity and Organization*, 12(3): 65-95.

Manderson, A.K. (2006) A systems based framework to examine the multi-contextural application of the sustainability concept. *Environment, Development and Sustainability*, 8(1): 85-97.

Mare Nostrum. (2014) EU adopts maritime planning directive, but fate of coastal zone legislation unclear. Webpage, 25/5/2014. Online at: http://marenostrumproject.eu/news-events/blog/eu-adopts-maritime-planning-directive-but-fate-of-coastal-zone-legislation-unclear [accessed 10/6/2016].

Markose, S.M. (2005) Computability and evolutionary complexity: markets as complex adaptive systems (CAS). *The Economic Journal*, 115(504): F159-F192.

Marsh, G.P. (1864) *Man and nature; or, Physical geography as modified by human action*. New York: Charles Scribner. Online at: http://memory.loc.gov/cgi-bin/query/r?ammem/consrvbib:@FIELD(NUMBER(vg07))| [accessed on 23/11/2015].

Martens, P. (2006) Sustainability: science or fiction? *Sustainability: Science, Practice, & Policy*, 2(1): 36-41.

Martens, P. and Rotmans, J. (2005) Transitions in a globalising world. *Futures*, 37(10): 1133-1144.

Martin, R. (2010) Roepke lecture in economic geography—rethinking regional path dependence: beyond lock-in to evolution. *Economic Geography*, 86(1): 1-27.

Martin, R. and Simmie, J. (2008) Path dependence and local innovation systems in city-regions. *Innovation: management, policy & practice*, 10(2-3): 183-196.

Martin, R. and Sunley, P. (2006) Path dependence and regional economic evolution. *Journal of Economic Geography*, 6(4): 395-437.

Martin, R. and Sunley, P. (2007) Complexity thinking and evolutionary economic geography. *Journal of Economic Geography*, 7(5): 573-601.

Martin, T.G., Burgman, M.A., Fidler, F., Kuhnert, P.M., Low-Choy, S., McBride, M. and Mengersen, K. (2012) Eliciting expert knowledge in conservation science. *Conservation Biology*, 26(1): 29-38.

Martin, T.G., Kuhnert, P.M., Mengersen, K. and Possingham, H.P. (2005) The power of expert opinion in ecological models using Bayesian methods: impact of grazing on birds. *Ecological Applications*, 15(1): 266-280.

Matthews, J.H. and Boltz, F. (2012) The shifting boundaries of sustainability science: are we doomed yet? *PLoS Biology*, 10(6): e1001344. DOI:10.1371/journal.pbio.1001344.

Maxwell, J.A. (2005) *Qualitative Research Design: An Interactive Approach*. Second Edition. Thousand Oaks, CA: Sage.

May, R.M. (1977). Thresholds and breakpoints in ecosystems with a multiplicity of stable states. *Nature*, 269(5628): 471-477.

Mayer, A.L. and Rietkerk, M. (2004) The dynamic regime concept for ecosystem management and restoration. *BioScience*, 54(11): 1013-1020.

McConnell, W.J., Millington, J.D.A., Reo, N.J., Alberti, M., Asbjornsen, H., Baker, L.A., Brozović, N., Drinkwater, L.E., Drzyzga, S.A., Fragoso, J., Holland, D.S., Jantz, C.A., Kohler, T.A., Maschner, H.D.G., Monticino, M., Podestá, G., Pontius, Jr., R.G., Redman, C.L., Sailor, D., Urquhart, G. and Liu, J. (2011) Research on coupled human and natural systems (CHANS): approach, challenges, and strategies. *Bulletin of the Ecological Society of America*, 92(2): 218-228.

McFadden, L. (2008) Exploring the challenges of integrated coastal zone management and reflecting on contributions to 'integration' from geographical thought. *The Geographical Journal*, 174(4): 299-314.

McGreavy, B., Lindenfeld, L., Hutchins Bieluch, K., Silka, L., Leahy, J. and Zoellick, B. (2015) Communication and sustainability science teams as complex systems. *Ecology and Society*, 20(1): 2.

McKenna, H.P. (1994) he Delphi technique: a worthwhile research approach for nursing? *Journal of Advanced Nursing*, 19(6): 1221-1225.

McLeod, E., Szuster, B., Hinkel, J., Tompkins, E.L., Marshall, N., Downing, T., Wongbusarakum, S., Patwardhan, A., Hamza, M., Anderson, C., Bharwani, S., Hansen, L. and Rubinoff, P. (2015b) Conservation organizations need to consider adaptive capacity: why local input matters. *Conservation Letters*, published online before print, 17/12/2015. DOI: 10.1111/conl.12210.

McLeod, E., Szuster, B., Tompkins, E.L., Marshall, N., Downing, T., Wongbusarakum, S., Patwardhan, A., Hamza, M., Anderson, C., Bharwani, S., Hansen, L. and Rubinoff, P. (2015a) Using expert knowledge to develop a vulnerability and adaptation framework and methodology for application in tropical island communities. *Coastal Management*, 43(4): 365-382.

McMichael, A.J., Butler, C.D. and Folke, C. (2003) New visions for addressing sustainability. *Science*, 302(5652): 1919-1920.

Mee, L., Cooper, P., Kannen, A., Gilbert, J. and O'Higgins, T. (2014) Sustaining Europe's seas as coupled social-ecological systems. *Ecology and Society*, 20(1): 1.

Melkert, M. and Vos, K. (2010) A comparison of quantitative and qualitative approaches: complementarities and trade-offs. Pages 33-40 in: Richards, G. and Munsters, W. (eds.) *Cultural Tourism Research Methods*. Wallingford: CABI.

Mertens, D.M. (2010) *Research and Evaluation in Education and Psychology: Integrating Diversity With Quantitative, Qualitative, and Mixed Methods*. 3rd Edition. Thousand Oaks, CA: Sage.

Metzger, M.J., Bunce, R.G.H., van Eupen, M. and Mirtl, M. (2010) An assessment of long term ecosystem research activities across European socio-ecological gradients. *Journal of Environmental Management*, 91(6): 1357-1365.

Miles, M.B. and Huberman, A.M. (1994) *Qualitative Data Analysis: An Expanded Sourcebook*. London: Sage.

Miller, F., Osbahr, H. ,Boyd, E., Thomalla, F., Bharwani, S., Ziervogel, G., Walker, B., Birkmann, J., van der Leeuw, S., Rockström, J., Hinkel, J., Downing, T., Folke, C. and Nelson, D. (2010) Resilience and vulnerability: complementary or conflicting concepts? *Ecology and Society*, 15(3): 11.

Miller, J.H. and Page, S.E. (2007) *Complex Adaptive Systems: an introduction to computational models of social life*. Princeton, NJ: Princeton University Press.

Miller, T.R. (2013) Constructing sustainability science: emerging perspectives and research trajectories. *Sustainability Science*, 8(2): 279-293.

Mirtl, M. (2010) Introducing the next generation of ecosystem research in Europe: LTER-Europe's multi-functional and multi-scale approach. Pages 75-93 in: Müller, F., Baessler, C., Schubert, H. and Klotz, S. (eds.) *Long-Term Ecological Research: Between Theory and Application*. Dordrecht: Springer.

Mitchell, M. (2009) *Complexity: A Guided Tour*. New York: Oxford University Press.

Mitchell, R.K., Agle, B.R. and Wood, D.J. (1997) Toward a theory of stakeholder identification and salience: defining the principle of who and what really counts. *Academy of Management Review*, 22(4): 853-886.

Mitroff, I.I. and Turoff, M. (2002) Philosophical and methodological foundations of Delphi. Pages 17-34 in: Linstone, H.A. and Turoff, M. (eds.) *The Delphi Technique: Techniques and Applications*. Newark, NJ: New Jersey Institute of Technology. Online at: http://is.njit.edu/pubs/delphibook/ [accessed 25/6/2016].

Moore, M. and Westley, F. (2011) Surmountable chasms: networks and social innovation for resilient systems. *Ecology and Society*, 16(1): 5.

Moore, M.-L., Westley, F.R., Tjornbo, O. and Holroyd, C. (2012) The loop, the lens, and the lesson: using resilience theory to examine public policy and social innovation. Pages 89-113 in: Nicholls, A. and Murdock, A. (eds.) *Social Innovation: Blurring Boundaries to Reconfigure Markets*. Basingstoke: Palgrave Macmillan.

Moran, E.F. (2006) *People and Nature: An Introduction to Human Ecological Relations*. Oxford: Blackwell.

Moran, E.F. (2010) *Environmental Social Science: Human–Environment Interactions and Sustainability*. Chichester: John Wiley & Sons.

Moran, E.F. and Brondízio, E.S. (2013) Introduction to human-environment interactions research. Pages 1-24 in: Brondízio, E.S. and Moran, E.F. (eds.) *Human-Environment Interactions: Current and Future Directions*. Dordrecht: Springer.

Moran, E.F. and Ostrom, E. (eds.) (2005) *Seeing the Forest and the Trees: Human-Environment Interactions in Forest Ecosystems*. Cambridge, MA: MIT Press.

Mostert, E., Pahl-Wostl, C., Rees, Y., Searle, B., Tàbara, D. and Tippett, J. (2007) Social learning in European river-basin management: barriers and fostering mechanisms from 10 river basins. *Ecology and Society*, 12(1): 19.

Müller, B. (2011) Urban and regional resilience – a new catchword or a consistent concept for research and practice? Remarks concerning the international debate and the German discussion. Pages 1-13 in: Müller, B. (ed.) *German Annual of Spatial Research and Policy 2010. Urban Regional Resilience: How Do Cities and Regions Deal with Change?* Berlin Heidelberg: Springer.

Murawski, S.A. (2007) Ten myths concerning ecosystem approaches to marine resource management. *Marine Policy*, 31(6): 681-690.

Musacchio, L.R. (2011) The grand challenge to operationalize landscape sustainability and the design-in-science paradigm. *Landscape Ecology*, 26(1): 1-5.

Myers, N. and Kent, J. (2001) *Perverse Subsidies: How Tax Dollars Can Undercut the Environment and the Economy*. Washington DC: Island Press.

Naveh, Z. (2007) Landscape ecology and sustainability. *Landscape Ecology*, 22(10): 1437-1440.

Nelson, D.R. (2011) Adaptation and resilience: responding to a changing climate. *Wiley Interdisciplinary Reviews: Climate Change*, 2(1): 113-120.

Nelson, D.R., Adger, W.N. and Brown, K. (2007) Adaptation to environmental change: contributions of a resilience framework. *Annual Review of Environment and Resources*, 32: 395-419.

Newell, B., Crumley, C.L., Hassan, N., Lambin, E.F., Pahl-Wostl, C., Underdal, A. and Wasson, R. (2005) A conceptual template for integrative human–environment research. *Global Environmental Change*, 15(4): 299-307.

Nguyen, T.G. and de Kok, J.L. (2007) Systematic testing of an integrated systems model for coastal zone management using sensitivity and uncertainty analyses. *Environmental Modelling & Software*, 22(11): 1572-1587.

NOAA. (2015) Large Marine Ecosystems of the World. Online at: http://www.st.nmfs.noaa.gov/ecosystems/lme/ [accessed on 23/11/2015].

Norberg, J. and Cumming, G.S. (eds.) (2008) *Complexity Theory for a Sustainable Future*. New York: Columbia University Press.

Norgaard, R.B. (1984) Coevolutionary development potential. *Land Economics*, 60(2): 160-173.

Norgaard, R.B. (1994) *Development Betrayed: The end of progress and a coevolutionary revisioning of the future*. London: Routledge.

Northrop, R.B. (2011) *Introduction to Complexity and Complex Systems*. Boca Raton, FL: CRC Press.

Novak, J.D. and Cañas, A.J. (2008) The theory underlying concept maps and how to construct them. Technical Report IHMC CmapTools 2006-01 Rev 01-2008. Pensacola, FL: Institute for Human and Machine Cognition (IHMC).

Nowotny, H. (2003) Democratising expertise and socially robust knowledge. *Science and Public Policy*, 30(3): 151-156.

NRC. (1999a) *Our Common Journey: a transition toward sustainability*. Board on Sustainable Development, National Research Council (NRC). Washington, DC: National Academy Press.

NRC. (1999b) *Human Dimensions of Global Environmental Change: Research Pathways for the Next Decade*. Committee on the Human Dimensions of Global Change and Committee on Global Change Research, National Research Council (NRC). Washington, DC: National Academy Press.

Nuno, A., Bunnefeld, N. and Milner-Gulland, E.J. (2014) Managing social–ecological systems under uncertainty: implementation in the real world. *Ecology and Society*, 19(2): 52.

Nyström, M., Folke, C. and Moberg, F. (2000) Coral reef disturbance and resilience in a human-dominated environment. *Trends in Ecology & Evolution*, 15(10): 413-417.

Nyström, M., Graham, N.A.J., Lokrantz, J. and Norström, A.V. (2008) Capturing the cornerstones of coral reef resilience: linking theory to practice. *Coral Reefs*, 27(4): 795-809.

O'Hagan, A.M. (2013) Comprehensive review of law, policy and institutional frameworks that cover the current approaches to interactions between aquaculture, fisheries and other sectors and identifying barriers and opportunities for more efficient management. Deliverable 2.5. Report prepared as part of the EU 7th Framework project - Interaction in coastal waters: A roadmap to sustainable integration of aquaculture and fisheries (COEXIST), Project number: 245178. Online at: http://www.coexistproject.eu/images/COEXIST/deliverables/WP2/COEXIST_245178_D2.5_FINAL.pdf [accessed 14/6/2016].

Ohl, C., Johst, K., Meyerhoff, J., Beckenkamp, M., Grüsgen, V. and Drechsler, M. (2010) Long-term socio-ecological research (LTSER) for biodiversity protection – a complex systems approach for the study of dynamic human–nature interactions. *Ecological Complexity*, 7(2): 170-178.

Ohl, C. and Swinton, S.M. (2010) Integrating social sciences into long-term ecological research. Pages 399-410 in: Müller, F., Baessler, C., Schubert, H. and Klotz, S. (eds.) *Long-Term Ecological Research: Between Theory and Application*. Dordrecht: Springer.

Okoli, C. and Pawlowski, S.D. (2004) The Delphi method as a research tool: an example, design considerations and applications. *Information & Management*, 42(1): 15-29.

Olsen, S. and Christie, P. (2000) What are we learning from tropical coastal management experiences? *Coastal Management*, 28(1): 5-18.

Olsson, L., Jerneck, A., Thoren, H., Persson, J. and O'Byrne, D. (2015) Why resilience is unappealing to social science: theoretical and empirical investigations of the scientific use of resilience. *Science Advances*, 1(4): e1400217. DOI: 10.1126/sciadv.1400217.

Olsson, P., Bodin, Ö. and Folke, C. (2010) Building transformative capacity for ecosystem stewardship in social–ecological systems. Pages 263-285 in Armitage, D. and Plummer, R. (eds.) *Adaptive Capacity and Environmental Governance*. Berlin Heidelberg: Springer.

Olsson, P., Folke, C. and Berkes, F. (2004b) Adaptive comanagement for building resilience in social–ecological systems. *Environmental Management*, 34(1): 75-90.

Olsson, P., Folke, C., Galaz, V., Hahn, T. and Schultz, L. (2007) Enhancing the fit through adaptive co-management: creating and maintaining bridging functions for matching scales in the Kristianstads Vattenrike Biosphere Reserve, Sweden. *Ecology and Society*, 12(1): 28.

Olsson, P., Folke, C. and Hahn, T. (2004a) Social-ecological transformation for ecosystem management: the development of adaptive co-management of a wetland landscape in southern Sweden. *Ecology and Society*, 9(4): 2.

Olsson, P., Folke, C. and Hughes, T.P. (2008) Navigating the transition to ecosystem-based management of the Great Barrier Reef, Australia. *Proceedings of the National Academy of Sciences of the United States of America*, 105(28): 9489-9494.

Olsson, P., Gunderson, L.H., Carpenter, S.R., Ryan, P., Lebel, L., Folke, C. and Holling, C.S. (2006) Shooting the rapids: navigating transitions to adaptive governance of social-ecological systems. *Ecology and Society*, 11(1): 18.

O'Mahony, C., Kopke, K., Twomey, S., O'Hagan, A.M., Farrell, E. and Gault, J. (2014) Integrated coastal zone management in Ireland - meeting Water Framework Directive and Marine Strategy Framework Directive targets for Ireland's transitional and coastal waters through implementation of integrated coastal zone management. Report prepared under contract for Sustainable Water Network (SWAN). Online at: www.swanireland.ie/download/resources/coastal_&_marine/ICZM%20Report.pdf [accessed 14/6/2016].

O'Mahony, T., Zhou, P. and Sweeney, J. (2013) Integrated scenarios of energy-related CO2 emissions in Ireland: a multi-sectoral analysis to 2020. *Ecological Economics*, 93: 385-397.

Ommer, R.E. and Perry, R.I. (2011) Conclusion: hierarchy, power, and potential regime shifts in marine social-ecological systems. Pages 403-406 in: Ommer, R.E., Perry, R.I., Cochrane, K. and Cury, P. (eds.) *World Fisheries: A Social-Ecological Analysis*. Oxford: Wiley-Blackwell.

Ommer, R.E., Perry, R.I., Murray, G. and Neis, B. (2012) Social–ecological dynamism, knowledge, and sustainable coastal marine fisheries. *Current Opinion in Environmental Sustainability*, 4(3): 316-322.

Onwuegbuzie, A.J. and Leech, N.L. (2005) On becoming a pragmatic researcher: the importance of combining quantitative and qualitative research methodologies. *International Journal of Social Research Methodology*, 8(5): 375-387.

Onwuegbuzie, A.J. and Leech, N.L. (2007) Validity and qualitative research: an oxymoron? *Quality & Quantity*, 41: 233-249.

OSPAR. (2000) Quality Status Report 2000. London: OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic.

OSPAR. (2010) Quality Status Report 2010. London: OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic. Online at: http://qsr2010.ospar.org/en/index.html [accessed 23/11/2015].

Österblom, H., Sissenwine, M., Symes, D., Kadin, M., Daw, T. and Folke, C. (2011) Incentives, social–ecological feedbacks and European fisheries. *Marine Policy*, 35(5): 568-574.

Ostrom, E. (2005) *Understanding Institutional Diversity*. Princeton, NJ: Princeton University Press.

Ostrom, E. (2007) A diagnostic approach for going beyond panaceas. *Proceedings of the National Academy of Sciences of the United States of America*, 104(39): 15181-15187.

Ostrom, E. (2008) Frameworks and theories of environmental change. *Global Environmental Change*, 18(2): 249-252.

Ostrom, E. (2009) A general framework for analyzing sustainability of social-ecological systems. *Science*, 325(5939): 419-422.

Ostrom, E. (2011-2012) The challenges of achieving conservation and development. *The Annual Proceedings of the Wealth and Well-Being of Nations*, 4: 21-27.

Ostrom, E. and Cox, M. (2010) Moving beyond panaceas: a multi-tiered diagnostic approach for social-ecological analysis. *Environmental Conservation*, 37(4): 451-463.

Ostrom, E., Janssen, M.A. and Anderies, J.M. (2007) Going beyond panaceas. *Proceedings of the National Academy of Sciences of the United States of America*, 104(39): 15176-15178.

Ostrom, V., Tiebout, C.M. and Warren, R. (1961) The organization of government in metropolitan areas: a theoretical inquiry. *American Political Science Review*, 55(4): 831-842.

Overdevest, C. and Zeitlin, J. (2014) Assembling an experimentalist regime: transnational governance interactions in the forest sector. *Regulation & Governance*, 8(1): 22-48.

Owens, S. and Cowell, R. (2002) *Land and Limits: Interpreting sustainability in the planning process*. London: Routledge.

Oxford Dictionary. (2015) Oxford Dictionaries Online (Oxford University Press). Online at: http://oxforddictionaries.com/ [accessed 23/11/2015].

Özbekhan, H. (1970) The Predicament of Mankind: Quest for Structured Responses to Growing World-Wide Complexities and Uncertainties. A Proposal. Prospectus of the Club of Rome.

Özbekhan, H. (1977) The future of Paris: a systems study in strategic urban planning. *Philosophical Transactions of the Royal Society of London. Series A, Mathematical and Physical Sciences*, 287(1346): 523-544.

Pahl-Wostl, C. (2007) Transitions towards adaptive management of water facing climate and global change. *Water Resource Management*, 21(1): 49-62.

Pahl-Wostl, C. (2009) A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. *Global Environmental Change*, 19(3): 354-365.

Pahl-Wostl, C., Craps, M., Dewulf, A., Mostert, E., Tabara, D. and Taillieu, T. (2007) Social learning and water resources management. *Ecology and Society*, 12(2): 5.

Pahl-Wostl, C., Holtz, G., Kastens, B. and Knieper, C. (2010) Analyzing complex water governance regimes: the management and transition framework. *Environmental Science & Policy*, 13(7): 571-581.

Pahl-Wostl, C., Lebel, L., Knieper, C. and Nikitina, E. (2012) From applying panaceas to mastering complexity: toward adaptive water governance in river basins. *Environmental Science & Policy*, 23: 24-34.

Paraskevopoulos, C., Getimes, P. and Rees, N. (eds.) (2006) *Adapting to EU Multi-Level Governance: Regional and Environmental Policies in Cohesion and CEE Countries*. Aldershot, UK: Ashgate Publishing.

Parenti, C. (2011) *Tropic of Chaos: Climate Change and the New Geography of Violence*. New York: Nation Books.

Parissaki, M. and Humphreys, E. (2005) Regional social capital in Europe. European Foundation for the Improvement of Living and Working Conditions (Eurofound). Luxembourg: Office for Official Publications of the European Communities. Online at: http://www.eurofound.europa.eu/pubdocs/2004/114/en/1/ef04114en.pdf [accessed 23/11/2015].

Parris, T.M. and Kates, R.W. (2003) Characterizing a sustainability transition: goals, targets, trends, and driving forces. *Proceedings of the National Academy of Sciences of the United States of America*, 100(14): 8068-8073.

Parrott, L., Chion, C., Gonzalès, R. and Latombe, G. (2012) Agents, individuals, and networks: modeling methods to inform natural resource management in regional landscapes. *Ecology and Society*, 17(3): 32.

Parrott, L. and Lange, H. (2013) An introduction to complexity science. Pages 17-33 in: Messier, C., Puettmann, K.J. and Coates, K.D. (eds.) *Managing Forests as Complex Adaptive Systems: Building resilience to the challenge of global change*. New York: Routledge.

Parrott, L. and Meyer, W.S. (2012) Future landscapes: managing within complexity. *Frontiers in Ecology and the Environment*, 10(7): 382-389.

Pauli, G. (2010) The Blue Economy: 10 Years, 100 Innovations, 100 Million Jobs - Report to the Club of Rome. Taos, NM: Paradigm Publications.

Pawłowski, A. (2007) How many dimensions does sustainable development have? *Sustainable Development*, 16(2): 81-90.

Penas Lado, E. (2016) *The Common Fisheries Policy: The Quest for Sustainability*. Oxford: Wiley Blackwell.

Pendall, R., Foster, K.A. and Cowell, M. (2010) Resilience and regions: building understanding of the metaphor. *Cambridge Journal of Regions, Economy and Society*, 3(1): 71-84.

Perry, R.I., Barange, B. and Ommer, R.E. (2010a) Global changes in marine systems: a social–ecological approach. *Progress in Oceanography*, 87(1-4): 331-337.

Perry, R.I., Ommer, R.E., Barange, M., Jentoft, S., Neis, B. and Sumaila, R.U. (2011) Marine social–ecological responses to environmental change and the impacts of globalization. *Fish and Fisheries*, 12(4): 427-450.

Perry, R.I., Ommer, R.E., Barange, M. and Werner, F. (2010b) The challenge of adapting marine social–ecological systems to the additional stress of climate change. *Current Opinion in Environmental Sustainability*, 2(5-6): 356-363.

Peterson, G. (2000) Political ecology and ecological resilience: an integration of human and ecological dynamics. *Ecological Economics*, 35(3): 323-336.

Peterson, G., Allen, C.R. and Holling, C.S. (1998) Ecological resilience, biodiversity, and scale. *Ecosystems*, 1(1): 6-18.

Petraitis, P. (2013) *Multiple Stable States in Natural Ecosystems*. Oxford: Oxford University Press.

Petschel-Held, G. (2005) Qualitative reasoning and global change research: experiences from modeling human-environment systems for policy advice. Paper for the 19th International Workshop on Qualitative Reasoning (QR-05), 18-20 May 2005, Graz University of Technology, Graz, Austria. Online at: http://qr05.tugraz.at/files/invited2.pdf [accessed on 22/6/2016].

Petts, J. (2006) Managing public engagement to optimize learning: reflections from urban river restoration. *Human Ecology Review*, 13(2): 172-181.

Pew. (2016a) EU 2016 fishing limits show need for fisheries ministers to make progress: Council defers action needed to fully implement the Common Fisheries Policy. Analysis, 25/4/2016. Philadelphia, PA: The Pew Charitable Trusts (Pew). Online at: http://www.pewtrusts.org/en/research-and-analysis/analysis/2016/04/25/eu-2016-fishing-limits-show-need-for-fisheries-ministers-to-make-progress [accessed 3/5/2016].

Pew. (2016b) Analysis of total allowable catches in Europe's north-western waters. Philadelphia, PA: The Pew Charitable Trusts (Pew). Online at: http://www.pewtrusts.org/~/media/Assets/2016/03/AnalysisofTotalAllowableCatchesinEuropesNorthwesternWaters.pdf?la=en [accessed 3/5/2016].

Phelan, L., Henderson-Sellers, A. and Taplin, R. (2011) Mitigation of the Earth's economy: a viable strategy for insurance systems. Pages 81-98 in: Filho, W.L. (ed.) *The Economic, Social and Political Elements of Climate Change*. Berlin, Heidelberg: Springer.

Phillips, C.R. (2008) Europe and the Atlantic. Pages 249-275 in: Greene, J.P. and Morgan, P.D. (eds.) *Atlantic History: A Critical Appraisal*. New York: Oxford University Press.

Piattoni, S. (2010) *The Theory of Multi-level Governance: Conceptual, Empirical, and Normative Challenges*. Oxford: Oxford University Press.

Pierre, J. and Peters, B.G (2000) *Governance, Politics and the State*. Basingstoke, UK: Macmillan.

Plano Clark, V.L., Creswell, J.W., O'Neil Green, D. and Shope, R.J. (2008) Mixing quantitative and qualitative approaches: an introduction to emergent mixed methods research. Pages 363-387 in: Hesse-Biber, S.N. and Leavy, P. (eds.) *Handbook of Emergent Methods*. New York: Guilford Press.

Plummer, R. and Armitage, D.R. (2007) Charting the new territory of adaptive co-management: a Delphi study. *Ecology and Society*, 12(2): 10.

Plummer, R. and FitzGibbon, J. (2006) People matter: the importance of social capital in the co-management of natural resources. *Natural Resources Forum*, 30(1): 51-62.

Plummer, R. and FitzGibbon, J.E. (2007) Connecting adaptive co-management, social learning and social capital through theory and practice. Pages 38–61 in Armitage, D., Berkes, F. and Doubleday, N. (eds.) *Adaptive Co-Management: Collaboration, Learning, and Multi-Level Governance*. Vancouver: University of British Columbia Press.

PNAS. (2015) Sustainability Science: About. Washington, DC: Proceedings of the National Academy of Sciences of the United States of America (PNAS). Online at: http://sustainability.pnas.org/page/about [accessed 23/11/2015].

Poitou-Charentes. (2003) Mid-term evaluation of the INTERREG IIIB Atlantic Area programme 2000-2006 – Summary of the final report. EDATER for Conseil régional Poitou-Charentes, December 2003.

Pope, J.G. and Symes, D. (2000) An ecosystem based approach to the Common Fisheries Policy: defining the goals. Online at: http://jncc.defra.gov.uk/pdf/DEFINING.pdf [accessed 11/6/2016].

Popper, K. (1978) Three Worlds. The Tanner Lecture on Human Values. Delivered at The University of Michigan, April 7, 1978. Online at: http://tannerlectures.utah.edu/_documents/a-to-z/p/popper80.pdf [accessed 23/11/2015].

Postmes, T. and Lea, M. (2000) Social processes and group decision making: anonymity in group decision support systems. *Ergonomics*, 43(8): 1252-1274.

Poteete, A.R., Janssen, M.A. and Ostrom, E. (2010) *Working Together: Collective Action, the Commons, and Multiple Methods in Practice*. Princeton, NJ: Princeton University Press.

Potter, M., Gordon, S. and Hamer, P. (2004) The nominal group technique: a useful consensus methodology in physiotherapy research. *NZ Journal of Physiotherapy*, 32(3): 126-130.

Powell, C. (2003) The Delphi technique: myths and realities. *Journal of Advanced Nursing*, 41(4): 376-382.

Power, M.E. and Chapin, III, F.S. (2010) Planetary stewardship in a changing world: paths toward resilience and sustainability. *Bulletin of the Ecological Society of America*, 91(2): 143-175.

Pretty, J. (2003) Social capital and the collective management of resources. *Science*, 302(5652): 1912-1914.

Prime Minister's Strategy Unit. (2004) Net Benefits: A sustainable and profitable future for UK fishing. London: Prime Minister's Strategy Unit, Cabinet Office. Online at: http://www.eurocbc.org/netbenefits.pdf [accessed 23/11/2015].

Pruessner, G. (2012) *Self-Organised Criticality: Theory, Models and Characterisation*. Cambridge: Cambridge University Press.

Putnam, R.D. (1993) The prosperous community: social capital and public life. *The American Prospect*, 4(13): 35-42.

Putnam, R.D. (1995) Bowling alone: America's declining social capital. *Journal of Democracy*, 6(1): 65-78.

Putnam, R.D. (2000) *Bowling Alone: The Collapse and Revival of American Community*. New York: Simon and Schuster.

Qiu, W. and Jones, P.J.S. (2013) The emerging policy landscape for marine spatial planning in Europe. *Marine Policy*, 39: 182-190.

Rajeswar, J. (2010) Deconstructing the development paradigm: a post-structural perspective. *Sustainable Development*, 18(5): 245-251.

Ramcilovik-Suominen, S. and Shannon, M.A. (2009) Principles of environmental governance in policy design and implementation: experiences from Alpine and Carpathian Conventions and implications for the Balkan Mountain Initiative. Pages 167-180 in: Avdibegović, M., Herbst, P. and Schmithüsen, F. (eds.) Proceedings of the 10th International Symposium on Legal Aspects of European Forest Sustainable Development, Faculty of Forestry, University of Sarajevo, Bosnia-Herzegovina, 7-9 May 2008. DOI: 10.13140/2.1.2812.8961.

Rammel, C., McIntosh, B. and Jeffrey, P. (2007) (Co)evolutionary approaches to sustainable development. *International Journal of Sustainable Development & World Ecology*, 14(1): 1-3.

Raskin, P., Banuri, T., Gallopín, G., Gutman P., Hammond, A., Kates, R. and Swart, R. (2002) Great Transition: The Promise and Lure of the Times Ahead. A report of the Global Scenario Group. SEI PoleStar Series Report No. 10. Boston, MA: Stockholm Environment Institute.

Ratter, B.M.W. (2012) Complexity and emergence – key concepts in non-linear dynamic systems. Pages 83-101 in: Glaser, M., Krause, G., Ratter, B.M.W. and Welp, M. (eds.) *Human-Nature Interactions in the Anthropocene: Potentials of Social-Ecological Systems Analysis*. New York: Routledge.

Raustiala, K. (2013) Institutional proliferation and the international legal order. Pages 293-320 in: Dunoff, J.L. and Pollack, M.A. (eds.) *Interdisciplinary Perspectives on International Law and International Relations: The State of the Art*. New York: Cambridge University Press.

Raven, P.H. (2002) Science, sustainability, and the human prospect. *Science*, 297(5583): 954-958.

Raven, P.H. and Johnson, G.B. (1986) *Biology*. St. Louis, MO: Times Mirror/Mosby College Publishing.

Ravetz, J.R. (2006) Post-normal science and the complexity of transitions towards sustainability. *Ecological Complexity*, 3(4): 275-284.

Ravetz, J.R. (2011) 'Climategate' and the maturing of post-normal science. *Futures*, 43(2): 149-157.

Redman, C.L., Grove, J.M. and Kuby, L.H. (2004) Integrating social science into the long-term ecological research (LTER) network: social dimensions of ecological change and ecological dimensions of social change. *Ecosystems*, 7(2): 161-171.

Reed, M.S., Evely, A.C., Cundill, G., Fazey, I., Glass, J., Laing, A., Newig, J., Parrish, B., Prell, C., Raymond, C. and Stringer, L.C. (2010) What is social learning? *Ecology and Society*, 15(4): r1.

Resilience Alliance. (2007a) Assessing resilience in social-ecological systems: a workbook for scientists. Version 1.1 (June 2007). Resilience Alliance. Downloaded from: http://www.resalliance.org/ [accessed 18/4/2014].

Resilience Alliance. (2007b) Assessing and managing resilience in social–ecological systems: Volume 2 supplementary notes to the practitioners workbook. Version 1.0 June 2007. Downloaded from: http://www.resalliance.org/ [accessed 6/7/2007].

Resilience Alliance. (2010) Assessing resilience in social-ecological systems: workbook for practitioners. Version 2.0. Resilience Alliance. Online at: http://www.resalliance.org/files/ResilienceAssessmentV2_2.pdf [accessed 23/11/2015].

Rhodes, R.A.W. (1996) The new governance: governing without government. *Political Studies*, 44(4): 652-667.

Rikkonen, P., Kaivo-oja, J. and Aakkula, J. (2006) Delphi expert panels in the scenario-based strategic planning of agriculture. *Foresight*, 8(1): 66-81.

Rittel, H.W.J. and Webber, M.M. (1973) Dilemmas in a general theory of planning. *Policy Sciences*, 4(2): 155-169.

Robertson, G.P., Collins, S.L., Foster, D.R., Brokaw, N., Ducklow, H.W., Gragson, T.L., Gries, C., Hamilton, S.K., McGuire, A.D., Moore, J.C., Stanley, E.H., Waide, R.B. and Williams, M.W. (2012) Long-term ecological research in a human-dominated world. *BioScience*, 62(4): 342-353.

Robinson, J. (2004) Squaring the circle? Some thoughts on the idea of sustainable development. *Ecological Economics*, 48(4): 369-384.

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin III, F.S., Lambin, E.F., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H.J., Nykvist, B., de Wit, C.A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P.K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R.W., Fabry, V.J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P. and Foley, J. (2009b) Planetary boundaries: exploring the safe operating space for humanity. *Ecology and Society*, 14(2): 32.

Roe, M. (2013) *Maritime Governance and Policy-Making*. London: Springer.

Rotmans, J., Kemp, R. and van Asselt, M. (2001) More evolution than revolution: transition management in public policy. *Foresight*, 3(1): 15-31.

Rotmans, J. and Loorbach, D. (2009) Complexity and transition management. *Journal of Industrial Ecology*, 13(2): 184-196.

Rowe, G. and Wright, G. (1999) The Delphi technique as a forecasting tool: issues and analysis. *International Journal of Forecasting*, 15(4): 353-375.

Rowlinson, M., Booth, C., Clark, P., Delahaye, A. and Procter, S. (2010) Social remembering and organizational memory. *Organization Studies*, 31(1): 69-87.

Ryan, A.B. (2006) Methodology: collecting data. Pages 70-89 in: Antonesa, M., Fallon, H., Ryan, A.B., Ryan, A. Walsh, T. and Borys, L. (eds.) *Researching and Writing your Thesis: a guide for postgraduate students*. Maynooth: Maynooth Adult and Community Education (MACE).

Sabel, C.F. and Zeitlin, J. (2008) Learning from difference: the new architecture of experimentalist governance in the EU. *European Law Journal*, 14(3): 271-327.

Sabel, C.F. and Zeitlin, J. (eds.) (2010) *Experimentalist Governance in the European Union: Towards a New Architecture*. Oxford: Oxford University Press.

Sabel, C.F. and Zeitlin, J. (2012a) Experimentalist governance. Pages 169-183 in: Levi-Faur, D. (ed.) *The Oxford Handbook of Governance*. Oxford: Oxford University Press.

Sabel, C.F. and Zeitlin, J. (2012b) Experimentalism in the EU: common ground and persistent differences. *Regulation & Governance*, 6(3): 410-426.

Sachs, J.D. (2008) Surging food prices and global stability. *Scientific American*, 298(6): 40.

Sackman, H. (1974) Delphi Assessment: Expert Opinion, Forecasting, and Group Process. A Report prepared for United States Air Force Project Rand. Document No. R-1283-PR, April 1974. Santa Monica, CA: Rand Corporation.

Sadeh, T. (2005) Google Scholar versus metasearch systems. Paper presented at the Workshop at the 29th ELAG conference, 31 May - 4 June 2005. Online at: http://www.bibsys.no/files/out/elag_archive/archive/elag2005/media/workshop8.pdf [accessed 4/7/2016].

Salomon, M. (2009) Recent European initiatives in marine protection policy: towards lasting protection for Europe's seas? *Environmental Science & Policy*, 12(3): 359-366.

Salomons, W., Kremer, H.H., Turner, R.K., Andreeva, E.N., Arthurton, R.S., Behrendt, H., Burbridge, P., Chen, C.-T.A., Crossland, C.J., Gandrass, J., Gordeev V.V., Harvey, N., Hong, G.H., Kjerfve, B., de Lacerda, L.D., Crossland, J.I.M., Morcom, N., Odada, E., Pacyna, J., Rabalais, N.N., Swaney, D. and Wiebe, W.J. (2005) The catchment to coast continuum. Pages 145-200 in: Crossland, C.J., Kremer, H.H., Lindeboom, H.J., Crossland, J.I.M. and Le Tissier, M.D.A. (eds.) *Coastal Fluxes in the Anthropocene*. Berlin Heidelberg: Springer-Verlag.

Samecki, P. (2009) Macro-regional strategies in the European Union. Discussion paper presented by Paweł Samecki, European Commissioner for Regional Policy, at the Ministerial conference on the EU Strategy for the Baltic Sea Region, Stockholm, 18/9/2009. Brussels: European Commission, Directorate-General for Regional and Urban Policy. Online at: http://ec.europa.eu/regional_policy/archive/cooperation/baltic/pdf/macroregional_strategies_2009.pdf [accessed 23/11/2015].

Sanginga, P.C., Kamugisha, R.N. and Martin, A.M. (2007) The dynamics of social capital and conflict management in multiple resource regimes: a case of the southwestern highlands of Uganda. *Ecology and Society*, 12(1): 6.

Sayre, N.F. (2005) Ecological and geographical scale: parallels and potential for integration. *Progress in Human Geography*, 29(3): 276-290.

Scapolo, F. and Miles, I. (2006) Eliciting experts' knowledge: a comparison of two methods. *Technological Forecasting & Social Change*, 73(6): 679-704.

Scheffer, M. (2009) *Critical Transitions in Nature and Society*. Princeton: Princeton University Press.

Scheffer, M. (2010) Complex systems: foreseeing tipping points. *Nature*, 467(7314): 411-412.

Scheffer, M., Bascompte, J., Brock, W.A., Brovkin, V., Carpenter, S.R., Dakos, V., Held, H., van Nes, E.H., Rietkerk, M. and Sugihara, G. (2009) Early-warning signals for critical transitions. *Nature*, 461: 53-59.

Scheffer, M. and Carpenter, S.R. (2003) Catastrophic regime shifts in ecosystems: linking theory to observation. *Trends in Ecology and Evolution*, 18(12): 648-656.

Scheffer, M., Carpenter, S., Foley, J.A., Folke, C. and Walker, B. (2001) Catastrophic shifts in ecosystems. *Nature*, 413(6856): 591-596.

Scheffer, M. and van Nes, E.H. (2004) Mechanisms for marine regime shifts: can we use lakes as microcosms for oceans? *Progress in Oceanography*, 60(2-4): 303-319.

Schellnhuber, H.J. (1999) 'Earth System' analysis and the second Copernican revolution. *Nature*, 402(6761 supplement): C19-C23.

Schellnhuber, H.J., Block, A., Cassel-Gintz, M., Kropp, J., Lammel, G., Lass, W., Lienenkamp, R., Loose, C., Lüdeke, M.K.B., Moldenhauer, O., Petschel-Held, G., Plöchl, M. and Reusswig, F. (1997) Syndromes of global change. *GAIA*, 6(1): 18-33.

Schmandt, J. (2006) Bringing sustainability science to water basin management. *Energy*, 31(13): 2350-2360.

Scholes, R.J., Reyers, B., Biggs, R., Spierenburg, M.J. and Duriappah, A. (2013) Multi-scale and cross-scale assessments of social–ecological systems and their ecosystem services. *Current Opinion in Environmental Sustainability*, 5(1): 16-25.

Scholz, R.W., Lang, D.J., Wiek, A., Walter, A.I. and Stauffacher, M. (2006) Transdisciplinary case studies as a means of sustainability learning: historical framework and theory. *International Journal of Sustainability in Higher Education*, 7(3): 226-251.

Schoon, M., Fabricius, C., Anderies, J.M. and Nelson, M. (2011) Synthesis: vulnerability, traps, and transformations—long-term perspectives from archaeology. *Ecology and Society*, 16(2): 24.

Schröter, D., Polsky, C. and Patt, A.G. (2005a) Assessing vulnerabilities to the effects of global change: an eight step approach. *Mitigation and Adaptation Strategies for Global Change*, 10(4): 573-596.

Schuh, B., Kintisch, M., Dallhammer, E., Preku, A., Gløersen, E., Toptsidou, M., Böhme, K., Valenza, A., Celotti, P., Brignani, N., Cristino, B., Stead, D., Zonneveld, W. and Waterhout, B. (2015) New role of macro-regions in European Territorial Cooperation: Annex – Part II. Study conducted for the Policy Department Structural and Cohesion Policies, Directorate-General for Internal Policies of the Union. Brussels: European Parliament. Online at: http://www.europarl.europa.eu/RegData/etudes/STUD/2015/540349/IPOL_STU(2015)540349_EN.pdf [accessed 10/7/2016].

Schumpeter, J.A. (1994) *Capitalism, Socialism and Democracy*. Introduction by Swedberg, R. London: Routledge. [Originally published in 1942. New York: Harper & Brothers.]

Schymik, C. (2011) Blueprint for a macro-region: EU strategies for the Baltic Sea and Danube regions. SWP Research Paper RP 10, September 2011. Berlin: Stiftung Wissenschaft und Politik (SWP). Online at: http://www.swp-berlin.org/fileadmin/contents/products/research_papers/2011_RP10_shy_ks.pdf [accessed 23/11/2015].

Scrase, J.I. and Sheate, W.R. (2002) Integration and integrated approaches to assessment: what do they mean for the environment? *Journal of Environmental Policy and Planning*, 4(4): 275-294.

Sea Around Us Project. (2015) Large Marine Ecosystems (LME) website. Vancouver, BC: Sea Around Us Project, Fisheries Centre, University of British Columbia. Online at: http://www.seaaroundus.org/data/#/lme [accessed on 23/11/2015].

Sechrest, L. and Sidani, S. (1995) Quantitative and qualitative methods: is there an alternative? *Evaluation and Program Planning*, 18(1): 77-87.

Serageldin, I. (1996) Sustainability as opportunity and the problem of social capital. *The Brown Journal of World Affairs*, 3(2): 187-203.

Sherman, K. (1995) Achieving regional cooperation in the management of marine ecosystems: the use of the large marine ecosystem approach. *Ocean & Coastal Management*, 29(1-3): 165-185.

Sherman, K., Celone, P. and Adams, S. (2004) NOAA Fisheries Service's Large Marine Ecosystems Program: status report. NOAA Technical Memorandum NMFS-NE-183.

Sherman, K. and Hempel, G. (eds.) (2009) The UNEP Large Marine Ecosystem Report: A perspective on changing conditions in LMEs of the world's Regional Seas. UNEP Regional Seas Report and Studies No. 182. United Nations Environment Programme, Nairobi, Kenya. Online at: http://iwlearn.net/publications/regional-seas-reports/unep-regional-seas-reports-and-studies-no-182 [accessed on 23/11/2015].

Sicking, L. and Abreu-Ferreira, D. (eds.) (2009) *Beyond the Catch: Fisheries of the North Atlantic, the North Sea and the Baltic, 900-1850*. Leiden: Brill.

Silberstein, M. and McGeever, J. (1999) The search for ontological emergence. *The Philosophical Quarterly*, 49(195): 182-200.

Simmie, J. and Martin, R. (2010) The economic resilience of regions: towards an evolutionary approach. *Cambridge Journal of Regions, Economy and Society*, 3(1): 27-43.

Simon, H.A. and Ando, A. (1961) Aggregation of variables in dynamic systems. *Econometrica*, 29(2): 111-138.

Singh, S.J., Haberl, H., Chertow, M., Mirtl, M. and Schmid, M. (eds.) (2013) *Long Term Socio-Ecological Research: Studies in Society-Nature Interactions Across Spatial and Temporal Scales*. Dordrecht: Springer.

Sissenwine, M. and Symes, D. (2007) Reflections on the Common Fisheries Policy: report to the General Directorate for Fisheries and Maritime Affairs of the European Commission. July 2007.

Skulmoski, G.J., Hartman, F.T. and Krahn, J. (2007) The Delphi method for graduate research. *Journal of Information Technology Education*, 6: 1-21.

Slottje, P., van der Sluijs, J.P. and Knol, A.B. (2008) Expert elicitation: methodological suggestions for its use in environmental health impact assessments. RIVM letter report 630004001/2008. Bilthoven, The Netherlands: National Institute for Public Health and the Environment (RIVM).

Small, M.L. (2011) How to conduct a mixed methods study: recent trends in a rapidly growing literature. *Annual Review of Sociology*, 37: 57-86.

Smit, B. and Pilifosova, O. (2001) Adaptation to climate change in the context of sustainable development and equity. Pages 877-912 in: McCarthy, J.J., Canziani, O.F., Leary, N.A., Dokken, D.J. and White, K.S. (eds.) *Climate Change 2001: Impacts, Adaptation, and Vulnerability*. Cambridge: Cambridge University Press.

Smit, B. and Wandel, J. (2006) Adaptation, adaptive capacity and vulnerability. *Global Environmental Change*, 16(3): 282-292.

Smith, A. (1776) An Inquiry into the Nature and Causes of the Wealth of Nations. Project Gutenberg EBook, last updated: 6/3/2013. Online at: https://www.gutenberg.org/files/3300/3300-h/3300-h.htm [accessed 9/5/2016].

Smith, A. and Stirling, A. (2010) The politics of social-ecological resilience and sustainable socio-technical transitions. *Ecology and Society*, 15(1): 11.

Smith, H.D. (1992) The British Isles and the age of exploration – a maritime perspective. *GeoJournal*, 26(4): 483-487.

Smith, M.E. (1995) The EU and transnational regions: a maritime perspective. Paper prepared for the annual conference of the European Community Studies Association, Charleston, South Carolina, USA, 11-14 May 1995. Online at: http://aei.pitt.edu/7290/01/002934_1.pdf [accessed on 23/11/2015].

Solow, R.M. (1993) Sustainability: an economist's perspective. Pages 179-187 in: Dorfman, R. and Dorfman, N.S. (eds.) *Economics of the Environment: Selected Readings*. New York: W.W. Norton & Co.

Sontag, S. (2004) *Regarding the Pain of Others*. London: Penguin.

Sørensen, E. and Torfing, J. (2003) Network politics, political capital and democracy. *International Journal of Public Administration*, 26(6): 609-634.

Spalding, M.D., Fox, H.E., Allen, G.R., Davidson, N., Ferdaña, Z.A., Finlayson, M., Halpern, B.S., Jorge, M.A., Lombana, A., Lourie, S.A., Martin, K.D., McManus, E., Molnar, J., Recchia, C.A. and Robertson, J. (2007) Marine ecoregions of the world: a bioregionalization of coastal and shelf areas. *BioScience*, 57(7): 573–583.

Spangenberg, J.H. (2007) Integrated scenarios for assessing biodiversity risks. *Sustainable Development*, 15(6): 343-356.

Stagl, S. (2007) Theoretical foundations of learning processes for sustainable development. *International Journal of Sustainable Development & World Ecology*, 14(1): 52-62.

Stake, R.E. (1995) *The Art of Case Study Research*. Thousand Oaks, CA: Sage.

Stake, R.E. (2005) Qualitative case studies. Pages 443-466 in: Denzin, N. and Lincoln, Y.S. (eds.) *The Sage Handbook of Qualitative Research*. Third Edition. Thousand Oaks, CA: Sage.

Star, S.L. (2010) This is not a boundary object: reflections on the origin of a concept. *Science, Technology, & Human Values*, 35(5): 601-617.

Star, S.L. and Griesemer, J.R. (1989) Institutional ecology, 'translations' and boundary objects: amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907–39. *Social Studies of Science*, 19(3): 387-420.

Stead, D. (2014) Rescaling Environmental Governance – the Influence of European Transnational Cooperation Initiatives. *Environmental Policy and Governance*, 24(5): 324-337.

Stead, D. and Meijers, E. (2009) Spatial planning and policy integration: concepts, facilitators and inhibitors. *Planning Theory & Practice*, 10(3): 317-332.

Steffen, W., Grinevald, J., Crutzen, P. and McNeill, J. (2011a) The Anthropocene: conceptual and historical perspectives. *Philosophical Transactions of the Royal Society A*, 369(1938): 842-867.

Steffen, W., Persson, Å, Deutsch, L., Zalasiewicz, J., Williams, M., Richardson, K., Crumley, C., Crutzen, P., Folke, C., Gordon, L., Molina, M., Ramanathan, V., Rockström, J., Scheffer, M., Schellnhuber, H.J., and Svedin, U. (2011b) The Anthropocene: from global change to planetary stewardship. *Ambio*, 40(7): 739-761.

Sterling, S. (2004) Higher education, sustainability, and the role of systemic learning. Pages 49-70 in: Corcoran, P.B. and Wals, A.E.J. (eds.) *Higher Education and the Challenge of Sustainability: Problematics, Promise, and Practice*. Dordrecht: Kluwer Academic Publishers.

Stern, P.C., Young, O.R. and Druckman, D. (eds.) (1992) *Global Environmental Change: Understanding the Human Dimensions*. Committee on the Human Dimensions of Global Change, National Research Council. Washington, DC: National Academy Press.

Steward, J.H. (1972) *Theory of culture change: the methodology of multilinear evolution*. Champaign, IL: University of Illinois Press. [Originally published in 1955.]

Steyaert, S. and Lisoir, H., editors. (2005) Participatory Methods Toolkit. A practitioner's manual. King Baudouin Foundation and the Flemish Institute for Science and Technology Assessment, Belgium.

Strijbos, S. (2010) Systems thinking. Pages 453-470 in: Frodeman, R., Klein, J.T. and Mitcham, C. (eds.) *The Oxford Handbook of Interdisciplinarity*. New York: Oxford University Press.

Stirling, A. (2006) Precaution, foresight and sustainability: reflection and reflexivity in the governance of science and technology. Pages 225-272 in: Voß, J.-P., Bauknecht, D. and Kemp, R. (eds.) *Reflexive Governance for Sustainable Development*. Cheltenham: Edward Elgar.

Sullivan, L.H. (1918) The tall office building artistically considered. Pages 202-213 in: Sullivan, L.H. (1947) *Kindergarten Chats (revised 1918) and Other Writings*. Athey, I. (ed.). New York: George Wittenborn. [Originally published in 1896 in *Lippincott's Monthly Magazine*, 57: 403-409.]

Sullivan, P.J., Acheson, J.M., Angermeier, P.L., Faast, T., Flemma, J., Jones, C.M., Knudsen, E.E., Minello, T.J., Secor, D.H., Wunderlich, R. and Zanetell, B.A. (2006) Defining and implementing best available science for fisheries and environmental science, policy, and management. American Fisheries Society, Bethesda, Maryland, USA and Estuarine Research Federation, Port Republic, Maryland, USA.

Sundstrom, S.M., Angeler, D.G., Garmestani, A.S., García, J.H. and Allen, C.R. (2014) Transdisciplinary application of cross-scale resilience. *Sustainability*, 6(10): 6925-6948.

Sutherland, W.J. (2006) Predicting the ecological consequences of environmental change: a review of the methods. *Journal of Applied Ecology*, 43(4): 599-616.

Swanson, F.J. and Chapin, III, F.S. (2009) Forest systems: living with long-term change. Pages 149-170 in: Chapin, III, F.S., Kofinas, G.P. and Folke, C. (eds.) *Principles of Ecosystem Stewardship: Resilience-Based Natural Resource Management in a Changing World*. New York: Springer.

Swyngedouw, E. (2004) Globalisation or 'glocalisation'? Networks, territories and rescaling. *Cambridge Review of International Affairs*, 17(1): 25-48.

Symes, D. (2012) Regionalising the Common Fisheries Policy: context, content and controversy. *Maritime Studies*, 11(1): 6. DOI: 10.1186/2212-9790-11-6.

Tàbara, J.D. and Chabay, I. (2013) Coupling human information and knowledge systems with social–ecological systems change: reframing research, education, and policy for sustainability. *Environmental Science & Policy*, 28: 71-81.

Talaue-McManus, L. (2010) Examining human impacts on global biogeochemical cycling via the coastal zone and ocean margins. Pages 497-514 in: Liu, K.-K., Atkinson, L., Quiñones, R. and Talaue-McManus, L. (eds.) *Carbon and Nutrient Fluxes in Continental Margins: A Global Synthesis*. Berlin Heidelberg: Springer-Verlag.

Tashakkori, A. and Teddlie, C. (2003) Handbook of Mixed Methods in Social & Behavioral Research. Thousand Oaks, CA: SAGE.

TCOPAA. (2007) Transnational Cooperation Operational Programme 'Atlantic Area 2007-2013'. Draft 29/5/2007. Online at: http://www.ifremer.fr/indicang/actualites/pdf/po-atlantic-area-21012007.pdf [accessed on 23/11/2015].

Teddlie, C. and Tashakkori, A. (2011) Mixed methods research: contemporary issues in an emerging field. Pages 285-300 in: Denzin, N.K. and Lincoln, Y.S. (eds.) *The SAGE Handbook of Qualitative Research*. Thousand Oaks, CA: Sage.

Tempera, F., Liquete, C. and Cardoso, A.C. (2016) Spatial distribution of marine ecosystem service capacity in the European seas. EUR 27843. Luxembourg: Publications Office of the European Union. DOI: 10.2788/753996.

Termeer, C.J.A.M., Dewulf, A. and van Lieshout, M. (2010) Disentangling scale approaches in governance research: comparing monocentric, multilevel, and adaptive governance. *Ecology and Society*, 15(4): 29.

Tett, P., Mongruel, R., Levrel, H., Hopkins, T., Sandberg, A., Hadley, D., Fernandes, T., Hendrick, V., Mette, A., Vermaat, J., Gilbert, A., d'Hernoncourt, J., McFadden, L., Priest, S., Green, C. and d'Alconà, M.R. (2011a) SAF Handbook: Guide to System Design & Issue Definition, v.3.09. Science and Policy Integration for Coastal Systems Assessment (SPICOSA) project report, WP3/WP6, 4/3/2011. Oban: Scottish Association for Marine Science. Online at: http://www.coastal-saf.eu/design-step/support/SPICSDGuide309.pdf [accessed 23/11/2015].

The World Bank. (2009) *The Sunken Billions: The Economic Justification for Fisheries Reform*. Washington, DC: The World Bank. Online at: http://siteresources.worldbank.org/EXTARD/Resources/336681-1224775570533/SunkenBillionsFinal.pdf [accessed 23/11/2015].

Thompson, J.N. (2005) *The Geographic Mosaic of Coevolution*. Chicago: University of Chicago Press.

Thompson, J.N. (2009) The coevolving web of life (American Society of Naturalists Presidential address). *The American Naturalist*, 173(2): 125-140.

Thorne, S. (2000) Data analysis in qualitative research. *Evidence-Based Nursing*, 3: 68-70.

Tol, R.S.J., Klein, R.J.T. and Nicholls, R.J. (2008) Towards successful adaptation to sea-level rise along Europe's coasts. *Journal of Coastal Research*, 24(2): 432-442.

Tolley, R., Lumsdon, L. and Bickerstaff, K. (2001) The future of walking in Europe: a Delphi project to identify expert opinion on future walking scenarios. *Transport Policy*, 8(4): 307-315.

Tompkins, E.L. and Adger, W.N. (2004) Does adaptive management of natural resources enhance resilience to climate change? *Ecology and Society*, 9(2): 10.

Torfing, J., Peters, B.G., Pierre, J. and Sørensen, E. (2012) *Interactive Governance: Advancing the Paradigm*. Oxford: Oxford University Press.

Tress, B., Tress, G., Décamps, H. and d'Hauteserre, A.-M. (2001) Bridging human and natural sciences in landscape research. *Landscape and Urban Planning*, 57(3-4): 137-141.

Trochim, W.M.K. and Cabrera, D. (2005) The complexity of concept mapping for policy analysis. *E:CO*, 7(1): 11-22.

Trowler, P., Saunders, M. and Bamber, V. (eds.) (2012) *Tribes and Territories in the 21st Century: Rethinking the significance of disciplines in higher education*. Abingdon, UK: Routledge.

Truffer, B., Voß, J.-P. and Konrad, K. (2008) Mapping expectations for system transformations: lessons from sustainability foresight in German utility sectors. *Technological Forecasting & Social Change*, 75(9): 1360-1372.

Tucker, C.M. (2010) Learning on governance in forest ecosystems: lessons from recent research. *International Journal of the Commons*, 4(2): 687-706.

Turner, B.L., II. (2010a) Sustainability and forest transitions in the southern Yucatán: the land architecture approach. *Land Use Policy*, 27(2): 170-179.

Turner, B.L., II. (2010b) Vulnerability and resilience: Coalescing or paralleling approaches for sustainability science? *Global Environmental Change*, 20(4): 570-576.

Turner, B.L., II, Kasperson, R.E., Matson, P.A., McCarthy, J.J., Corell, R.W., Christensen, L., Eckley, N., Kasperson, J.X., Luers, A., Martello, M.L., Polsky, C., Pulsipher, A. and Schiller, A. (2003a). A framework for vulnerability analysis in sustainability science. *Proceedings of the National Academy of Sciences of the United States of America*, 100(14): 8074-8079.

Turner, B.L., II, Matson, P.A., McCarthy, J.J., Corell, R.W., Christensen, L., Eckley, N., Hovelsrud-Broda, G.K., Kasperson, J.X., Kasperson, R.E., Luers, A., Martello, M.L., Mathiesen, S., Naylor, R., Polsky, C., Pulsipher, A., Schiller, A., Selin, H. and Tyler, N. (2003b) Illustrating the coupled human–environment system for vulnerability analysis: three case studies. *Proceedings of the National Academy of Sciences of the United States of America*, 100(14): 8080-8085.

Turner, N.J., Gregory, R., Brooks, C., Failing, L. and Satterfield, T. (2008) From invisibility to transparency: identifying the implications. *Ecology and Society*, 13(2): 7.

Turoff, M. (1970) The design of a policy Delphi. *Technological Forecasting & Social Change*, 2(2): 149-171.

UN. (1973) Report of the United Nations Conference on the Human Environment, Stockholm, 5-16 June 1972. Document A/CONF.48/14/Rev.1. New York: United Nations. Online at: http://www.un-documents.net/aconf48-14r1.pdf [accessed 23/11/2015].

UN. (2002) Report of the World Summit on Sustainable Development, Johannesburg, South Africa, 26 August-4 September 2002. A/CONF.199/20. New York: United Nations (UN). Online at: http://www.un.org/ga/search/view_doc.asp?symbol=A/CONF.199/20&Lang=E [accessed 23/11/2015].

UNCED. (1992) Agenda 21: The United Nations Programme of Action from Rio. United Nations Conference on Environment and Development (UNCED), Rio de Janerio, Brazil, 3-14 June 1992. New York: United Nations Department of Economic and Social Affairs, Division for Sustainable Development. Online at: https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf [accessed 23/11/2015].

UNEP. (2006) Report of the Ad Hoc Technical Expert Group on implementation of integrated marine and coastal area management (IMCAM). United Nations Environment Programme, Convention on Biological Diversity, CoP8, Curitiba, Brazil, 20-31 March 2006. UNEP/CBD/COP/8/INF/23.

UNEP. (2009) Environmental governance. Nairobi: United Nations Environment Programme. [Copyright: Luo Huong at the 2009 UNFCCC Conference in Copenhagen.] Online at: http://www.unep.org/pdf/brochures/EnvironmentalGovernance.pdf [accessed 27/4/2016].

UNESCO. (2007) The UN Decade of Education for Sustainable Development (DESD 2005–2014): The First Two Years. Paris: United Nations Educational, Scientific and Cultural Organization (UNESCO). Online at: http://unesdoc.unesco.org/images/0015/001540/154093e.pdf [accessed 23/11/2015].

UNESCO. (2016) MSP FAQ. Webpage, last updated 12/4/2016. United Nations Educational, Scientific and Cultural Organization (UNESCO) Intergovernmental Oceanographic Commission Marine Spatial Planning Initiative. Paris: UNESCO. Online at: http://www.unesco-ioc-marinesp.be/msp_faq [accessed 9/6/2016].

UNGA. (2012) Resolution adopted by the General Assembly. A/RES/66/288. The future we want [Annex]. 27/7/2012. New York: General Assembly of the United Nations (UNGA). Online at: http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/66/288&Lang=E [accessed 23/11/2015].

UNGSP. (2010) Sustainable Development: From Brundtland to Rio 2012. Background Paper for consideration by the UN Secretary-General's High-Level Panel on Global Sustainability (UNGSP) at its first meeting, 19 September 2010, United Nations Headquarters, New York. Prepared by John Drexhage and Deborah Murphy, International Institute for Sustainable Development (IISD). Online at: http://www.un.org/wcm/webdav/site/climatechange/shared/gsp/docs/GSP1-6_Background%20on%20Sustainable%20Devt.pdf [accessed 23/11/2015].

UNGSP. (2012) Resilient People, Resilient Planet: A Future Worth Choosing - The Report of the United Nations Secretary-General's High-level Panel on Global Sustainability [UNGSP]. New York: United Nations. Online at: http://en.unesco.org/system/files/GSP_Report_web_final.pdf [accessed 23/11/2015].

van Apeldoorn, B. and Overbeek, H. (2012) Introduction: the life course of the neoliberal project and the global crisis. Pages 1-20 in: Overbeek, H. and van Apeldoorn, B. (eds.) Neoliberalism in Crisis. Basingstoke: Palgrave Macmillan.

van Asselt, H. (2011) Legal and political approaches in interplay management: dealing with the fragmentation of global climate governance. Pages 59-85 in: Oberthür, S. and Stokke, O.S. (eds.) *Managing Institutional Complexity: Regime Interplay and Global Environmental Change*. Cambridge, MA: MIT Press.

van der Brugge, R., Rotmans, J. and Loorbach, D. (2005) The transition in Dutch water management. *Regional Environmental Change*, 5(4): 164-176.

van Hoof, L., van Leeuwen, J. and van Tatenhove, J. (2012) All at sea; regionalisation and integration of marine policy in Europe. *Maritime Studies*, 11:9. DOI: 10.1186/2212-9790-11-9.

van Hoof, L. and van Tatenhove, J. (2009) EU marine policy on the move: the tension between fisheries and maritime policy. *Marine Policy*, 33(4): 726-732.

van Kerkhoff, L. (2005) Integrated research: concepts of connection in environmental science and policy. *Environmental Science & Policy*, 8(5): 452-463.

van Kerkhoff, L. and Lebel, L. (2006) Linking knowledge and action for sustainable development. *Annual Review of Environment and Resources*, 31: 445-477.

van Kersbergen, K. and van Waarden, F. (2004) 'Governance' as a bridge between disciplines: cross-disciplinary inspiration regarding shifts in governance and problems of governability, accountability and legitimacy. European Journal of Political Research, 43(2): 143-171.

van Leeuwen, J., Raakjaer, J., van Hoof, L., van Tatenhove, J., Long, R. and Ounanian, K. (2014) Implementing the Marine Strategy Framework Directive: a policy perspective on regulatory, institutional and stakeholder impediments to effective implementation. *Marine Policy*, 50(Part B): 325-330.

van Nes, E.H. and Scheffer, M. (2007) Slow recovery from perturbations as a generic indicator of a nearby catastrophic shift. *The American Naturalist*, 169(6): 738-747.

van Paassen, A., Opdam, P., Steingröver, E. and van den Berg, J. (2011) Landscape science and societal action. Pages 17-40 in: van Paassen, A., van den Berg, J., Steingröver, E., Werkman, R. and Pedroli, B. (eds.) *Knowledge in action: The search for collaborative research for sustainable landscape development*. Wageningen: Wageningen Academic.

van Putten, I.E., Jennings, S., Frusher, S., Gardner, C., Haward, M., Hobday, A.J., Nursey-Bray, M., Pecl, G., Punt, A. and Revill, H. (2013) Building blocks of economic resilience to climate change: a south east Australian fisheries example. *Regional Environmental Change*, 13(6): 1313-1323.

van Teijlingen, E., Pitchforth, E., Bishop, C. and Russell, E. (2006) Delphi method and nominal group technique in family planning and reproductive health research. *Journal of Family Planning and Reproductive Health Care*, 32(4): 249-252.

van Zolingen, S.J. and Klaassen, C.A. (2003) Selection processes in a Delphi study about key qualifications in senior secondary vocational education. *Technological Forecasting & Social Change*, 70(4): 317-340.

Vasconcellos, M. (2014) An experience of the use of the cognitive mapping method in qualitative research. Pages 471-490 in: Okada, A., Buckingham Shum, S.J. and Sherborne, T. (eds.) *Knowledge Cartography: Software Tools and Mapping Techniques*. Second Edition. London: Springer.

Vermaak, J. (2009) Reassessing the concept of 'social capital': considering resources for satisfying the needs of rural communities. *Development Southern Africa*, 26(3): 399-412.

Vervoort, J.M., Rutting, L., Kok, K., Hermans, F.L.P., Veldkamp, T., Bregt, A.K. and van Lammeren, R. (2012) Exploring dimensions, scales, and cross-scale dynamics from the perspectives of change agents in social–ecological systems. *Ecology and Society*, 17(4): 24.

Vincent, K. (2007) Uncertainty in adaptive capacity and the importance of scale. *Global Environmental Change*, 17(1): 12-24.

Vitousek, P.M., Mooney, H.A., Lubchenco, J. and Melillo, J.M. (1997) Human domination of Earth's ecosystems. *Science*, 277(5325): 494-499.

von Bertalanffy, L. (1950) An outline of general system theory. *The British Journal for the Philosophy of Science*, 1(2): 134-165.

von Bertalanffy, L. (1968) *General System Theory: Foundations, Development, Applications*. New York: George Braziller.

von Bertalanffy, L. (1972) The history and status of general systems theory. *The Academy of Management Journal*, 15(4): 407-426.

von Stackelberg, P. (2009) Footprints of the future: timelines and exploratory forecasts in futures research. Journal of Futures Studies, 13(4): 13-34.

Voß, J.-P., Bauknecht, D. and Kemp, R. (eds.) (2006a) *Reflexive Governance for Sustainable Development*. Cheltenham: Edward Elgar.

Voß, J.-P., Kemp, R. and Bauknecht, D. (2006b) Reflexive governance: a view on an emerging path. Pages 419-437 in: Voß, J.-P., Bauknecht, D. and Kemp, R. (eds.) *Reflexive Governance for Sustainable Development*. Cheltenham: Edward Elgar.

Voß, J.-P., Newig, J., Kastens, B., Monstadt, J. and Nölting, B. (2007) Steering for sustainable development: a typology of problems and strategies with respect to ambivalence, uncertainty and distributed power. *Journal of Environmental Policy & Planning*, 9(3-4): 193-212.

Wakefield, J. (2010) Undermining the Integrated Maritime Policy. *Marine Pollution Bulletin*, 60(3): 323-333.

Walker, B.H. (2003) The Resilience Alliance. Interview. Page 12 in: IHDP Update 02/2003; newsletter of the International Human Dimensions Programme on Global Environmental Change, Bonn, Germany.

Walker, B. (2005) A resilience approach to integrated assessment. *The Integrated Assessment Journal*, 5(1): 77-97.

Walker, B. (2007) Resilience thinking: interview with Brian Walker. Questions asked by Tein McDonald. *Ecological Management & Restoration*, 8(2): 85-91.

Walker, B.H., Abel, N., Anderies, J.M. and Ryan, P. (2009a) Resilience, adaptability, and transformability in the Goulburn-Broken Catchment, Australia. *Ecology and Society*, 14(1): 12.

Walker, B., Carpenter, S., Anderies, J., Abel, N., Cumming, G., Janssen, M., Lebel, L., Norberg, J., Peterson, G.D. and Pritchard, R. (2002) Resilience management in social-ecological systems: a working hypothesis for a participatory approach. *Conservation Ecology*, 6(1): 14.

Walker, B.H., Gunderson, L.H., Kinzig, A.P., Folke, C., Carpenter, S.R. and Schultz, L. (2006) A handful of heuristics and some propositions for understanding resilience in social-ecological systems. *Ecology and Society*, 11(1): 13.

Walker, B., Holling, C.S., Carpenter, S.R. and Kinzig, A. (2004) Resilience, adaptability and transformability in social–ecological systems. *Ecology and Society*, 9(2): 5.

Walker, B. and Meyers, J.A. (2004) Thresholds in ecological and social–ecological systems: a developing database. *Ecology and Society*, 9(2): 3.

Walker, B.H. and Pearson, L. (2007) A resilience perspective of the SEEA. *Ecological Economics*, 61(4): 708-715.

Walker, B. and Salt, D. (2006) *Resilience Thinking: Sustaining Ecosystems and People in a Changing World*. Washington, DC: Island Press.

Walker, B. and Salt, D. (2012) *Resilience Practice: Building Capacity to Absorb Disturbance and Maintain Function*. Washington, DC: Island Press.

Walliman, N. (2006) *Social Research Methods*. London: Sage.

Walters, C.J. and Holling, C.S. (1990) Large-scale management experiments and learning by doing. *Ecology*, 71(6): 2060-2068.

Waltner-Toews, D., Kay, J.J. and Lister, N.-M.E. (eds.) (2008) *The Ecosystem Approach: Complexity, Uncertainty, and Managing for Sustainability*. New York: Columbia University Press.

Warren, W.A. (2005) Hierarchy theory in sociology, ecology, and resource management: a conceptual model for natural resource or environmental sociology and socioecological systems. *Society & Natural Resources*, 18(5): 447-466.

Wasson, B. and Underdal, A. (2002) Human–environment interactions: methods and theory. Global Change Newsletter, 49: 22-23. International Geosphere-Biosphere Programme (IGBP). Online at: http://www.igbp.net/download/18.5831d9ad13275d51c098000338/NL49.pdf [accessed 23/11/2015].

WCED. (1987a) Report of the World Commission on Environment and Development [WCED]: Our Common Future. Transmitted to the General Assembly as an Annex to document A/42/427 [4 August 1987] - Development and International Co-operation: Environment. New York: General Assembly of the United Nations. Online at: http://www.un.org/ga/search/view_doc.asp?symbol=A/42/427&Lang=E [accessed 23/11/2015].

WCED. (1987b) Address by Mrs Gro Harlem Brundtland, Chairman, at the Closing Ceremony of the Eighth and Final Meeting of the World Commission on Environment and Development [WCED], 27 February 1987, Tokyo, Japan. Online at: http://www.dipecodir.it/upload/file/Cecchi/EcoTurCa/Documenti/1987%20Tokyo%20Declaration.pdf [accessed 23/11/2015].

WCED. (1987c) Presentation of the report of the World Commission on Environment and Development to UNEP's 14th Governing Council session by Mrs. Gro Harlem Brundtland, Prime Minister of Norway and Chairman, World Commission on Environment and Development [WCED], Monday, June 8, 1987, Nairobi, Kenya. Online at: http://leopold.asu.edu/sustainability/sites/default/files/Warren,%20World%20Commission,%20Brundtland.pdf [accessed 23/11/2015].

Webb, C. and Bodin, Ö. (2008) A network perspective on modularity and control of flow in robust systems. Pages 85-118 in Norberg, J. and Cumming, G. (eds.) *Complexity Theory for a Sustainable Future*. New York: Columbia Press.

Weisz, H. and Clark, E. (2011) Society–nature coevolution: interdisciplinary concept for sustainability. *Geografiska Annaler: Series B, Human Geography*, 93(4): 281-287.

Wenger, E. (1998) *Communities of Practice: Learning, Meaning, and Identity*. Cambridge: Cambridge University Press.

Westley, F., Carpenter, S.R., Brock, W.A., Holling, C.S. and Gunderson, L. (2002) Why systems of people and nature are not just social and ecological systems. Pages 103-119 in: Gunderson, L.H. and Holling, C.S. (eds.) *Panarchy: Understanding Transformations in Human and Natural Systems*. Washington, DC: Island Press.

White, M.A. (2013) Sustainability: I know it when I see it. *Ecological Economics*, 86: 213-217.

White, R.M. (1995) Sustainable development: mirage or achievable goal? Pages 237-243 in: Technology and Development Steering Committee [National Research Council/World Bank] (ed.) *Marshaling Technology for Development: Proceedings of a Symposium* [November 28-30, 1994, Arnold and Mabel Beckman Center, Irvine, California]. Washington, DC: National Academy Press.

Wiener, J.B. (2002) Sustainable governance. Pages 131-144 in: Gillroy, J.M. and Bowersox, J. (eds.) *The Moral Austerity of Environmental Decision Making: Sustainability, Democracy, and Normative Argument in Policy and Law*. Durham, NC: Duke University Press.

Wilson, J.A. (2006) Matching social and ecological systems in complex ocean fisheries. *Ecology and Society*, 11(1): 9.

Wise, M. (2000a) The Atlantic arc: transnational European reality or regional mirage? *Journal of Common Market Studies*, 38(5): 865-890.

Wise, M. (2000b) From Atlantic arc to Atlantic area: a case of subsidiarity against the regions? *Regional Studies*, 34(9): 865-873.

Withycombe Keeler, L., Wiek, A., White, D.D. and Sampson, D.A. (2015) Linking stakeholder survey, scenario analysis, and simulation modeling to explore the long-term impacts of regional water governance regimes. *Environmental Science & Policy*, 48: 237-249.

Wolf, K.L., Blahna, D.J., Brinkley, W. and Romolini, M. (2013) Environmental stewardship footprint research: linking human agency and ecosystem health in the Puget Sound region. *Urban Ecosystems*, 16(1): 13-32.

Woolcock, M. (2001). The place of social capital in understanding social and economic outcomes. *Isuma: Canadian Journal of Policy Research*, 2(1): 11-17.

Woolcock, M. and Narayan, D. (2000) Social capital: implications for development theory, research and policy. *The World Bank Observer*, 15(2): 225-249.

Wright, F.L. (2005) *Frank Lloyd Wright: An Autobiography*. Warwick: Pomegranate. [Originally published in 1943. New York: Duell, Sloan and Pearce.]

Wu, J. (2012) A landscape approach for sustainability science. Pages 59-77 in: Weinstein, M.P. and Turner, R.E. (eds.) *Sustainability Science: The Emerging Paradigm and the Urban Environment*. New York: Springer.

Wu, J. and Hobbs, R.J. (2007) Landscape ecology: the-state-of-the-science. Pages 271-287 in: Wu, J. and Hobbs, R.J. (eds.) *Key Topics in Landscape Ecology*. Cambridge: Cambridge University Press.

Wulun, J. (2007) Understanding complexity, challenging traditional ways of thinking. *Systems Research and Behavioral Science*, 24(4): 393-402.

Yetim, F. and Turoff, M. (2004) Structuring communication processes and enhancing public discourse: the Delphi method revisited. Pages 235-252 in: Aakhus, M. and Lind, M. (eds.) *Proceedings of the 9th International Working Conference on the Language-Action Perspective on Communication Modelling (LAP 2004) 2-3 June 2004, Rutgers University, New Brunswick, NJ, USA*. Online at: http://comminfo.rutgers.edu/~aakhus/lap/Yetim_Turoff.pdf [accessed 25/6/2016].

Yin, R.K. (2003) *Case Study Research: Design and Methods*. Third Edition. Thousand Oaks, CA: Sage.

Yin, R.K. (2009) *Case Study Research: Design and Methods*. Fourth Edition. Thousand Oaks, CA: Sage.

Young, O.R. (2011) Effectiveness of international environmental regimes: existing knowledge, cutting-edge themes, and research strategies. *Proceedings of the National Academy of Sciences of the United States of America*, 108(50): 19853-19860.

Young, O.R., Berkhout, F., Gallopín, G.C., Janssen, M.A., Ostrom, E. and van der Leeuw, S. (2006a) The globalization of socio-ecological systems: an agenda for scientific research. *Global Environmental Change*, 16(3): 304-316.

Young, O.R., Lambin, E.F., Alcock, F., Haberl, H., Karlsson, S.I., McConnell, W.J., Myint, T., Pahl-Wostl, C., Polsky, C., Ramakrishnan, P., Schroeder, H., Scouvart, M. and Verburg, P.H. (2006b) A portfolio approach to analyzing complex human-environment interactions: institutions and land change. *Ecology and Society*, 11(2): 31.

Zaccarelli, N., Petrosillo, I., Zurlini, G. and Riitters, K.H. (2008) Source/sink patterns of disturbance and cross-scale mismatches in a panarchy of social-ecological landscapes. *Ecology and Society*, 13(1): 26.

Zeitlin, J. (2005) Social Europe and experimentalist governance: towards a new constitutional compromise? Pages 213-241 in: de Búrca, G. (ed.) *EU Law and the Welfare State: In Search of Solidarity*. Oxford: Oxford University Press.

Zeitlin, J. (2011a) Presidential address: SASE annual meeting 2010, Philadelphia, USA – Pragmatic transnationalism: governance across borders in the global economy. *Socio-Economic Review*, 9(1): 187-206.

Zeitlin, J. (2011b) Transnational transformations of governance: the European Union and beyond. Inaugural lecture, delivered upon accession to the office of Professor of Public Policy and Governance at the University of Amsterdam on 11 November 2010. Oratiereeks 388. Amsterdam: Amsterdam University Press.

Zelli, F. and van Asselt, H. (2013) The institutional fragmentation of global environmental governance: causes, consequences, and responses. *Global Environmental Politics*, 13(3): 1-13. DOI: 10.1162/GLEP_a_00180.

Zins, C. (2000) Success, a structured search strategy: rationale, principles, and implications. *Journal of the American Society for Information Science*, 51(13): 1232-1247.

Zurlini, G., Petrosillo, I., Jones, K.B. and Zaccarelli, N. (2013) Highlighting order and disorder in social–ecological landscapes to foster adaptive capacity and sustainability. *Landscape Ecology*, 28(6): 1161-1173.

Zurlini, G., Petrosillo, I., Zaccarelli, N. and Riitters, K.H. (2008) Environmental security as related to scale mismatches of disturbance patterns in a panarchy of social-ecological landscapes. Pages 383-398 in: Petrosillo, I., Müller, F., Jones, K.B., Zurlini, G., Krauze, K., Victorov, S., Li, B.-L. and Kepner, W.G. (eds.) *Use of Landscape Sciences for the Assessment of Environmental Security*. Dordrecht: Springer.

Zürn, M. and Faude, B. (2013) On fragmentation, differentiation, and coordination. *Global Environmental Politics*, 13(3): 119-130.

Appendix A

Alternative methods and techniques considered

The following candidate methods and techniques for eliciting expert opinion were considered during the study design phase (see Chapter 5, section 5.3).

1. Brainstorming

This involves a period of free-thinking, which is used to generate and articulate ideas and solutions to a specific problem, followed by more rigorous discussion of these ideas and solutions (Steyaert and Lisoir 2005: 198). The technique requires a facilitator and uses a simple set of rules. It aims to stimulate creative thinking and reduce participants' inhibitions about generating as many deliberately unusual ideas and solutions as possible; it permits dissident viewpoints to enter into the research process at an early stage. Brainstorming is useful for gathering a lot of ideas prior to, for example, scenario analyses, planning or decision making. Jones (2004) states:

> 'It is a process of freeing up participants from censoring their thoughts (and each others) and reaching deeper levels of creative reflection and participation in a group process. By eliminating negativity, brainstorming encourages full member participation and contribution to the process' (p. 106).

During brainstorming, experts are treated as individuals rather than as a panel (Okoli and Pawlowski 2004: 24). Babiuch and Farhar (1994: 37) proffer five basic rules for a brainstorming session: (1) it should focus on a single, well-defined problem; (2) all ideas should be considered regardless of apparent relevance; (3) participants should not criticise or evaluate ideas; (4) participants should not explore the implications of ideas; and (5) participants should develop a generic relevance tree or list to stimulate ideas. Brainstorming allows the researcher to obtain a broad range of views on an issue. One potential disadvantage is that one or a few experts may dominate the discussion, causing some experts to remain silent (de Loe 1995: 56).

2. Mind, cognitive and concept mapping

Mapping techniques – involving concise, graphical representations and diagramming of data, relationships within the data, ideas, concepts and themes – are considered a useful tool for facilitating brainstorming exercises and other collaborative knowledge elicitation and/or representation methods and techniques (e.g. Cañas *et al.* 2003: 45). Such maps can be constructed with the assistance of software. The three types of mapping system considered were: mind, cognitive and concept mapping.

Mind mapping

Mind mapping techniques involve outlining key issues and other information in non-linear ways. They allow a group's ideas to be quickly charted to show logical groupings and the links between them (Steyaert and Lisoir 2005: 201). The resulting skeletal framework graphic or graphics usually comprise hierarchical relations and a branched tree or trees radiating out from a central topic, reflecting and representing cognitive associations. However, the mind map structure remains list-like, and the links are left unlabeled and typically represent unspecified connections among ideas. This limits the usefulness of mind maps at a later time (Cañas *et al.* 2003: 89).

Cognitive mapping

Cognitive maps or causal maps are large interconnected networks of ideas represented as nodes, each portrayed as a short sentence or paragraph with (mainly) bipolar directional links (i.e. arrows to two other nodes), which are unlabeled. The implicit label for a link is causal. 'Cognitive maps are not hierarchical and typically take the form of a large complex network containing hundreds of ideas, which may have more than one focal point' (Cañas *et al.* 2003: 89).

Concept mapping

Novak and Cañas (2006) describe concept maps as

> 'graphical tools for organizing and representing knowledge. They include concepts, usually enclosed in circles or boxes of some type, and relationships between concepts indicated by a connecting line linking two concepts. Words on the line, referred to as linking words or linking phrases, specify the relationship between the two concepts' (p. 1).

The concepts are represented in a hierarchical structure with reference to a particular focus question. Concept maps include cross-links representing relationships among concepts in different knowledge domains. In the creation of new knowledge, cross-links often represent creative leaps on the part of the knowledge producer (Novak and Cañas 2006: 2). Cañas *et al.* (2003: 6) state that one of the most fundamental goals in the use of concept maps is to foster meaningful learning.

> 'A standard procedure for Concept Map construction involves defining the topic or focus question, identifying and listing the most important or "general" concepts that are associated with that topic, ordering the concepts from top to bottom in the mapping field, and adding and labeling linking phrases. Once the preliminary Concept Map has been built, cross-links are identified and added, and a review of the map for completeness and correctness is performed' (Cañas *et al.* 2003: 8).

3. Individual interviews

Individual interview techniques may be used to elicit views and capture data from one expert at a time. Interviews, whether conducted face-to-face or remotely (by telephone or online using email and web conferencing, for example) are preferable to pen and paper type surveys when interpersonal contact and relationships are important, or when immediate follow-up and/or clarification of elicited comments is desirable (Frechtling 2002: 50). It may be easier to explore a complex issue with an individual than with a group. There are three principal types of individual interview technique:

- Structured interviews follow a rigid format in which carefully phrased, usually identical questions are administered in order by the interviewer (following a detailed protocol) who must minimise deviation from the question wording to ensure uniformity.
- Unstructured interviews (also called in-depth interviews) do not follow a rigid format and the interviewer (following a loosely structured protocol) encourages free and open responses (i.e. in the expert's own words) to open-ended questions. Essentially a guided conversation for the purpose of eliciting rich, detailed material that can be used in analysis.
- Semi-structured interviews are similar to unstructured interviews, but are protocol-based, that is, conducted using a list of fixed and/or open-ended questions in a specific order (Lowe and Lorenzoni 2007).

Of these, only unstructured and semi-structured interviews were considered. The structured interview technique was rejected on the basis that such a rigid format could not usefully elicit and/or capture spontaneous, innovative and creative responses from experts concerning complex problems and detailed subject matter.

The main strength of the unstructured interview format is the flexibility it affords to both the interviewer and interviewee. The interviewer is not constrained to a predetermined structure and may guide and develop the flow of the interview, and immediately probe for meaning and explore interesting and pertinent responses in more depth. The technique allows the interviewee to more fully (expansively and/or deeply) express their personal perspective in their responses. On the other hand, unstructured interviews can be expensive and time consuming. The personal dialogue between interviewer and interviewee requires the interviewer to be highly skilled in order to elicit rich and detailed material for analysis, while avoiding bias. Frechtling (2002: 52) mention other disadvantages, including that the interviewee may distort information through recall error, selective perceptions or desire to please the interviewer; flexibility can result in inconsistencies across interviews; and the large volume of information may make it difficult to transcribe and reduce data. Furthermore, the interviewer may experience difficulties related to controlling (standardising and optimising) the interview environment.

Options for recording detailed interview data for subsequent analysis include digital video and/or audio recording (with a participant's permission and confidentiality) and more difficult hand-written or typed summary notes. Digital recordings will require verbatim transcriptions of everything said, plus the interviewer's notes. This is clearly a time-consuming and potentially expensive process. Other disadvantages include the potential inhibition of responses introduced by recording. Recordings may be used to expand notes taken by the interviewer. Otherwise, detailed notes must be taken during the interview, which requires the interviewer to call on memory for expanding and clarifying notes immediately after the interview.

4. Questionnaire survey

According to Okoli and Pawlowski (2004: 19), the traditional survey technique involves administering a questionnaire designed and pre-tested by the researcher. This can include questions that solicit quantitative or qualitative data, or both. Because the purpose is to average out and generalise results to a larger population, the issue of validity centres on the random selection (using statistical sampling techniques) of a representative sample of the population of interest. The respondents (i.e. the fraction of the selected random sample that responds) fill out the survey and return it. The researcher then analyses the usable responses (taking into account non-response bias) to investigate the research questions. Respondents are almost always anonymous to each other. When more than one round is involved, participant dropout (attrition) may be an issue. 'The richness of data depends on the form and depth of the questions, and on the possibility of follow-up, such as interviews' (Okoli and Pawlowski 2004: 19). As a standalone technique, traditional surveys are limited to collecting data from individual experts rather than from panels.

5. Expert panel

The expert panel is a versatile generic tool, various formats of which are used in the focus group, nominal group, RAND method and the Delphi approach. The purpose of establishing an expert panel is to utilise the best available, usually independent experience concerning specific tasks such as synthesising a variety of qualitative and quantitative data from different sources, analysis, forecasting or decision making. Specific methods and techniques are usually employed to identify, select and motivate the panellists, and to elicit, share, synthesise, develop and prioritise knowledge, and achieve consensus (Steyaert and Lisoir 2005: 200; Rikkonen *et al.* 2006: 74). The expert panel technique is suited to complex problems. In many cases, expert panels are used in combination with other techniques for the collection and analysis of the data, and may be convened at specific stages of the research process, usually at the beginning and end of an evaluation. Traditionally, expert panels meet face-to-face. However, part of the panel's work, particularly at later stages, may be undertaken by remote communication using telephone, email, online video conferencing and so forth. The credibility of the technique largely depends on the use of panellists with recognised expertise or specialism relevant to the subject and tasks.

Disadvantages include the potential risk of individual bias and negative group dynamics such as domination by one or more individuals, unwillingness to criticise peers or their perspectives, value minority views or explore areas of uncertainty. The convergence of opinions to achieve consensus may obscure or undervalue individual opinions that are, nevertheless, highly relevant. Potential weaknesses may be avoided or minimised through careful design of protocols and use of expert panels within a mixed methods approach.

The time- and cost-effectiveness of the technique varies depending on the number of panel meetings, meeting arrangements and the expense involved in travelling. Online and other remote communication techniques can significantly reduce costs, particularly when panellists are geographically dispersed.

6. Focus group

A focus group session is a structured, in-depth and interactive group discussion (or series of discussions) on a particular subject among a small panel of between four and 12 experts (or other category of participants) facilitated by the researcher (de Ruyter 1996: 44; Steyaert and Lisoir 2005: 200). The aim of the technique is to openly elicit information about expert's personal views and explore why these are held, as well as to generate data and insights by observing the panel's dynamics and reflective discussion. The focus group technique combines elements of both interviewing and participant observation; it asks the same type of open-ended questions as unstructured and semi-structured interviews, but in a strong social context (Frechtling 2002: 53; Davies 2004: 13). It is usual for the facilitator to follow a protocol listing topics or question areas to be covered by the panel.

The synergistic group interaction and encouragement of creative thinking helps to shape and refine data. 'Hearing from other participants stimulates further thought, encouraging people to reflect on their own views or behaviour and triggering further material' (Davies 2004: 13).[171] The focus group should only conclude when no new ideas are being generated (Potter *et al.* 2004: 127). Crucially, the panel is not required to reach any kind of consensus. Davies (2004) considers the role of the researcher-as-facilitator the key to making focus groups effective by helping the panel to 'focus and structure their discussion, bring discussion back or move it on, widen the discussion to include everyone, and ensure a balance between participants' (p. 15). The researcher probes individuals and the panel as a whole to encourage in-depth exploration. The data recording procedures are essentially the same as for unstructured interviews.

The focus group technique provides much less depth at the individual level than unstructured interviews and the relevance of findings may be considered limited to the specific individuals included in the panel (Frechtling 2002: 43; Davies 2004: 16). Session output is relatively unstructured (de Ruyter 1996: 44). 'Although the session can provide an extensive list of attributes, the process does

[171] De Ruyter (1996: 44) refers to the opposite, in which group dynamics inhibit the exchange of opinions and ideas and lead to the loss of minority or opposing points of view.

not facilitate establishing attribute priorities' (Claxton *et al.* 1980: 311). There is also the potential for an individual or subset of the panel to be outspoken and dominate (or intimidate) other panellists. Traditionally, focus groups are physical (face-to-face) meetings, requiring geographically dispersed panel members to travel to one location. This is likely to be time consuming and expensive.

7. Nominal group technique

The nominal group technique (NGT) is closely related to brainstorming but follows a highly structured protocol and group meeting format for building the knowledge base (Day and Bobeva 2005: 104). The prefix 'nominal' refers to a non-interacting group, that is, a group in name only. Like the focus group, the NGT is primarily consultative. It is similar to the Delphi approach in that a panel of experts (or other category of participants) is asked to generate initial ideas or opinions regarding an issue, then develop and prioritise them, but the panel is not necessarily required to reach a consensus (Campbell *et al.* 2002: 360). However, Davies (2004: 17) states that the aim of the panel is to reach a consensus in areas of both agreement and disagreement.

The NGT usually involves a physical gathering of panellists facilitated by a researcher. As with the focus group technique, the researcher-as-facilitator role requires a specific and strong skill set. The role of facilitation is primarily to inspire faithful adoption of the meeting structure (Duggan and Thachenkary 2004: 401). 'Nominal groups are either facilitated by an expert on the subject (the Delbecq technique, named after its instigator [André Delbecq]) or a non-expert, who has credibility with the participants (the Glaser technique)' (Campbell and Cantrill 2001: 7). Davies (2004) states that

> 'A good facilitator is vital to ensure that all participants in the group are able to contribute to the discussion, and that the group works in a disciplined manner to reach agreement and agreed difference' (p. 17).

Panellists may be provided with detailed background information so that they understand the aim and context of the research question being addressed (Campbell and Cantrill 2001: 6). Conversely, Potter *et al.* (2004: 126) point to the minimal, if any, pre-meeting preparation required by participants. The creative generation (brainstorming) of ideas is silent, and strictly individual and independent of other panellists; this is so as to avoid the problems of verbal group interaction that may occur in focus groups (van Teijlingen *et al.* 2006: 250).

The NGT is a sequential process following a structured protocol (e.g. Table 2 in Potter *et al.* 2004: 128). After the initial lists of ideas have been elicited, pooled and collated, the panel meets for a structured discussion of each idea in turn (cf. the Delphi approach, which does not include discussion). This enables interactive clarification and evaluation; the process can end at this stage or the panellists may then anonymously and privately judge and establish (rate or rank) the relative importance of each idea. This may be followed by further iterations with another round of feedback, further discussion and re-rating/ranking to produce final results (Claxton *et al.* 1980: 309; Campbell and Cantrill 2001: 6-7; Sutherland 2006: 610). This may involve the group deciding the priority ordering of the alternatives based on voting and/or a statistical criterion for aggregating the individual judgements (Duggan and Thachenkary 2004: 401). The combination of discussion and rating/ranking allows qualitative and quantitative data to be gathered and analysed (van Teijlingen *et al.* 2006: 251). Although the NGT is essentially a qualitative technique, its product can be presented quantitatively.

According to Campbell and Cantrill (2001: 7), the NGT process yields far more ideas than a conventional, unstructured group meeting, where normal group interactions serve to constrain freedom of expression. By enabling individuals to work in the presence of others without significant interaction, and by partitioning of activities into creative thinking and idea generation, evaluation, and decision making, the NGT equalises participation and reduces the negative effects of freely interacting groups, such as ineffective idea generation, unequal participation in discussions, loss of individualism, domination by more vocal and influential participants, and ineffective conflict resolution (Duggan and Thachenkary 2004: 400, 401). The highly structured process and direct involvement of panellists in both data collection and analysis helps to minimise researcher bias (Potter *et al.* 2004: 127). Nevertheless, the NGT is not a particularly effective means of synthesising ideas (Duggan and Thachenkary 2004: 402).

The traditional NGT data recording procedures involve flip charts during the meeting, supported by digital audio and/or video recording to enable subsequent transcription (Potter *et al.* 2004: 127). Potter *et al.* (2004: 130) found the NGT to be cost effective and time efficient, despite stating that data analysis is a time-consuming process due to the volume of information collected and the nature of the analytical procedures required (p. 127). Campbell and Cantrill (2001: 6) state that the meeting process can take between 1 and a half and 6 hours. As well as the traditional face-to-face setting, the NGT has been applied in an online setting. A comparative study by Lago *et al.* (2007: 293) of the two settings for structuring group decision making found that traditional NGT outperformed the online version with regards to the decision process. However, only marginal differences were found in the outcomes between the two settings.

8. RAND appropriateness method

The RAND[172] appropriateness method is a formal group consensus technique[173] based on systematically combining expert opinion and the available scientific (systematic literature review) evidence, often in a more quantifiable way than other approaches, by asking panellists to rate, discuss and then re-rate statements (Campbell and Cantrill 2001: 8; Campbell *et al.* 2002: 360). Each panellist's ratings carry equal weight irrespective of how much or little they contribute to the discussion (Campbell *et al.* 2002: 361).

The RAND method combines elements of both the Delphi approach (such as systematic literature review, predetermined questions, selection of expert panels, and first round postal survey where panellists are asked to read the accompanying

[172] RAND Corporation, Santa Monica, California, USA (http://www.rand.org).

[173] 'Consensus techniques are group facilitation techniques which explore the level of consensus among a group of experts by synthesising and clarifying expert opinion in order to derive a consensus opinion from a group with individual opinions combined into a refined aggregated opinion' (Campbell *et al.* 2002: 360).

evidence and rate the preliminary statements) and the NGT (such as a face-to-face panel meeting where panellists discuss each statement in turn) but differs from the NGT in that panellists are asked to rate the appropriateness of predetermined statements based on a synthesis of the available evidence. 'They are not asked to generate a set of ideas, although they are encouraged to suggest, and then rate, amendments' (Campbell and Cantrill 2001: 8; Campbell *et al.* 2002: 360). Unlike the conventional Delphi panels, the RAND method requires panellists to meet face-to-face, resulting in implications of negative group dynamics, expense and time as described for the focus and NGT above.

9. Delphi approach

The Delphi approach (also called the Delphi technique, method, survey, panel, process, approach or just Delphi) is essentially a systematic approach to structuring a group communication process so that the group can effectively deal with a particular issue or complex problem (Linstone and Turoff 2002: 3). Delphi is both a procedure (method) and a tool (technique). It is an iterative, sequential, multistage and flexible process that aims to derive informed anonymous agreement and consensus among a panel of experts through qualitative assessment of evidence, thereby minimising the liabilities of individual expert decisions. The Delphi method can be used qualitatively, that is, without quantitative statistical consensus (Fletcher and Marchildon 2014; Habibi *et al.* 2014). Given the number of existing and emerging Delphi variants in the literature, some of which differ significantly from the classical or conventional Delphi, I consider it more appropriate to consider it the Delphi approach.

The 'Delphi technique' was originally conceived in the years following the Second World War by researchers at the RAND Corporation who were investigating ways to obtain the most reliable consensus of opinion on a particular topic among a group of experts by means of a series of intensive questionnaires interspersed with controlled opinion feedback (Dalkey and Helmer 1963: 458). The RAND researchers found that, compared to the simple consensus procedure of bringing experts together in a committee for an open discussion, the Delphi technique

> 'eliminates committee activity altogether, thus further reducing the influence of certain psychological factors, such as specious persuasion, the unwillingness to abandon publicly expressed opinions, and the bandwagon effect of majority opinion' (Helmer and Rescher 1959: 47).

With rapid development of the technique during the 1960s and its broad application in numerous fields, the Delphi approach has become a popular and widely used set of procedures for eliciting and refining reliable group judgements, often without an obligation for consensus (Linstone and Turoff 2002: 11). Its uses include for planning and forecasting, developing a range of possible alternatives, hypothetical 'futures', problem solving, obtaining consensus, clarifying divergent views, exploring underlying assumptions, exposing and considering a range of policy options, supporting decision making, evaluating complex social and economic dimensions, collecting tacit knowledge, facilitating creative thinking and idea generation, exposing personal values and social goals, and a variety of other objectives (Linstone and Turoff 2002: 4; Landeta 2006: 468).

There are several named variants of the Delphi approach, each representing a cluster of similar technique styles or modifications of the conventional Delphi. These include the 'policy Delphi' (Turoff 1970; de Loe 1995), 'decision Delphi' and 'group Delphi' (van Zolingen and Klaassen 2003). Of these, the policy Delphi, originally proposed by Turoff (1970), is particularly prevalent. Mitroff and Turoff (2002) state that the policy Delphi communication process 'is designed to produce the best underlying pro or con arguments associated with various policy or resource allocation alternatives' (p. 29). The main aim of the policy Delphi is not to obtain a consensus of expert opinion as in a conventional Delphi; it is used when the inquirer or decision maker requires the full range of different options and opinions from panellists (who are not necessarily experts) plus supporting for-and-against evidence concerning a topic (Steyaert and Lisoir 2005: 109). The divergence of opinions is pivotal (Engels and Kennedy 2007: 3). De Loe (1995: 57) describes the conventional Delphi, as originally developed at

RAND, as a 'decision-making tool' and the policy Delphi variant as a 'decision-facilitation tool'.[174]

Characteristics of Delphi

Regardless of the variations of the continuously evolving Delphi approach across diverse applications, there are several defining Delphi characteristics (Linstone and Turoff 2002: 3; Yetim and Turoff 2004: 237-238) including:

> *Participation*. Experts (or other persons with valued opinion) from relevant fields and disciplines are first identified and invited to participate as panellists in the study.
>
> *Facilitation and structured information flow*. The approach requires a facilitator (the inquirer) to plan the Delphi procedure, design survey questionnaires or other data collection instruments and administer them in rounds. This involves distributing the questionnaires to panellists, collating, analysing and synthesising the responses, and feeding back a summary report to the panellists. Computer-assisted Delphi make use of information and communication technology to help structure and facilitate information flow.
>
> *Nominal idea generation*. The first round usually involves asking panellists to individually list their initial ideas or opinions. The resulting list comprises ideas generated only nominally by a group.
>
> *Controlled feedback*. A summary report, controlled by the facilitator, containing analysis and comments concerning the synthesis of individual responses (i.e. the de facto group judgment or view at that stage) is fed back to the panellists, possibly with another questionnaire if another round is to be undertaken.

[174] 'The Policy Delphi rests on the premise that the decision maker is not interested in having a group generate his/her decision, but rather in having an informed group present all the options and supporting evidence for his/her consideration. Therefore, the Policy Delphi is a tool for the analysis of policy issues and not a mechanism for making a decision. Generating a consensus is not the prime objective. The structure of the communication process, as well as the choice of the respondent group, may make achieving consensus on a particular resolution very unlikely. In fact, in some cases the sponsor may even request a design that inhibits consensus formulation' (Steyaert and Lisoir 2005: 114).

Iteration. Panellists are given the opportunity to revise their initial ideas or opinions in response to the feedback (summary report). The iterative process (or round) of collating responses, providing feedback and eliciting revisions continues until a pre-determined level of consensus or stability of an individual's response is achieved, or until the facilitator concludes that the process has achieved its aim. The number of rounds varies between studies, but three rounds are common.

Controlled discussion. Deliberately, there are no direct discussions among panellists to avoid the potential influences on the process of negative group dynamics.

> 'Instead, participants indirectly interact with each other through a series of questionnaires, i.e., through adding additional ideas, responding to each other's ideas, or updating their original judgments based on the group views of the problem. In most cases, voting is used to give each participant an opportunity to compare his/her own view with the group view' (Yetim and Turoff 2004: 238).

Anonymity. Though aware of working with their peers, panellist's responses are afforded (some degree of) explicitly guaranteed anonymity among peers to exclude unwanted social pressures. Anonymity is facilitated by the use of post and email or other online technologies for communication. This does not, of course, apply in a face-to-face Delphi (or group Delphi; van Zolingen and Klaassen 2003: 321, 323) where panellists meet, even if responses are kept secret, or when anonymity is deliberately removed by including panellist discussion.

Asynchronous communication. Most Delphi involve an asynchronous communication medium (post, email, online forum) for gathering ideas or opinions from panellists as well as for distributing summary reports (Yetim and Turoff 2004: 238). However, the Internet and group-facilitation software make possible synchronous (even real-time) computer-assisted Delphi communications (Linstone and Turoff 2002: 5).

Delphi stages, structure and sequence

Hasson *et al.* (2000: 1009) refer the absence of universal guidelines to help researchers facilitate a Delphi compared to other data collection methods. Nevertheless, several of the characteristics outlined above translate into a number of identifiable stages in the Delphi process. Although the number and exact details of these stages varies between different Delphi methodologies and studies in the literature (e.g. Campbell *et al.* 2002: 360; Linstone and Turoff 2002: 5-6; Plummer and Armitage 2007; Skulmoski *et al.* 2007: 3-5), the following procedural stages appear typical:

1. Planning. Identify the research problem (or topic) to be addressed by the group. This determines the appropriateness of employing a Delphi rather than an alternative technique in the first place.
2. Panel selection. Determine what expertise or specialisation is required to provide insight on the topic. Selection of individuals for the Delphi panel according to explicit procedure.
3. Preparation. Design a structured questionnaire or other data collection instrument (plus any supporting information) for Round One and pilot test with small group (implementing alterations, refinements, etc.).
4. Round One. Distribute first round questionnaires (plus any supporting information) for completion by panellists. Collate responses from each questionnaire. Analyse and distil the responses. Prepare a summary report plus second round questionnaire based on the findings so far, for feeding back to panellists.
5. Preparation. Design and pilot test questionnaires for Round Two.
6. Round Two. Implement second round questionnaires. Collate responses. Analyse and distil elicited responses. Prepare either a summary report and third round questionnaire if required, or
7. Conclusion. Prepare the final report summarising the findings and analysis (for feeding back to panellists).

8. Evaluation. Final evaluation of the Delphi process and utilisation of the results.

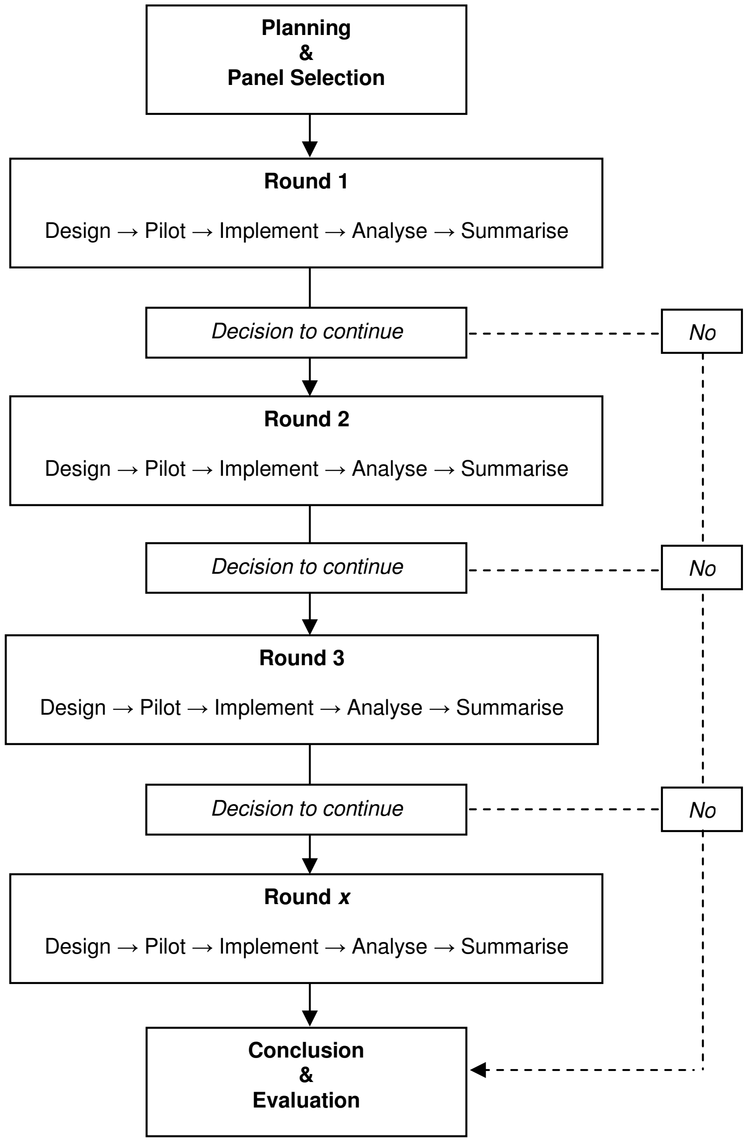

Figure A.1 Typical Delphi structure and sequence.

The above stages produce the characteristic Delphi 'round' structure (Figure A.1). The inherent flexibility of the approach allows for lesser or greater number of iterations (rounds) to be introduced during the process according to the facilitator's judgement on whether and when the aims of the Delphi have been fulfilled. For example, a third round may be deemed unnecessary if the aims were achieved by the first two rounds. Conversely, a fourth or greater number of rounds may be added during the study process if, for example, a new aim or direction emerges as a consequence of the preceding rounds.[175]

Advantages and disadvantages of Delphi

Delphi provides an opportunity for experts (panellists) to communicate their opinions and knowledge anonymously about a complex problem; to see how their evaluation of the issue aligns with others; and to change their opinion, if desired, after reconsideration of the findings of the group's work (Kennedy 2004: 505).

Gordon (2003) considers the primary strength of the Delphi process to be its ability to explore 'coolly and objectively' (p. 9) issues that require judgment. To this may be added the ability to make explicit uncertainty, lack of empirical evidence, speculation and divergent views (Powell 2003: 377; Okoli and Pawlowski 2004: 19). For McKenna (1994), the main advantage is the 'achievement of concurrence in a given area where none previously existed' (p. 1222). Delphi is particularly useful for generating debate rather than reaching a conclusion, although output is at best an opinion (Powell 2003: 377; Okoli and Pawlowski 2004: 26-27). By motivating independent thought and the gradual formation of group solutions, Delphi is well suited for dealing with open ended and creative aspects of complex problems. 'The Delphi method captures a wide range of interrelated variables and multidimensional features common to most complex problems, both of which are necessary elements for detailed scientific analysis' (Gupta and Clarke 1996: 186).

Delphi is particularly suited to eliciting knowledge from a panel of geographically dispersed individuals (Adler and Ziglio 1996: 9; Hamilton and Breslawski 1996) while simultaneously promoting learning among panel members (Gupta and Clarke 1996: 186). According to Powell (2003: 377), the feedback between Delphi rounds can widen knowledge and stimulate new ideas among the

[175] This, of course, must take into account the potential for panel attrition and dropout and the implications for study validity. Provided a mechanism can be constructed to address these issues, and provided panellists remain willing to participate in an extended study or follow-up process, it may be possible to maintain an open-ended Delphi concerning, for example, an emerging issue or area of theoretical development. This could take the form of an annual or biennial 'update' round to augment the concentrated Delphi study by considering and exposing new knowledge and developments in understanding concerning the topics originally under consideration.

panellists. Gupta and Clarke (1996) state that empirical experiments show that Delphi can be used simultaneously as a learning and research instrument: 'As a cooperative learning exercise, the Delphi method embraces the philosophy that the whole is greater than the sum of its parts, thus facilitating team work and group decision making' (p. 186). Day and Bobeva (2005: 104) state that Delphi 'offers reliability and generalisability of outcomes, ensured through iteration of rounds for data collection and analysis, guided by the principles of democratic participation and anonymity' (p. 104).

Anonymity, whether full or partial, is considered a key advantage of Delphi (Okoli and Pawlowski 2004: 16; Landeta 2006: 469). By avoiding direct confrontation between panellists (Dalkey and Helmer 1963: 459) and reducing the influence of some undesirable psychological effects, such as inhibition, dominant personalities, seniority and the biasing effects of personality traits (Gupta and Clarke 1996: 186; Powell 2003: 377; Landeta 2006: 469), the controlled Delphi interaction provides a level playing field for participation and the communication and documentation of facts and opinions. It provides an opportunity for panellists 'to see how their evaluation of the issue aligns with others, and to change their opinion, if desired, after reconsideration of the findings of the group's work' (Kennedy 2004: 505).

> 'Direct confrontation [...] all too often induces the hasty formulation of preconceived notions, an inclination to close one's mind to novel ideas, a tendency to defend a stand once taken, or, alternatively and sometimes alternately, a predisposition to be swayed by persuasively stated opinions of others' (Dalkey and Helmer 1963: 459).

Thus, Delphi creates a personal stake for the panellist in the success of the study (Gupta and Clarke 1996: 186).

Okoli and Pawlowski (2004: 19-20) compare and contrast the strengths and weaknesses of a Delphi study versus the traditional questionnaire survey approach as a research strategy. They find, *inter alia*, that Delphi permits a construct validation step by asking panellists to validate the researcher's analysis and interpretation; non-response and attrition rates in Delphi are typically low due to the researcher having personally obtained assurances of participation and being well placed to communicate with potential dropouts; and Delphi studies inherently provide richer data than traditional surveys because of their multiple iterations and their response revision due to feedback.

The Delphi has been described as a quick, efficient and relatively inexpensive approach for eliciting responses (Gupta and Clarke 1996: 186, 187). However, Powell (2003: 377) points out that not everyone agrees with this; that extensive time commitment is needed and the duration and cost of a Delphi study will be related to the scale of the survey, the complexities involved in the processing of the questionnaires and the number of rounds.

There are other limitations to the approach and Delphi studies may be difficult to perform well (Gordon 2003: 9). Gupta and Clarke (1996: 187) mention conceptual and methodological inadequacies, potential for sloppy execution, crudely designed questionnaires, poor choice of experts, unreliable result analysis, limited value of feedback and consensus, and instability of responses among consecutive Delphi rounds. In addition, there is the inherent difficulty of dealing with the subjectivity of panellist opinion and the potential for panellists to inadvertently or deliberately promote desired outcomes or influence future decisions. Landeta (2006: 469) refers to criticism of the approach due to its deficient application, including the not very rigorous selection of experts, the lack of explanation concerning its evolution and dropout, questions and problems that are badly formulated, and insufficiently analysed results.

Differences over issues of scientific methodology and study design, hence validity, regarding the Delphi approach indicate a particular area of weakness (Gupta and Clarke 1996: 187; Powell 2003: 381; Landeta 2006: 469) as do questions about whether the main claims of Delphi can be substantiated (Gordon 2003: 10). Yetim and Turoff (2004: 239) respond that the widespread use of Delphi 'indicates that it has survived this criticism' (p. 239).

In a paper concerning the validity of Delphi in the social sciences, Landeta (2006: 469) considers significant methodological weaknesses of Delphi to include its basic source of information (who is 'expert', what biases each expert has, etc.); the use of consensus as a way to approach the truth; the limitation of the interaction involved in written and controlled feedback; the restriction to the possibility of social compensation for individual contribution to the group (the reinforcement and motivation normally provided by the support and social approval of the other expert group members are removed); the impunity conferred by the anonymity with respect to irresponsible actions on the part of the experts; the ease inherent in the methodology of interested manipulation by the person running the study; the difficulty of checking the method's accuracy and reliability; the time required to carry it out; the effort required on the part of the participants; and the non-consideration of possible interrelations between the forecast incidents.

Gordon (2003:10) points to the time a Delphi can take: 'A single round can easily require three weeks; a three-round Delphi is at least a three to four month affair, including preparation and analysis time' (p. 10). If there is attrition during the study, the number dropping out or losing interest may affect the validity of the outcome.

In summary, the advantages of Delphi include: structured group communication process for use with geographically-dispersed panellists; can encompass a wide range of expertise; avoids direct confrontation of experts; individuals are able to express their own opinions, with anonymity and confidentiality of responses; the potential to gain large quantities of data and condense expert opinions into a few precise and clearly defined statements; limited time required for panellists to complete surveys; rapid consensus can be achieved; relatively cost effective to administer and analyse; and a versatile method. The disadvantages of Delphi include: concerns about the reliability of the method; limited or conflicting guidelines for determining consensus, sample size and sampling techniques; success of the method depends on the quality, commitment and motivation of the participants; can be time-consuming for panellists; dependence on speedy responses by busy experts; dropout rates can be high; the potential for significant time delays between rounds (data collection, analysis, processing); the facilitator's view may dominate in the analysis; and does not cope well with widely differing opinions or large changes in opinions.

10. Case study approach

There are different views about what a case study approach entails. According to Dul and Hak (2008: 3), for some, case study research is a strictly exploratory research strategy concerning single instances in which nothing can be proven. For others, such as Yin (2003), the problem of generalisation can be solved and, therefore, theories can also be tested in (preferably) multiple case studies. Gerring (2007) calls case study a 'definitional morass' (p. 17). Yin (2003: 13-14) provides a well known, all-inclusive definition in two parts that addresses the scope and technical characteristics of a case study: First, a case study is an empirical enquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between object of study and context are not clearly evident. Second, the case study enquiry copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result benefits from the prior development of theoretical propositions to guide data collection and analysis.

Dul and Hak (2008: 4) point out that Yin's definition, like others, does not capture one crucial methodological characteristic that distinguishes case study from other research approaches such as the survey: the fact that its focus is on a single instance, or sometimes a small number of instances, of the object of study. Other definitions explicitly refer to singularity. For example, Eisenhardt (1989) describes the case study approach as 'a research strategy which focuses on understanding the dynamics present within single settings' (p. 534). In another example, Gerring (2007) defines the case study approach as the 'intensive study of a single case for the purpose of understanding a larger class of similar units (a population of cases)' (p. 211). He considers the term 'case study' synonymous with single-unit study, single-case study and within-case study. Yin's definition, however, does emphasise another distinctive characteristic of the case study, that is, real-lifeness. Unlike in an experiment, in a case study the object of study or its environment are not manipulated (hence Yin's 'real-life context') (Dul and Hak 2008: 4). In an attempt to capture both distinctive characteristics, Dul and Hak (2008) define case study research as

> 'research in which (a) one case (single case study) or a small number of cases (comparative case study) in their real life context are selected, and (b) scores obtained from these cases are analysed in a qualitative manner' (p. 278).

How does case study research differ from survey research? The case study draws conclusions on the basis of qualitative analysis of data/information[176] regarding a single instance (single case study) or small number of instances (comparative case study), whereas the survey draws conclusions on the basis of a quantitative (statistical) analysis of data from a population with a large number of instances (Dul and Hak 2008: 5). Both, however, involve studies of instances in their real-life context.

The case study approach is essentially concerned with the case: 'As a form of research, case study is defined by interest in individual cases, not by the methods of inquiry used' (Stake 2005: 443). Consequently, the case study approach can draw from a range of possible research methods and ways of organising research. Because of its singular focus, a case study is useful for revealing and describing the multidimensional complexity of social–ecological systems (SES), regions and other contemporary social constructs in their real-world problem contexts. By studying a complex case, Ryan (2006: 71) states that a large number of concepts and ways of making sense of the world or experience are likely to emerge; such reasoning phenomena can be simultaneously unique and general. In other words

[176] Stake (2005: 443) notes that case study research is not essentially qualitative.

> 'discourses, frames of reference or mental models are common, but everybody has a unique relationship to them. Generalisability is present in any single case, that is, every individual is representative in some way of the social' (Ryan 2006: 71).

Nevertheless, in this research, generalisation is only part of the objective (Study objective 1, to develop a SES conceptual framework and theoretical foundation). Another part of the objective is to qualitatively investigate resilience in EASES (Study objective 2) and produce knowledge useful to policy actors concerned with Atlantic Europe (Study objective 5). In other words, to understand the specific instance, the case.

Here it is worthwhile to mention five common misunderstandings about case study research identified by Flyvbjerg (2006, 2011). These misunderstandings tend to constitute the conventional view, or orthodoxy, of the case study. They are the basis on which the theory, reliability and validity of case study research are contested in the social sciences (Flyvbjerg 2011: 302). Flyvbjerg's (2011) responses in the form of revisions or 'corrections' to the five misunderstandings are summarised in Table A.1.

Table A.1 Five misunderstandings about case study research.

Misunderstanding 1:	General, theoretical (context-independent) knowledge is more valuable than concrete, practical (context-dependent) knowledge.
Correction:	Predictive theories and universals cannot be found in the study of human affairs. Concrete case knowledge is therefore more valuable than the vain search for predictive theories and universals. (p. 304)
Misunderstanding 2:	One cannot generalise on the basis of a single case, therefore, the case study cannot contribute to scientific development.
Correction:	One can often generalise on the basis of a single case, and the case study may be central to scientific development via generalisation as supplement or alternative to other methods. But formal generalisation is overvalued as a source of scientific development, whereas 'the force of example' and transferability are underestimated. (p. 305)

Misunderstanding 3:	The case study is most useful for generating hypotheses in the first steps of the research process, while hypothesis testing and theory building is best carried out by other methods later in the process.
Correction:	The case study is useful for both generating and testing of hypotheses but is not limited to these research activities alone. (p. 306)
Misunderstanding 4:	The case study contains a bias toward verification, that is, a tendency to confirm the researcher's preconceived notions.
Correction:	The case study contains no greater bias toward verification of the researcher's preconceived notions than other methods of inquiry. On the contrary, experience indicates that the case study contains a greater bias toward falsification of preconceived notions than toward verification. (p. 311)
Misunderstanding 5:	It is often difficult to summarise and develop general propositions and theories on the basis of specific case studies.
Correction:	It is correct that summarizing case studies is often difficult, especially as concerns case process. It is less correct as regards case outcomes. The problems in summarizing case studies, however, are due more often to the properties of the reality studied than to the case study as a research method. Often it is not desirable to summarize and generalize case studies. Good studies should be read as narratives in their entirety. (p. 313)
	Based on Flyvbjerg (2011).

Flyvbjerg (2006: 241) concludes that the case study is a necessary and sufficient method for certain important research tasks in the social sciences. He argues that the often sharp separation between qualitative and quantitative methods in the literature is spurious and illogical. In Flyvbjerg's view, both the case study research approach and approaches that focus on large random samples or entire populations (e.g. questionnaire surveys with related quantitative analysis) are essential for the sound development of social science. 'The advantage of large samples is breadth, whereas their problem is one of depth. For the case study, the situation is the reverse' (p. 241).

Thus, for this research I adopted a case study approach in which a single and unique, complex but bounded case (EASES) is studied both intrinsically and instrumentally. That is, studied in part as an end in itself with the aim of achieving a better understanding of the particular case ('intrinsic' (Stake 2005) or ‘descriptive’ (Yin 2003) case studies); and in part as a means to an end with the aim of advancing understanding about something other than the particular case, such as an abstract construct, wider issue or generalisable theory (‘instrumental’ (Stake 2005) or ‘exploratory’ and ‘explanatory’ (Yin 2003) case studies).

A carefully designed case study can address the complexity, relationality and contextuality of continually changing social–ecological realities. As an approach, case study offers a relatively unconstrained way of dealing with the relationships between the abstract conceptual/theoretical level and concrete/specific components. Case study design is open to the use of different types of information, in different forms, from different sources; and different data collection techniques. The case study approach is especially advantageous when the things being studied are ones over which the researcher has little or no control.

Appendix B

Procedure for identifying and selecting candidates for the expert panel

1. Introduction

Given the type and source of the information to be collected, a group (panel) of experts (panellists) was formed in order to elicit expert opinion during the study. The procedure for selecting suitable individuals with appropriate expertise to form the panel involved identifying potential panellists (candidates) before making a selection according to explicit criteria in order to justify selection bias. Therefore, this appendix begins with the definition of 'expert' and the criteria used to select candidate panellists.

Definition of expert

According to Cornelissen *et al.* (2003: 4) and Azadi *et al.* (2007: 238), an expert is a person whose knowledge in a specific domain is obtained gradually through a period of learning and experience. Such a definition bypasses the issues of status, authority and reputation. It also obviates the need to specify an individual as a scientist, academic, specialist, policy maker, manager, professional, lay person and so forth. A loose definition circumvents either/or considerations, for example, whether an individual is either an insider or outsider (in terms of community of practice), with experience gained either in theoretical or practical circumstances, and who is either directly or indirectly involved with the system being studied (Cornelissen *et al.* 2003: 4; Davis and Wagner 2003: 485; Azadi *et al.* 2007: 238).

The term 'expert' should not be confused with the term 'stakeholder'. As Cornelissen *et al.* (2003: 5) put it, experts are not necessarily stakeholders and stakeholders are not necessarily experts. A stakeholder can be any individual or group who can affect or is affected by the behaviour of the system (Mitchell *et al.* 1997). Experts are allowed to give an opinion on the meaning of information; stakeholders, on the other hand, are allowed to formulate the relevant issues but cannot give an opinion on the meaning of information (Cornelissen *et al.* 2003: 5).

A loose definition of expert also avoids any requirement to exclude participants selected for convenience, for example, on the basis of personal contacts or immediate availability.

Definition is important because a selection procedure may seek to establish an expert panel that is either deliberately homogenous (e.g. all scientists) or heterogeneous (e.g. scientists and policy makers or managers). This has implications for how the researcher deals with different forms of expert knowledge. For instance, Azadi *et al.* (2007: 247) consider it generally much more difficult to deal with knowledge elicited from a heterogeneous group of experts.

As Lowe and Lorenzoni (2007) point out, 'there is no agreed definition of what constitutes an 'expert' in the expert knowledge elicitation literature' (p. 133). Nevertheless, selection criteria usually reflect some form of definition. Therefore, following the example of Lowe and Lorenzoni's (2007: 133) paper concerning the elicitation of expert perceptions for managing climate change, for this study experts were considered to be

> *individuals who, having specialised in their particular area of work or research, have extensive knowledge of all or some of the following issues relevant to resilience in EASES: maritime (ocean and coastal) regional issues, including governance, preferably in a European setting; sustainability and/or sustainable development; complex adaptive systems and social–ecological systems theory; and resilience.*

Selection criteria

Clearly, a candidate has to be capable of giving a coherent and well-judged opinion on the meaning of information gathered and communicated in this study (Lowe and Lorenzoni 2007: 133; Nguyen and de Kok 2007: 1578). For the sake of validity, only candidates who met a certain minimum selection criterion were considered: the person had to have a recognised qualification and specialist knowledge in a subject area or areas relevant to this study, irrespective of their discipline. Relevant knowledge could be demonstrated through scholarly publications (minimum of one peer-reviewed journal article[177]), acknowledged areas of research interest and/or involvement in an applicable research project or projects. Furthermore, all candidates had to be able to communicate in the English language and have an active email account (to facilitate contact and subsequent communication). The former was taken for granted and the latter assumed from the existence of an email address.

2. Identification of academic candidates

The strategy devised for identifying academic candidates panellists consisted of undertaking structured searches for relevant scholarly literature available in electronic format on the World Wide Web using querying based on the researcher's (my) reasoning (Zins 2000), with subsequent information retrieval.

Alternative approaches were considered. So-called 'blind search' methods (Zins 2000: 1232) were rejected as ineffectual. Associative browsing, or following hypertext and hypermedia links embedded in electronic information resources such as a web page, was rejected as arbitrary and time consuming. Structured browsing of hierarchical lists and tables of networked content, such as web directories, was rejected as potentially biased by the originator's purpose and terminology.

Two web search engines were used: Google Scholar (http://scholar.google.com/) and Elsevier's Scirus (http://www.scirus.com/), which has since been retired. Both are federated search systems, which work by searching a single multidisciplinary repository of preprocessed information already drawn from multiple, diverse information resources (Sadeh 2006).[178] Both are free to access and search a wide range of electronic scholarly resources including journal databases, peer-reviewed articles, abstracts, conference papers, preprints (previews), citations, theses,

[177] A greater minimum number of peer-reviewed publications was rejected on the basis that it fails to recognise innovation within personal trajectories (e.g. when an academic adopts a new area of research interest).

[178] Metasearch systems differ from federated search systems in that they hold information 'about how a resource can be searched and how results can be extracted from it, but they do not contain any of the data that is stored in any of the resources that they can access' (Sadeh 2005: 2).

reports, books, open access databases, institutional repositories and digital archives. The coverage of each search engine resource is both overlapping and complementary.[179] However, Scirus is (now was) limited to searching only web pages containing scientific content and so does not cover the whole spectrum of scholarly data. Thomson Scientific's ISI Web of Knowledge (http://newisiknowledge.com/) (now Thomson Reuters Web of Science http://ipscience.thomsonreuters.com/) was also considered, but rejected on the basis of the restricted scope of the search results returned during pilot testing to identify the most appropriate search engine (Table B.1).

Table B.1 Search strings used during pilot test to identify a suitable web search engine (16/1/2008).

	Scirus	**Google Scholar**	**ISI Web of Knowledge**
1) *sustainability* + *resilience* + *"social-ecological"* + *system*	21,983	2,070	25
2) *sustainability* + *resilience* + *"social-ecological"* + *system* + *marine* OR *coastal*	2,532,338 (or 14,385 if first string is refined by *marine OR coastal*)	1,140	>100,000 (or 2 if first string is refined by *marine OR coastal*)

Google Scholar was selected as the primary web search engine on the basis that during pilot runs it captured a more focused and therefore manageable field of results specific to the study topic than did Scirus (Table B.1). However, because the relevance-ranking capability of Scirus tended to return different results, Scirus was used to cross-reference a number Google Scholar results and to establish further details regarding candidates. It was noted that neither Google Scholar nor Scirus require any specific query structure (i.e. sequence of search words or phrases). Table B.1 contains the results yielded by pilot test made by querying

[179] By default, Scirus used an algorithm based on (1) the location and frequency of a search term within a result and (2) the number of links to a page to calculate ranking by relevance, with the option of ranking results by date (http://www.scirus.com/srsapp/aboutus/). Google Scholar also uses an algorithm to relevance-rank articles by weighing the full text of each article, the author, the publication in which the article appears, and how often the piece has been cited in other scholarly literature (http://scholar.google.com/intl/en/scholar/about.html).

search strings (including Boolean operators as appropriate) on 16/1/2008 to identify a suitable web search engine or engines.

Two additional pilot searches were conducted. The first was made to check the number of results for the much-cited author Carl Folke[180] using the author: operator, which yielded the results in Table B.2.

Table B.2 Pilot search using the *author:* operator.

	Scirus	**Google Scholar**	**ISI Web of Knowledge**
Carl Folke	87	270	0
C Folke	86	954	0
Folke Carl	87	270	67
Folke C	86	954	175 (or *Folke C** 191)

The search strategy allowed for modifying the querying process when necessary to improve or refine the results. Based on my (the researcher's) familiarity with the subject matter of this study, a set of search words and phrases was created to reflect as precisely as possible the subject matter and priority (Table B.3).

Table B.3 Set of search words or phrases.

Search word or phrase:
sustainability, "sustainable development"
system
"social-ecological", "socio-ecological"
complex, complexity
resilience, vulnerability
maritime, marine, ocean, coast, coastal
europe, european, atlantic

Words with alternative spellings (e.g. words that can be Anglicised or Americanized) were avoided and only the singular form was used. The final selection of the initial search string (Table B.4, string A) was preceded by a

[180] See: Janssen, M.A., Schoon, M.L., Ke, W. and Börner, K. (2006) Scholarly networks on resilience, vulnerability and adaptation within the human dimensions of global environmental change. *Global Environmental Change*, 16(3): 240-252.

number of searches to refine the string to the required scope of the retrieved results. Search string A was then typed as a query into the search engine using the standard Google Scholar graphical user interface (electronic form) and appropriate syntax (18/1/2008). The results returned from querying string A (n=74) were then selectively and individually browsed and the names, email addresses and affiliations of all relevant individuals were actively sought and recorded. Any results not published in the English language were excluded. Subsequently, it was decided to expand the search by modifying the search string (string B) to increase the number of results (n=312). Only the results with unvisited hyperlinks were followed and browsed as before. Because the affiliations of the majority of candidates identified using strings A and B lay outside of Europe, it was decided to query a number of additional search strings (C to G) and include any additional results.

Table B.4 Search strings used to identify candidates for the expert panel, and number of results (Google Scholar, 18/1/2008).

	String	**Search results**
A:	*sustainability* OR *"sustainable development"* + *"social-ecological system"* OR *"socio-ecological system"* + *maritime* OR *marine* OR *ocean* OR *coast* OR *coastal* + *europe* OR *european* + *atlantic*	n=74
B:	*sustainability* OR *"sustainable development"* + *"social-ecological system"* OR *"socio-ecological system"* + *maritime* OR *marine* OR *ocean* OR *coast* OR *coastal* + *europe* OR *european* OR *atlantic*	n=312
C:	*european* OR *"european union"* + *maritime* OR *"maritime policy"* OR *"marine strategy"* + *governance* OR *management* + *system* + *"social-ecological"* OR *"socio-ecological"* + *resilience*	n=136
D:	*"eu maritime policy"* OR *"european union maritime policy"* OR *"european maritime policy"* OR *"eu integrated maritime policy"* OR *"integrated maritime policy for the eu"* OR *"integrated maritime policy for the european union"*	n=90
E:	*"social-ecological system"* OR *"socio-ecological system"* + *eu* OR *europe* + *marine* OR *maritime* + *policy* OR *governance*	n=56
F:	*"northeast atlantic"* OR *"north-east atlantic"* + *"social-ecological"* OR *"socio-ecological"*	n=49
G:	*"integrated maritime policy"* + *eu* OR *"european union"*	n=13

The results returned from querying each string were then individually browsed (without duplication) and the names, email addresses and affiliations of the relevant individuals were actively sought (using the main Google search engine) and recorded.[181] Limitations and exclusions were introduced to filter the long list: Any results not published in the English language were excluded. Any candidates who were close personal acquaintances were excluded. All results categorised as ‘not applicable’, ‘duplicate’, ‘not available’ and ‘rejected’ (due to various reasons, including not relevant or too general an area of research interest, grey literature only, masters thesis, unobtainable email address, etc.) were omitted. This produced a shortlist of 98 candidates.

The intention was not to generate a definitive list of all possible individuals suitable for an expert panel, but rather a valid and manageable list of candidates that could be invited to participate in the study. At this juncture, I considered the shortlist too long and impractical. Therefore, I decided to introduce a subjective ranking procedure to establish a group of candidates to prioritise for contacting with an invitation to participate.

Taking into consideration issues of ideal panel size, anticipated invitation take up and dropout rate (see subsection 5.3.2), a weighted scoring system was used to select priority candidates. Points were awarded against each candidate on the shortlist as follows:

Doctoral qualification	5 points
Peer-reviewed paper(s)	5 points
Relevant research interests	5 points
Location in one of the Atlantic Europe states (France, Ireland, Portugal, Spain, United Kingdom)	10 points
Location elsewhere in Europe/Scandinavia	5 points
Expertise concerning Atlantic Europe/North-East Atlantic	10 points
Expertise concerning spatial planning	5 points
Expertise concerning social–ecological systems/resilience	5 points

[181] Any additional searches required to cross-reference, establish or confirm details of experience were conducted without contacting the candidate.

Although highly subjective, the aim was to establish a baseline score (15 points for PhD, papers and research interests) then add points for the approximate geographical location of a candidate's research activities, and for demonstrable expertise in relevant areas. This produced a weighted list of the selected candidates (n=98) as follows:

Score	Number of candidates
40	25
35	20
30	20
25	33

The first batch of candidates to be contacted with an invitation to participate in the study comprised the 25 candidates with the highest score. After sufficient time had passed for most of this group to reply and either accept or decline, the second batch of candidates (score 35, n=20) was contacted, and so on until all shortlisted candidates had been contacted.

3. Identification of practitioner candidates

Attempts to identify practitioner candidates by replicating the search strategy used to identify academic candidates using querying search strings were unsuccessful. Therefore, a different strategy was attempted in which I used my personal insight and knowledge to identify practitioner candidates (including policy experts) by first identifying the relevant organisations, programmes or projects with which they were associated. This involved personal brainstorming to produce an inventory of organisations and institutions that have some relationship with the subject areas relevant to the study. The purpose was to identify as many relevant organisations and institutions as possible; that is, relevant in terms of their 'proximity' to issues concerning the Atlantic Europe macro-region. For example, EU institutions such as the European Commission and transnational networks such as the CPMR's Atlantic Arc Commission. This list was used to populate the precursor of Figure 6.4, which summarises the key groups, networks, organisations, institutions and governance systems identified in the conceptualisation of EASES.

The websites (focusing in particular on 'about us' and any staff or personnel pages) and related resources of the organisations and institutions identified were then searched to identify individuals with relevant experience. As required, Google web search was used to cross-reference and locate additional information regarding an individual's experience, including the duration of experience. The required information (person's name, email address, affiliation and length of relevant practical experience) was recorded (Mitchell *et al.* 1997).

Upon review, however, I considered this method of identifying practitioner candidates to be methodologically weak, highly subjective and lacking validity. Therefore, it was rejected.

Various authors offer guidance regarding expert selection procedures (see, for example, Tolley *et al.* 2001; van Zolingen and Klaassen 2003; Okoli and Pawlowski 2004; Scapolo and Miles 2006; Gordon 2009). An alternative method (not pursued) would have been to use a procedure for selecting qualified expert practitioners in line with the guidelines provided by Delbecq *et al.* (1975, cited in Okoli and Pawlowski 2004) in relation to a nominal group technique study, but also applicable to a Delphi study. It involves a multistep, iterative approach to identifying experts, summarised as follows:

> *Step 1*. Prepare a knowledge resource nomination worksheet (KRNW) first identifying important classes of experts (not individuals) under the categories: disciplines or skills, organisations, and related literature.
>
> *Step 2*. The KRNW is then populated with names of potential experts under each category, starting with a personal list of contacts before applying Delbecq *et al.*'s procedure to ensure identification of the most qualified experts. The same names may appear under more than one category. Concerning identified organisations, the objective is to contact people in these organisations who are experts themselves, and who can provide additional contacts within and outside their own organisations.

Step 3. Next, the identified experts are contacted and asked to nominate others for inclusion on the list. These first-round contacts are provided with a brief description of the study and explanation that they have been identified as international experts on the subject.

Step 4. Experts are then ranked according to the person's degree of qualification.

Step 5. Based on the rankings, the experts are invited to participate in the study, stopping when the required number is reached (target panel size is 18 with a minimum of 12).

4. Selection of candidates

The selected candidate experts on the shortlist (n=98) were each contacted by email with a request to participate in this study (as outlined in subsection 5.4.1).

Appendix C

Communications with candidates for expert panel

This appendix contains copies of the:

1. Invitation to participate in the study of EASES.
2. Consent form.
3. Follow-up communication to candidates who agreed to participate.
4. Follow-up communication to candidates who had not yet either accepted or declined the invitation.

1. Invitation to participate in the study of EASES

30 October 2009

Study: Resilience in the European Atlantic social–ecological system (EASES)

Dear Name,

I am inviting you to participate on an expert panel for a study concerning resilience in a conceptual maritime social–ecological system encompassing Europe's Atlantic seaboard and adjacent ocean space. Your particular knowledge, experience and opinion would be of great value.

The aims of the study are to:

1. Explore the essential identity of the macro-regional level "European Atlantic social–ecological system" (EASES) in relation to existing structures and processes considered critical to the functioning of the system.
2. Identify, map and better understand the key complex adaptive system attributes that determine resilience in EASES.
3. Consider how a resilience perspective may help a system of multilevel adaptive governance to focus on pathways to maritime sustainability at the macro-regional level of Atlantic Europe.

There are two study documents: (1) Initial Conceptualisation of EASES, which outlines various system attributes and is the point of departure for the study, and (2) Context and Concepts, which provides supporting material. These and the workbook to be completed by panellists are available for download on the study website at xxxx

The website is restricted. To access it you need to log in using the following:

Username: xxxx
Password: xxxx

The study is a key component of research I am undertaking as a doctoral candidate under the supervision of Dr. Colin Sage, Department of Geography, University College Cork.

The study results will be used in developing a framework for resilience analysis and for examining a possible architecture of governance concerning EASES in particular but also macro-regional maritime social–ecological systems in general.

In addition to academic publication, my intention is to provide study findings to decision makers. In particular those concerned with developing a European maritime governance framework and those engaged in Atlantic area spatial development and governance.

If you agree to participate, you will join a carefully selected group of geographically dispersed experts in an iterative consultation facilitated by myself. This will comprise two rounds in which your ideas, opinion and comments will be sought.

There is no requirement for you to travel or attend meetings. The consultation will be via e-mail.

Round 1. Please download a copy of the round one workbook from the website. E-mail a completed copy to me (by Monday 23rd November 2009). I will analyse and synthesise panellists' responses into a summary report and then post this on the website.

Round 2. I will send an e-mail to inform you of the round one report and ask you to download, complete and return a copy of the round two workbook. During round two you will have the opportunity to add, revise, refine and generally respond to panellists' ideas and opinions summarised from round one.

Although a confluence of ideas is sought during the consultation, a panel consensus is not required. Any significantly divergent views will be represented in the reports.

Please note that the methodology requires anonymity between panellists during the study. The comments and responses you enter in the workbooks will not be attributed to you by name or affiliation at any stage during or after the study. The study results will be presented in aggregate form without links to identify individuals.

However, you may consent to allow your name and affiliation to be disclosed so that your participation and valuable contribution can be fully acknowledged in final reports and all associated academic publications. All other contributions and communications received from you will remain strictly confidential.

Round one will open on Monday 9th November 2009. The intention is to complete the consultation by the end of January 2010.

Hopefully you will find the study both straightforward and flexible, affording you the opportunity to contribute as much of your valuable time and effort as you choose, when you choose. (During piloting, it was found that approximately 3 to 4 hours were required to complete round one.)

If you have any questions, please contact me at xxxx@ucc.ie

I would be very grateful if you would reply by e-mail no later than Friday 6th November 2009 to let me know if you agree or not to participate in the study. If you agree, please also complete and return the attached Participant Consent Form. Thank you.

Yours sincerely,

Andy Scollick

2. Consent form

Participant Consent Form

Study: Resilience in the European Atlantic social–ecological system (EASES)

Researcher: Andy Scollick, Doctoral Candidate, Department of Geography, University College Cork, Ireland, E-mail: a.scollick@ucc.ie

Supervisor: Dr. Colin Sage, Senior Lecturer, Department of Geography, University College Cork, Ireland, E-mail: c.sage@ucc.ie

Instructions

Please read and respond to *all* the following consent conditions and declarations.

Click on either the *Yes* or *No* box to confirm choice with an 'X'.

Complete your details (*your name and e-mail address count as your signature*) and return the form as a file attachment to a.scollick@ucc.ie

1. Consent conditions

I have read and understand the information provided for the above study, including the purpose of the study, what will be required of me, and the way in which my contribution will be used. . . . . Yes ☐ No ☒

I have had the opportunity to ask any questions and have received satisfactory answers to all my questions (*if any*). . . . . Yes ☐ No ☐

I understand that:

During the study my identity will be anonymous to other participants. . . Yes ☐ No ☐

The information I give to the named researcher will be analysed solely by the named researcher. . . . . Yes ☐ No ☐

The information generated by the study may be published in the doctoral thesis of the named researcher and any associated publications; the information will be reported without any direct attribution to me personally. . . . . Yes ☐ No ☐

The information I give to the named researcher and anything else I disclose will be treated as strictly confidential and handled in accordance with the provisions of the Data Protection Acts 1988 and 2003 (Republic of Ireland), and that confidentiality will be maintained. . Yes ☐ No ☐

Page 1 of 2

There is no financial compensation for my participation in the study. . . . Yes ☐ No ☐

My participation is voluntary and it is my right to cease my participation at any time and withdraw my consent by sending an e-mail to the named researcher to that effect, without giving any reason, without loss of standing, and without my legal rights being affected . . . . Yes ☐ No ☐

2. Future contact

I willingly agree to be contacted in the future by the named researcher with regard to a brief evaluation of the study process and outcomes. . . . . Yes ☐ No ☐

3. Disclosure of identity at end of study

I choose to allow my name and the name of the organisation to which I am affiliated to be disclosed at the completion of the study, in any resulting publications, for the sole purpose of acknowledging my participation and overall contribution to the study (*your identity will not be linked with any responses or information you have provided*) . . . . Yes ☐ No ☐

CONSENT

I willingly agree to participate in the above study and give my permission for the information I am about to give to the named researcher to be used for research purposes only . . . . Yes ☐ No ☐

Please sign by clicking shaded areas below and typing. (*Your name and e-mail address count as your signature*). Return as a file attachment to a.scollick@ucc.ie

Name of Participant:

E-mail address:

Date:

Please retain a copy of this completed Participant Consent Form for your records.

End of Form

3. Follow-up communication to candidates who agreed to participate and submitted a consent form

13 November 2009

Subject: Resilience in the European Atlantic social–ecological system (EASES)

Dear Name,

Thank you for participating. As of now, the panel for the study concerning resilience in the European Atlantic social-ecological system (EASES) comprises 14 experts from across a range of disciplines. It is anticipated that a number of others will join the panel next week.

On the cover of the Round One Workbook is a request to please return the completed workbook by 23 November 2009.

Given the rolling start to Round One, can you please complete and return the workbook to me no later than Monday 30 November 2009. Thank you.

I will then endeavour to supply you with the analysis and summary report for this round plus the Round Two Workbook in mid December.

I wish to re-emphasise that it is not obligatory to respond to each section or question (but you are very welcome to do so). The intention is to capture a diversity of opinions from across a broad spectrum of expertise using the same workbook.

If you have any questions at any stage, don't hesitate to contact me.

Your participation in this study is very much valued and appreciated.

Kind regards,

Andy Scollick

4. Follow-up communication to candidates who had not yet either accepted or declined the invitation

13 November 2009

Dear Name,

I wrote to you on 30 October 2009 inviting you to participate on an expert panel for a study to identify key characteristics that determine resilience in the European Atlantic social-ecological system (EASES). You were identified as a candidate on the basis that your knowledge and experience would be of great value to this study.

As of today, there are 14 participants on the panel, representing a diversity of expertise.

Your participation would be very welcome. Therefore, would you please let me know by Friday 20 November 2009 if you would like to accept or decline the invitation?

For your convenience, I have attached a generic copy of the original invitation with amended dates, plus the consent form. Please note that the submission date for the Round One Workbook has now been extended to 30 November 2009. I have included the remaining text from the original invitation email below. Thank you.

Yours sincerely,

Andy Scollick

Appendix D

Expert panel

This appendix lists (in alphabetical order) the panellists who participated in the study of EASES (19 panellists in round one and 7 panellists in round two). Current or most recent affiliations are shown.

Dr. Jeff Ardron	Institute for Advanced Studies in Sustainability, Potsdam
Professor Karl Bruckmeier	National Research University Higher School of Economics, Moscow
Dr. Ivonne Cruz	Environmental Defense Fund, New York
Dr. Tim Daw	Stockholm Resilience Centre, Stockholm University
Dr. Elizabeth De Santo	Franklin & Marshall College, Lancaster, Pennsylvania
Professor David Florido del Corral	University of Seville
Professor Bernhard Glaeser	German Society for Human Ecology, Berlin
Dr. Marion Glaser	Leibniz Center for Tropical Marine Ecology, Bremen
Dr. Gillian Glegg	Plymouth University
Dr. Andreas Kannen	Helmholtz-Zentrum Geesthacht, Germany
Dr. Martin Le Tissier	University College Cork, Ireland
Dr. Christopher Lowe	Swansea University
Dr. Tavis Potts	University of Aberdeen
Mr. Colin Pringle	Member, Conservation Breeding Specialist Group at IUCN and Chief Technical Advisor at RSPB
Dr. Hance Smith	Cardiff University
Dr. Dominic Stead	Delft University of Technology
Dr. Tim Stojanovic	University of Aberdeen
Dr. Luc van Hoof	IMARES Wageningen UR
Dr. Bas Waterhout	Delft University of Technology

Appendix E

Round one and round two questions

This appendix lists:

1. 49 open-ended questions asked in round one of the study of EASES.
2. 12 open-ended questions asked in round two of the study of EASES.

1. Questions asked in the round one workbook

Part A. Defining key attributes of EASES in its present state

1. Spatial boundaries

1a) Are there any spatial units and boundaries (suggested in Tables x and x) that you think should be added or removed? Please give your reasons.

1b) Do you have any other comments regarding spatial units and boundaries, boundary setting and/or the scope of EASES that you feel are important to pass on to others?

2. Boundary conditions

2a) Are there any external conditions (suggested in Figure x) influencing EASES that you think should be added or removed?

2b) What do you consider to be the key flows and exchanges across the boundaries of EASES? They need not be any of those suggested in Figure x.

2c) Do you have any other comments regarding boundary conditions that you feel are important to pass on to others?

3. Internal structure, processes and functions

3.1 Natural capital and ecosystem services

3a) What do you consider to be the key non-renewable and renewable natural resources that are sourced from 'inside' the Atlantic Europe (ocean and coastal) macroregion? Please list in no particular order.

3b) What do you consider to be the key non-renewable and renewable natural resources (if any) that are introduced (e.g. imported) into the Atlantic Europe macroregion from 'outside'? Please list in no particular order.

3c) What do you consider to be the key ecosystem services associated with the Atlantic Europe macroregion (rather than the wider environment in general)? Please give your reasons and list in no particular order.

3d) Do you have any other comments regarding natural capital and ecosystem services that you feel are important to pass on to others?

3.2 Groups, organisations, institutions and governance

4a) What do you consider to be the key groups of people, networks, organisations, institutions and governance systems in or across the Atlantic Europe macroregion? These may be ones that function exclusively at the level of Atlantic Europe or at higher (overarching) or lower (nested) levels, but which nevertheless have a significant influence at the macroregional level. Please give your reasons.

4b) Do you have any other comments regarding groups, networks, organisations, institutions and governance that you feel are important to pass on to others?

3.3 Human activities

5a) Which human activities do you consider to be key in terms of pressures, disturbances and consequences (impacts) for EASES, i.e. the Atlantic Europe ocean and coastal macroregion? 1) Please give your reasons and list in no particular order. 2) Please also indicate if you consider the human activity to be located primarily within, outside or else straddling the boundaries of EASES/Atlantic Europe.

5b) Do you have an opinion regarding the notion of a ‘complex problem cluster’ unique to the Atlantic Europe maritime macroregion?

5c) Do you have any other comments regarding human activities that you feel are important to pass on to others?

3.4 Social assets and capacities (‘capitals’)

3.4.1 Social capital

6a) Which aspects of social capital do you consider key to the functioning of the Atlantic Europe macroregion? In other words what are the key relationships connecting which key groups within the macroregion? Key in the sense that these are relationships that must be maintained to facilitate societal functioning, must be retained in the face of disturbances, and are important to strengthen and build in order to cope with change and recover from future disturbances.

6b) Are there any trends in Atlantic Europe concerning key aspects of social capital (capacity) that you are aware of and consider to be important? E.g. significant improvements or declines in social and economic cohesiveness, social learning, social cooperation, collective action, levels of participation, effectiveness of institutions and agencies, and so forth.

6c) Do you have any other comments regarding social capital (capacity) that you feel are important to pass on to others?

3.4.2 Cultural capital

7a) Can you identify or suggest any key aspects of cultural capital relevant in the context of the Atlantic Europe macroregion? Please give your reasons.

7b) Do you have any other comments regarding cultural capital that you feel are important to pass on to others?

3.4.3 Political capital

8a) Which key groups, networks, organisations or institutions do you consider have the greater ability and, conversely, the lesser ability to engage in political decision-making concerning and affecting the Atlantic Europe macroregion? These need not be the AAC or any of those previously mentioned. Please indicate whether they have greater or lesser ability. Please give your reasons.

8b) Are there any relevant office holders, groups, networks, organisations or institutions (at whatever level) that you consider to be excluded from political decision-making concerning and affecting the Atlantic Europe macroregion? Please give your reasons.

8c) Do you have any other comments regarding political capital that you feel are important to pass on to others?

3.4.4 Economic capital

9a) Are there any specific aspects of economic capital that you think should be highlighted as having a key role in the functioning of the Atlantic Europe macroregion? Key in the sense that it is an asset or capacity that must be maintained to facilitate societal functioning, must be retained in the face of disturbances, and is important to strengthen and build in order to cope with change and recover from future disturbances.

9b) Are there any trends in Atlantic Europe concerning key aspects of economic capital that you are aware of and consider to be important?

9c) Do you have any other comments regarding economic capital that you feel are important to pass on to others?

3.4.5 Financial capital

10a) Are there better ways of mobilising and creating other capitals than through existing EU structural fund interventions? Do you have an opinion or any suggestions?

10b) Do you have any other comments regarding financial capital that you feel are important to pass on to others?

3.5 Urban–rural subsystems

11a) Do you have an opinion regarding the proposed use of the ASDP four-level typology of urban–rural subsystems as a way of representing urban–rural area and network structure, function and dynamics in EASES?

11b) Do you have any other comments regarding urban–rural subsystems that you feel are important to pass on to others?

3.6 Other

12a) Are there any other ecological, social and/or economic components and processes not covered above that you consider key to the internal structure and general functioning of EASES? Please give your reasons.

12b) Do you have any other comments regarding internal structure, processes and functions that you feel are important to pass on to others?

4. Hierarchy and cross-scale interactions

13a) Do you have an opinion regarding the conceptual nested hierarchical structure (Figure 6) used to relate the focal level (Atlantic Europe/EASES) to other levels of aggregation and organisation?

13b) A number of different scales have been suggested in Figure x. Are there any that you think should be added or removed? Please give your reasons.

13c) Can you identify or suggest key interactions between the focal level of Atlantic Europe/EASES and the levels above (see Figure x)? Please state the character of the interactions and resulting influences. Please indicate the dominant direction of the interaction (i.e. toward the focal level, toward the higher level, or in both directions).

13d) Can you identify or suggest key interactions between the focal level of Atlantic Europe/EASES and the levels below (see Figure x)? Please state the character of the interactions and resulting influences. Please indicate the dominant direction of the interaction (i.e. toward the focal level, toward the higher level, or interaction in both directions).

13e) Can you identify or suggest key interactions between different scales that (might) significantly influence the functioning of EASES? Please give your reasons.

13f) Can you identify or suggest any significant scale mismatches concerning EASES? Please give your reasons.

13g) Do you have any other comments regarding hierarchical structure, different scales or cross-level and cross-scale issues that you feel are important to pass on to others?

Part B. Identifying key drivers of change in EASES

5. Historical profile

14a) How far into the past and how far into the future do you consider it appropriate to examine EASES?

14b) Are there any key historical disturbances and shock events (suggested in Figure x) that you think should be added, removed or emphasised?

14c) If you added or emphasised any disturbances and shock events in 14b above: can you identify or suggest any key resulting changes in Atlantic Europe that are associated with them?

14d) Can you identify or suggest any historical pattern of disturbance affecting Atlantic Europe? Please give your reasons.

14e) Do you have any other comments regarding the historical profile and/or key past disturbances that you feel are important to pass on to others?

6. Disturbances

15a) What do you consider to be the key disturbances affecting the Atlantic Europe macroregion at present, in the recent past, and in the near future? Please use the table on the following page and list in no particular order.

15b) Of the disturbances you have listed in the Table, are there any you consider to be particularly harmful or threatening?

15c) Can you identify or suggest any novel types of disturbances emerging that could affect EASES?

15d) Do you have any other comments regarding disturbances that you feel are important to pass on to others?

7. Key changes and trends

16a) What do you consider to be the key changes occurring in the Atlantic Europe macroregion at present and what are their trends? These changes may be taking place across the whole macroregion or involve particular components or subsystems. Please indicate the trend (if any) associated with each change and list in no particular order.

16b) Do you have any other comments regarding key changes and trends that you feel are important to pass on to others?

2. Questions asked in the round two workbook

Part C. Your response to round one

17) Do you have any additions, revisions, or comments regarding the Round One Responses Report and/or Executive Summary? Where applicable, please indicate to which document, section or paragraph your response refers to.

18a) What is your opinion regarding whether the social and ecological foundations differ enough between southern and northern aspects of EASES to justify two different approaches to governance within the Atlantic Europe macro-region?

18b) If applicable, can you identify or suggest any enabling conditions, governance mechanisms or other factors that could help accommodate any south–north departmentalisation of EASES, in terms of governance rather than management?

Part D. Identifying critical resilience-related dynamics of EASES

8. Patterns and processes of change

19a) What phase of the adaptive cycle do you consider each of the following levels of system organisation to be in at present? The four phases of the adaptive cycle are: accumulation, conservation, release, and reorganisation. The first two phases constitute the system development mode; the latter two the renewal (‘creative destruction’) mode.

NB. The adaptive cycle describes a ‘typical’ pattern of change in social–ecological systems and other complex adaptive systems. However, patterns of change vary between systems and transitions among the four phases may not be sequential or even reflect a cycle.

- Higher level systems? For any encompassing systems (supranational and global levels) you choose to specify: What phase is each in at present?
- Focal level system? At the macro-regional level: What phase is EASES (the whole social–ecological system) in at present?
- Lower level systems? For any sub-systems of EASES (national, subnational regional and local levels) you choose to specify: What phase is each in at present?

19b) Do you consider EASES or any other system you identified in 8a to be currently approaching a transition to another phase of the adaptive cycle? Please also indicate if you think the transition is likely to involve crossing a critical threshold to result in fundamentally altered system structure and behaviour (i.e. involve a 'critical transition').

- Higher level systems? Encompassing systems you specified in 19a.
- Focal level system? EASES (the whole macro-regional level system).
- Lower level systems? Sub-systems you specified in 19a.

19c) Figure 2 depicts key cross-scale interactions between different levels. What do you consider to be the (preferably no more than five) key interactions or feedbacks that influence resilience in EASES, i.e. the system's capacity to adapt and transform in order to persist? They need not be any of those suggested in Figure 2.

NB. The 'rule of hand' proposition (Walker *et al.* 2006) suggests that the essential resilience-related dynamics in EASES may be determined by typically no more than five key interactions or feedbacks.

19d) Do you have any other comments regarding patterns and processes of change involving EASES or the panarchy in which EASES is situated?

Part E. Exploring resilience capacity in EASES

9. Sources of resilience capacity

20a) What do you consider to be the key sources of resilience (i.e. the capacity to adapt and transform in order to persist) in EASES? They need not be any of those suggested in Box 2. Please give your reasons.

20b) What is your opinion regarding using the identified 'sources of resilience' as guidelines for developing a governance framework in relation to EASES? That is, for developing the institutions and decision making structures rather than the processes of decision making and implementation.

20c) Do you have any other comments regarding sources of resilience in EASES?

10. Strategies for enhancing social–ecological resilience

21a) A set of strategies for managing social–ecological resilience in EASES has been suggested in Box x (and Appendix x in more detail). Are there any strategies or practices that you think should be added, removed, or prioritised on the basis of demonstrable success in marine and coastal management? Please give your reasons.

21b) Do you have any other comments regarding strategies and practices for reducing vulnerability, enhancing capacity for adaptation and transformation, or generally managing resilience in EASES?

Appendix F

Key human activities, associated pressures and consequences, and principal location of activities relative to boundaries of EASES/Atlantic Europe

Panellists were asked (Question 5a): *Which human activities do you consider to be key in terms of pressures, disturbances and consequences (impacts) for EASES, i.e. the Atlantic Europe ocean and coastal macro-region?* Panellists were also asked to indicate if they considered the human activity to be located primarily within, outside or else straddling the boundaries of EASES.

Sixteen panellists responded. The individual responses are presented in full below so as to preserve reasons, attached importance, etc. Each paragraph or bulleted block in quotation marks relates to a different panellist. These are summarised in aggregate form in Table 6.21.

"Tourism and recreation, consumption (fishing, fossil fuels), coastal urbanisation, shipping."

"Overfishing and trawling, within/straddling/outside boundaries."

"Most important activities currently out at sea are shipping, oil & gas extraction, fishing, tourism, communication and fuel infrastructure (cables, pipes). Also land based activities with an effect in the coastal zone. One could argue that the key factor in all of this is not so much the individual activities as it is the combination of activities and the way the management system is dealing with the activities and pressures and effects on the socio-economic system."

"In my opinion, overfishing, habitat destruction and land-based pollution are key in the region. Oil and gas exploration to some extent, offshore, though improvements have been made with regard to safety. Improvements have also been made toward reducing destructive fishing practices (such as bottom-trawling and the use of driftnets). But fisheries are still mismanaged and there are still some destructive practices allowed by the [European] Commission, such as pair-trawling for sea bass (which involves cetacean bycatch […]).”

- “Over fishing, for obvious reasons.
- Tourism/infrastructure, [regarding how these two industries generally claim benefits even when linked with destruction of ecosystem services including traditional ways of life.
- Industry, through pollution.
- Short political terms, [regarding compromising the national heritage when embarking upon mega infrastructure projects that will end up having no environmental and social benefits, rather the other way around].”

- “Building – location and nature of built environment.
- Exploitation of natural resources – modifies environment and future options.”

“Three key pressures I would suggest are:

- Coastal development pressures – the infrastructure that supports the very many activities around the shores such as housing, trade, shipping and transport and industry, takes space from natural ecosystems and causes loss of biodiversity. [Located primarily within] EU.
- Wastewater disposal – waste waters from industrial and domestic sources as well as diffuse discharges from land (either agricultural or urban etc.) contribute to pollution and biodiversity loss around the shores of the EU. [Located primarily within] EU.
- Fisheries – while I would not necessarily consider fisheries important in terms of output or economy it certainly is destructive and causes loss of biodiversity and economy (which is unlikely to recover). Straddling.”

“The answers are general, but activities would have to be specified and typified:

- Agriculture (located within; important throughout the region: the coast-adjacent areas are important agricultural production areas; modern agriculture also a pollution/eutrophication source and big consumer of water).

- Fisheries (located within; inshore and offshore: practiced in most waters in the region).
- Aquaculture (located within; mussel culture and fish farming, in some parts of the region).
- Industry (partly inside, partly outside the region, but as large-scale air water and soil polluter and wastewater-producer: needs to be broken down into sectors and branches; of special significance also food processing industry because of high water use).
- Households and urbanization (located within; because of the high levels of water consumption and wastewater production).
- Energy production (located within; the development of renewable energy systems seems important for the future – solar, wind, wave energy, bioenergy production).
- Tourism (especially in coastal areas, because of its growing economic significance and environmental consequences).
- Transport and trade (inside and outside the region; marine, on land, in the air)."

"The major impact is cumulative impacts from many sources – growing and probably nearing thresholds.

- Fishing (or specifically overfishing by certain sectors, e.g. scallop dredging).
- Seabed integrity (particularly through dragged fishing methods).
- Diffuse pollution from coastal areas.
- Climate change – unpredictable but major impacts."

- "Fisheries because of importance for local communities and problems of overfishing.
- Wind energy (and other marine renewable energies) because it might become a major driver for the future.
- Shipping and ports because the request major infrastructure and large land areas, but also provide employment."

- "Fossil fuel burning (change in sea level). Mainly outside, but straddling.

- Agriculture/industry discharge (change in biogeochemical structure of water). Inside.
- Fishing (change of biodiversity). Inside.
- Shipping (change of topography). Straddling."

- "Fisheries – the key driver of change of marine biodiversity; within and straddling.
- Coastal development – driving force and pressures within coastal systems.
- Aquaculture – rapidly expanding sector with relatively unknown meta-consequences. Within but impacts without (e.g. feed fisheries)."

- "Fisheries: cover the largest area and extract the largest biomass from marine ecosystems, as well as sometimes seriously damaging habitats. Within the boundaries of EASES.
- Anthropogenic CO2: leading to climate change and ocean acidification. Both these effects are having increasingly significant effects on marine ecosystems. Both within and outside of the EASES boundaries.
- Land-base pollution: while contaminants in the NE Atlantic have been greatly reduced, there are still some concerns. Within the boundaries.
- Agricultural enrichment/run-off: very serious in the Baltic, it also plays a role in the NE Atlantic, leading to plankton blooms and possibly linked to algal die-offs, and oxygen depleted zones. Within the boundaries.
- Anthropogenic noise: while its effects have not been well quantified, it is certainly clear that noise in the NE Atlantic has increased greatly and likely does stress organisms such as cetaceans. Mostly within boundaries, though some from outside as well.
- Shipping traffic: contributes a lot to air pollution (e.g. black carbon, NOx, SOx, CO2, etc.), which can also cycle to impact the marine environment. Ship traffic is also associated with ship-strikes, oily discharges (intentional and unintentional; legal and mostly illegal), and introduction of species through ballast water."

- "Fisheries – straddling or inside depending on sector.

- Burning fossil fuels – straddling but mostly outside.
- Offshore power generation – inside.
- Coastal development – inside.
- Mineral and aggregate extraction – inside.
- Hydrocarbon extraction – inside."

- "Contamination of maritime coastal waters. Straddling. The impact of these human activities is very extended and the consequences are too widespread: on natural resources, on oceanographic conditions, on ecological trends.
- Fisheries implemented according the industrial pattern. Straddling. The activity affects seriously to renewable live resources, destroying ecosystem interactions."

"Fundamental use groups; all are key, but in different ways. All are located both within and beyond the EASES boundary:

- [Sea and land use (activities): transport, strategic, minerals & energy, living resources, waste disposal, leisure & recreation, conservation, coastal engineering.
- Land use (activities) only: settlement, manufacturing & services.
- Technical management activities: information management & assessment, professional practice (including natural/social sciences, surveying, planning, law).
- General management (activities): technical management co-ordination, organisation management, policy, strategic planning]."

The panellist added that the concept of fundamental use groups "is useful for understanding not only the nature of human-environment interactions, but also particularly the psychology, politics, governance and management drivers behind these."

End