



## Using Soft Systems Modelling to understand decision-making about coastal schemes

### Compiled by

Dr Tim Stojanovic, University of St Andrews  
Dr Marta Meschini, University of Liverpool



# CO-OPT

Resilient Coasts:  
Optimising Co-Benefit Solutions

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## ***Executive Summary***

- This report summarises the results of an online workshop which was convened in May 2022 as part of the NERC-ESRC CoOpt research project [Resilient Coasts: Optimising co-benefit solutions](#) (2021-24). It brought together a range of coastal professional practitioners to consider how decisions are made in the UK about schemes for coastal flood and erosion risk management. Nature-based/green solutions were a particular topic of consideration.
- The workshop also provided the academics involved in the CoOpt project with a better understanding of the practical challenges faced by professional practitioners, so that the final outcomes of this project can be better tailored to their needs.
- Shoreline Management Planning was highlighted as a strategic basis for decisions. A Shoreline Management Plan is a non-statutory policy document which advises on the most sustainable approach to coastal flood and coastal erosion risk management. However, it was noted that despite their strengths, including setting out policy options for the short, medium and long term, these Plans do not specify the particular form of coastal scheme which should be developed, its funding or detailed design, nor define in detail when a change in management should take place. As the timeframes range from 20 to 50 years, this may result in management decisions being delayed and discourage a change in policy. Policy implementation has proven difficult, especially when adjustments are required or a change in previous policy is made. Uptake of nature-based solutions (such as managed realignment) is falling behind targets.
- The workshop utilized techniques from the 'Soft Systems Methodology' approach. Delegates worked in small groups to: (1) describe the decision-making system, (2) consider the broader constraints and context in which decisions are made, and (3) develop conceptual models of decision-making as a tool to review how decisions are made in the real world, including possible improvements.
- The CoOpt project recommends that these findings form a resource for future work when planning about desirable and feasible changes to coastal decision-making.
- Nature-based/green solutions were presented - this term covers a very wide range of coastal interventions (or schemes). These schemes range from hybrid infrastructures with ecological niches, to soft engineering solutions such as beach replenishment, to habitat creation such as dunes, saltmarshes or other coastal restoration. These schemes are not suitable in all locations. But such schemes potentially offer a range of benefits, including: coastal hazard management/ risk reduction/ adaptation; improved amenity and nature conservation; and climate mitigation through carbon sequestration. However, the development of such schemes on a large scale is often a major undertaking and differs significantly from the development of traditional, engineered flood-defence solutions.
- The workshop findings suggest that the breadth of the terminology 'nature-based' whilst being a term which captures the imagination, may itself be a hindrance to a detailed understanding of the issues.
- The workshop concluded with a discussion about the challenges of nature-based solutions. 27 issues were identified. The findings highlight the importance of three themes: (1) an effective policy framework; (2) better financing and (e)valuation, and; (3) addressing gaps in awareness and understanding about change in coastal systems and the role of different actors. These issues need to be tackled if there is to be increased implementation of nature-based solutions on the coast.

Thanks to all delegates and the workshop organisers for the time dedicated to this output.

## **Workshop Goals and Project background**

Dr Leonie Robinson, University of Liverpool, introduced the research project *CoOpt* (Resilient Coasts: Optimising co-benefit solutions). This is an interdisciplinary project involving natural and social scientists from the Universities of Liverpool, Cranfield and St Andrews and the National Oceanography Centre, as well as professional practitioners from government agencies and local authorities across the UK. The research project is one of six which are part of the Sustainable Management of Marine Resources programme (2021-24), funded by the Natural Environment Research Council (NERC) and the Economic and Social Research Council (ERSC).

The core focus of the project is on coastal management, in particular how decisions are made about the development of coastal schemes. Such schemes are works *in situ* that aim to address coastal flooding and erosion risks. There are a range of options including seawalls, embankments, groynes, beach recharge, managed realignment, and habitat creation and restoration (see Section 1a). These schemes have a range of potential benefits and impacts depending on their design. They also need to be considered in the context of future climate change, including projections of sea level rise. Other approaches at different scales also influence how coastal flooding and erosion are experienced (e.g. property level adaptation, flood warning systems, or flood insurance schemes).

The aim of the half-day workshop was to find out how decisions about coastal schemes are made. What is the process and evidence for deciding on these schemes? Since a wide range of organisations are involved in such decisions, a primary objective was to learn from delegates how they are involved in such decisions and to understand the complexity of the issues involved. The means to achieve this was a technique called 'Soft Systems Methodology' (SSM), a set of heuristics that can be used to structure thinking about complex issues (see Section 2). The workshop also sought to help delegates to: explain their own work and understand the work of others; review the utility of the SSM approach; and support the CoOpt research project to better understand the work of professional practitioners.

### **1. Introduction**

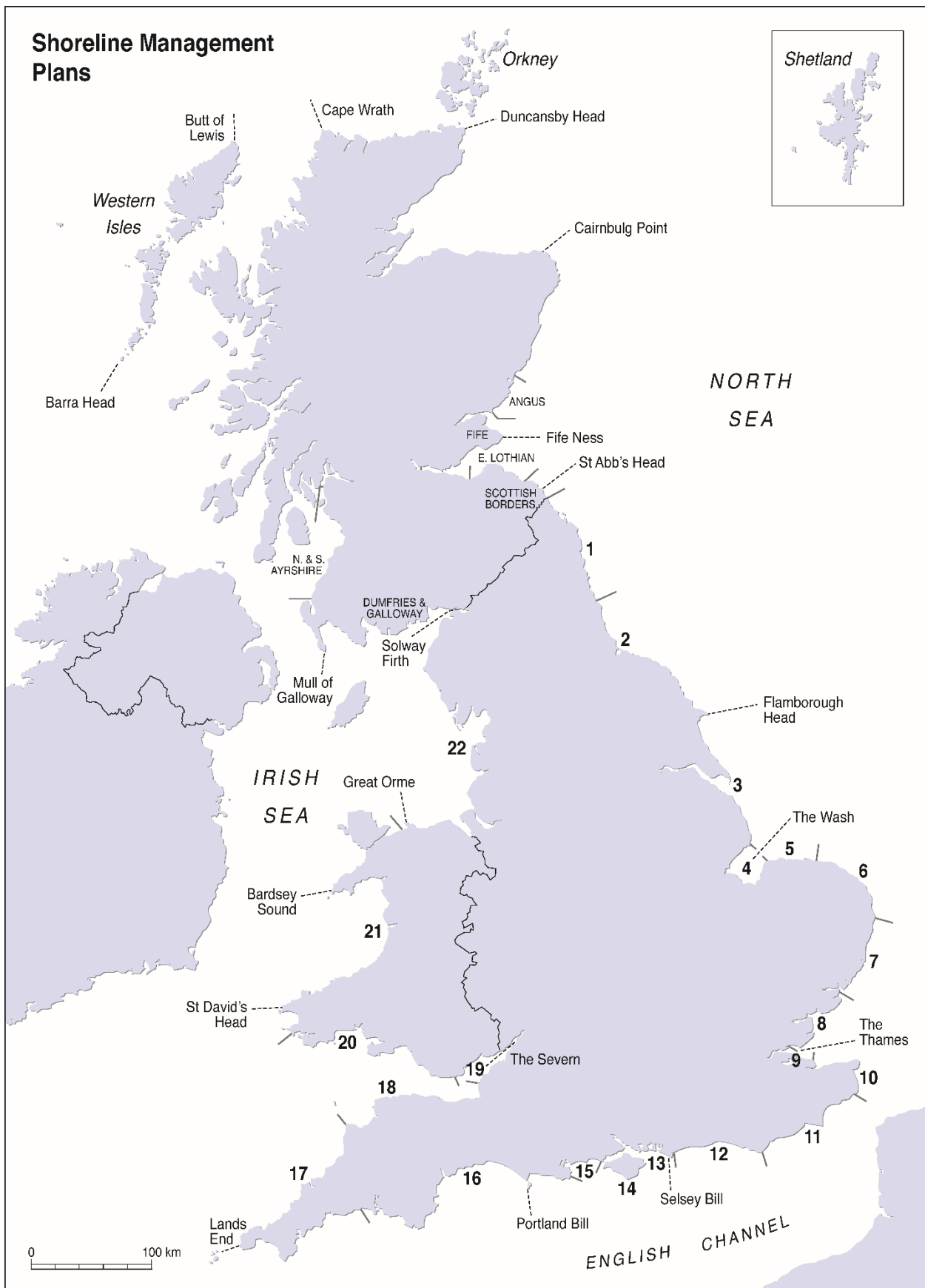
The workshop was attended by representatives from organisations including government departments, non-departmental government agencies, local authorities, coastal groups, industry and NGOs (Appendix D). The workshop was conducted online and consisted of two short presentations followed by three group exercises, a plenary, and a discussion on the topic of 'nature-based solutions.'

#### **1.1 Coastal Schemes and the broader context of shoreline management**

Dr Tim Stojanovic, University of St Andrews, gave a brief overview of the history of Shoreline Management Planning in the UK. A Shoreline Management Plan is a strategic, non-statutory policy document which advises on the most sustainable approach to managing coastal flood and coastal erosion risks. The systems for decision-making are somewhat different in Wales, Scotland and England. Tim highlighted that these strategic non-statutory Shoreline Management Plans (SMPs) have now gone through three major phases of development: SMP1, SMP2 and SMP 'Refresh'. Preceding the existence of shoreline management, institutional arrangements for coastal and flood protection were criticised as fragmented and disjointed, with a reactive approach to dealing with coastal hazards and development that did not sufficiently consider functioning of natural coastal systems.

An initial phase of SMPs (1993-2000) attempted to address this challenge. Research defined natural sediment cells around the coast, to provide a different basis for planning than administrative jurisdictions. A series of 39 SMPs were commissioned by Coastal Groups consisting of public bodies such as engineers in local authorities and environmental agencies. Each Coastal Group is based on a coastal sediment "cell" or "sub-cell" (See Figure 1), within which the movement of coastal sediments is relatively self-contained. UK consultancies were key actors in the development of Shoreline Management Plans (See Appendix B).

A review of Shoreline Management Planning in 2005 reflected on the success of the first generation of plans and identified a number of areas for improvement. One aspect highlighted was the need for more effective stakeholder engagement and consultation, including the public, and other professionals who play an important role in the outcome, such as local authority planners. Another issue was a fundamental transition in terminology from 'coastal defence' to 'flood and coastal erosion risk management' (FCERM) to reflect the need for a change in mindset towards what is perceived as a more sustainable goal. This led to a second phase of shoreline management plans being produced (2005-2019). In England and Wales, the system was streamlined and 22 SMPs were produced (Figure 1). In Scotland, the approach has been for individual local authorities to commission SMPs. More recently, a third phase of Shoreline Management has developed as the 22 SMPs in England and Wales are being 'refreshed' whilst a new coastal change management system is being introduced in Scotland (2023). This 'refresh' has been required by the need for SMPs to respond to a range of emerging issues, such as national policies to meet net gain for biodiversity and net zero for climate mitigation, and updated projections of climate change impacts. The lack of implementation of the managed realignment strategies set out in the SMP2s has also been highlighted as a challenge to be addressed (Committee on Climate Change, 2018).



**Figure 1.** Shoreline Management Plans in the UK (See Appendix B for details about each SMP). Source: Original.

Key: Dashed Lines show boundaries of major sediment cells. Unbroken lines show lateral boundaries of SMPs: 1 SMP Scottish border to the River Tyne (Northumberland and North Tyneside); 2 SMP The Tyne to Flamborough Head (North East); 3 SMP Flamborough Head to Gibraltar Point; 4 SMP Gibraltar Point to Hunstanton (The Wash); 5 SMP Hunstanton to Kelling Hard (North Norfolk); 6 SMP Kelling Hard to Lowestoft (Kelling to Lowestoft); 7 SMP Lowestoft to Felixstowe (Lowestoft Ness to Felixstowe Languard; 8 SMP Essex and South Suffolk; 9 SMP River Medway & Swale Estuary; 10 SMP Isle of Grain to South Foreland; 11 SMP South Foreland to Beachy Head; 12 SMP Beachy Head to Selsey Bill (South Downs); 13 SMP Selsey Bill to Hurst Spit (North Solent); 14 SMP Isle of Wight; 15 SMP Hurst Spit to Durlston Head (Poole & Christchurch Bays); 16 SMP Durlston Head to Rame Head; 17 SMP Rame Head to Hartland Point (Cornwall & Isles of Scilly); 18 SMP Hartland Point to Anchor Head (North Devon & Somerset); 19 SMP Anchor Head to Lavernock Point (Severn Estuary); 20 SMP Lavernock Point to St Ann's Head (South Wales); 21 SMP St Ann's Head to Great Ormes Head (West of Wales); 22 SMP Great Ormes Head to Scotland (North West England and North Wales). The SMPs in Scotland are named on the map.



The SMPs produced are usually a comprehensive portfolio of documents. One important component is often a review of coastal processes, which summarises the scientific understanding of how natural coastal processes are operating. Other components can include Scenario Assessments, Policy Appraisals, Habitats Assessments, Strategic Environmental Assessments, and Economic appraisals. A key feature is a series of 'Policy Statements' for natural units along the shoreline which are appraised for 20, 50 and 100-year epochs. DEFRA's guidance on SMPs suggests the following general policy options for short stretches of coast<sup>i</sup>:

- **Advance the Line**
- **Hold the Line**
- **No active intervention**
- **Managed Realignment**

*“A Shoreline Management Plan is a large-scale assessment of the risks associated with coastal processes and helps to reduce these risks to people and the developed, historic and natural environment. The SMP aims to:*

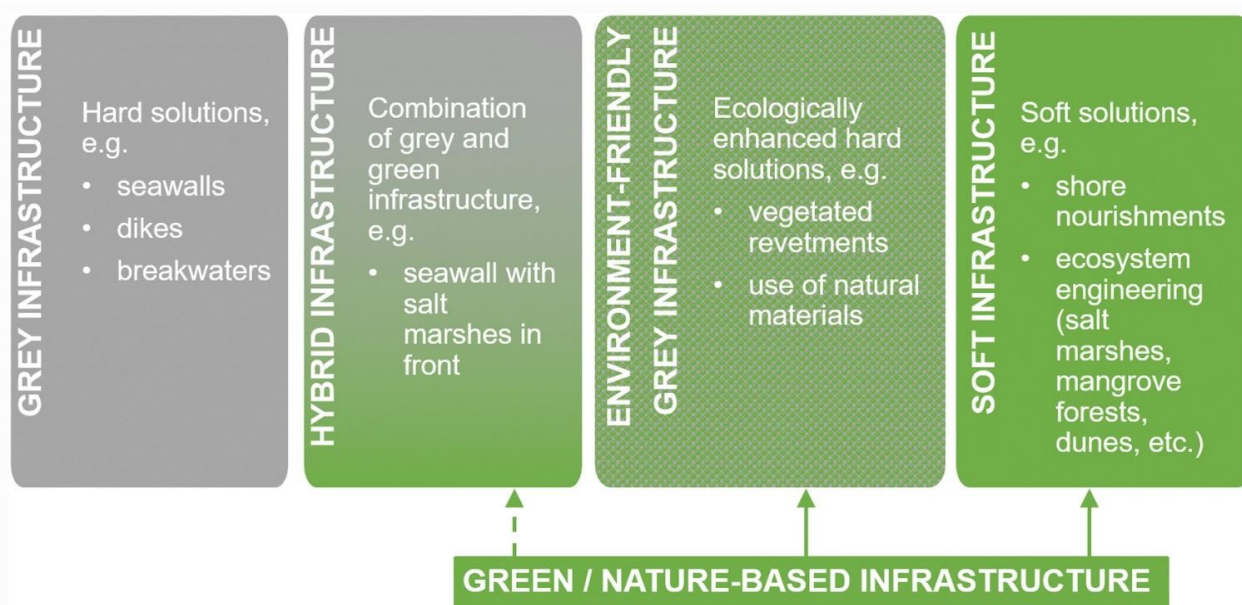
- reduce the threat of flooding to people and their property; and*
- benefit the environment, society and the economy.”*

Defra (2006)

Whilst SMPs set out these *strategic* priorities for coastal stretches, it is important to note that they **do not stipulate the particular form of coastal scheme** which should be developed (nor do they secure the financial resources or permissions to carry it out). The scheme is usually subject of a more detailed strategic plan and a particular detailed scheme design. The legal powers that authorities have to implement a scheme are permissive rather than there being in general obligation to 'protect the coast'. Implementation of SMP policies has proved challenging, especially where adaptation is needed or there is a change from previous policies (for example changing a policy from 'hold the line' in SMP1 to 'no active intervention' or 'managed realignment' in SMP2).

## 1.2 Types of Coastal Scheme

The infrastructure that constitutes the physical response to flooding, erosion or sea level rise can vary widely. A typology of schemes might be considered on a grey to green continuum (Figure 2). The optimal solution for a particular site depends on a variety of contextual factors.



**Figure 2.** Typology of Coastal Schemes (Source: Schoonees et al., 2019). Note that “Managed Realignment” might be considered as ‘hybrid infrastructure’ if a new line of defence is established, or simply ‘soft infrastructure’ if old defences are abandoned.

Common **grey** or **hard** schemes include engineered structures such as seawalls, dykes, embankments, groynes, and gabions. **Hybrid** solutions may include a mix of schemes, for example where habitat with flood defence value is created in front of infrastructure, which might tally with an ‘advance the line policy’. **Grey-green** solutions involve modification of

<sup>i</sup> The actual length of these policy units ranges across English and Welsh Shoreline Management Plans from <0.01km to (e.g. 4d12 SMP12 Beachy Head to Selsey Bill) to >90km (PDZ1, SMP4 - Gibraltar Point to Hunstanton) with an average distance of 3km.

engineered structures to create ecological niches. **Soft** engineered solutions include activities such as beach nourishment. A range of **nature-based solutions**<sup>ii</sup> draw upon the wave attenuation properties of habitats, such as dune or saltmarsh restoration or creation. A significant policy in the UK is **Managed Realignment** where existing engineered defence structures are breached or abandoned, sometimes creating a new line of defence to landward, and a new habitat is created or allowed to migrate landward. Nature-based solutions is a term which covers a wide variety of options. **No active intervention** or allowing natural process to function uninterrupted remains a baseline option. Many national and international policy drivers are leading to increased consideration of nature-based solutions, but they are not possible or appropriate in every location. It may be noted that a range of **other interventions** (monitoring, flood warning, flood insurance, building/household level flood proofing) can enhance resilience or manage flood risk, but do not constitute an *in-situ* intervention with a coastal scheme. The workshop focused on the process of identifying and selecting appropriate coastal schemes.

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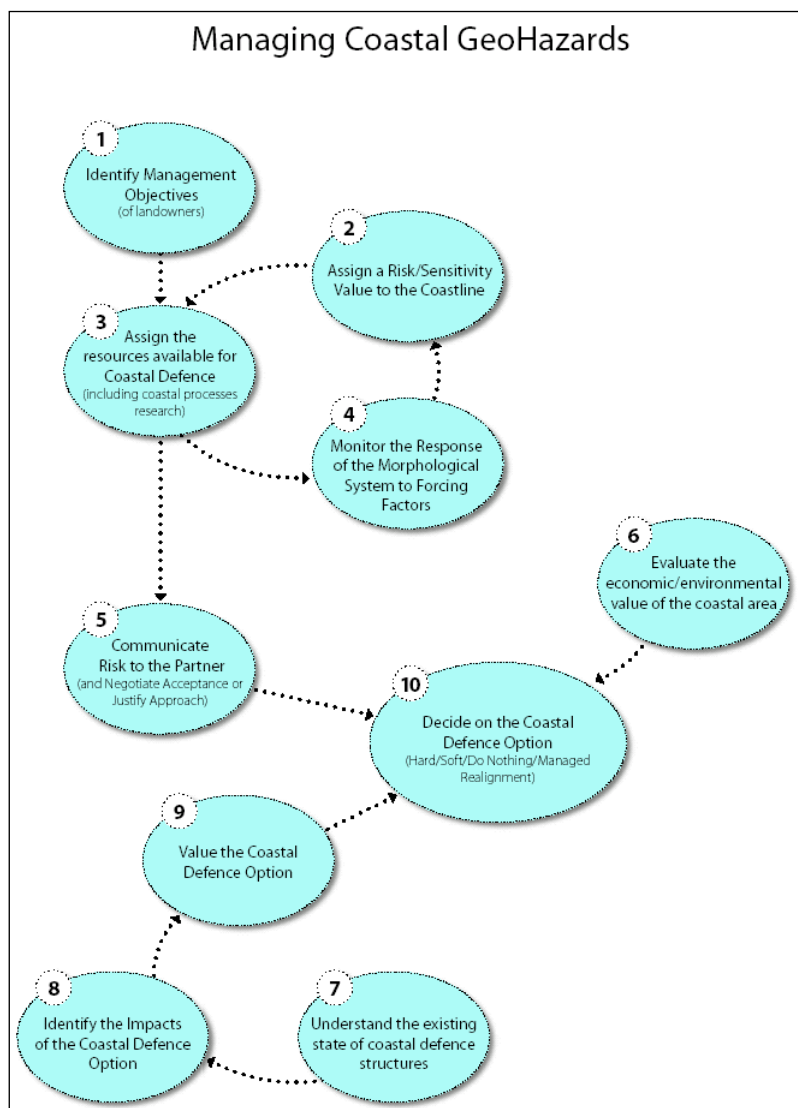
<sup>ii</sup> 'Nature-based solutions' is one of a variety of terms have developed with some common meanings. Bridges *et. al.* (2021, p.124) based on N. Pontee document the following terms: "Natural and nature-based solutions, Ecological engineering, Engineering with nature, Soft defences, Greening the coast, Working with nature, Building with nature, Green infrastructure, Natural flood management, Working with natural processes, Living shorelines."

## 2. Introduction to Soft Systems Methodology a technique for Structuring Complex Issues

The technique of Soft Systems Methodology (SSM) was developed in the field of management science. Early ideas were developed by the Department of Systems Engineering at the University of Lancaster (Checkland and Scholes, 1999). The approach supports a group of stakeholders to explore together:

- How should problems be understood?
- What are the key goals and steps in a process?
- What are the key measures of performance? (and how these provide evidence to evaluate necessary change in a system)

The methodology has been implemented, and modified in a variety of contexts, including industry, information and healthcare systems. It has been widely used in the UK civil service and in business. The methodology builds on 'systems thinking' and consists of a series of collaborative exercises. The term 'soft' in SSM recognises that the real world is complex and messy and does not function like a system (although we wish that health or education systems were more 'systematic'). However, the premise of the SSM is that it is useful to think about a complex set of human activities 'as though they were a system'. This allows for systematic reflection by taking multiple perspectives on the issue and developing a comprehensive understanding of what is going on. The heuristics used in the methodology produce a range of outputs which aid group reflection. One example is 'a model of a human activity system'. Figure 3 below shows one such output, completed by local authority and coastal engineers to represent a system for 'managing coastal geohazards'.



**Figure 3.** Example Human Activity System Model for Coastal Geohazards Management (Stojanovic *et al.*, 2006).

The SSM methodology has evolved over time and is presented in different ways. However, nine key steps have been identified. **This workshop** focused on only **three** core exercises ("Root Definition" "CATWOE" and "Human Activity System models"), the results of which are presented below.



### 3. Results

For the exercises, the delegates were divided into three working groups A, B and C. The groups comprised approximately seven to nine delegates and were designed to be as broad as possible to reflect a combination of views from public agencies, private sector organisations, NGOs and academics.

#### 3.1 Exercise 1: Establishing a Root Definition

This step aims to describe a system, including its aims and means. A system is understood to be a purposeful set of human activities.

- **P** describes what a system does (i.e. the activity);
- **Q** describes how it does it (i.e. the process);
- **R** describes what it achieves (i.e. the purpose).

This leads to the formulation: a system to do P by Q which achieves R. An additional aspect of this step is to define some transformation (T) made possible by PQR.

- **T** describes a transformation that occurs. This implies there is some sort of entity that existed in a particular form before the transformation (i.e. an input), now exists in a transformed state after the process is done (i.e. the output)

Overall, this step is important in order to reach a common understanding of the basic characteristics of the system and to benefit from the insights of the different perspectives of those involved about the activity, process and purposes. During the workshop, groups were asked to focus on the decision-making process to commission coastal schemes.

There were considerable differences in the way each group conceptualised the basic system, but given extra time in the workshop for cross-comparison of findings, a synthesis of the ideas from each group seems possible and advantageous (See section 3.4).

<i>Establishing a Root definition</i>	<b>Group A</b>	<b>Group B</b>	<b>Group C</b>
<b>P-</b> what the system does	Protects people, informs people, defends coasts. Increases resilience, protection, defending the coastal system. Delivers on environmental aspects (enhanced habitats and environmental systems), ensures environmental obligations are met (net zero commitments, potential for net gain). Manages the coast, taking decisions based on all aspects (economics, communities at risk) to protect what we have and allow it to function properly. System reflects the tensions between local aspirations and funding available.	Protects existing infrastructure (e.g. housing, properties, land), provides buffers, increases habitat, and sequesters carbon. Implements schemes based on green or hard infrastructure that are buffer strips which create the above, plus reduce impact of storm surges. Supporting habitat is a secondary aim [possibilities to do this are heavily reliant on existing infrastructure]	Acts to reduce risk. Applies different forms of interventions for a desirable outcome, including constructing defences, managing existing habitat better, etc. Better understands the coastal zone. Maintains and maximises coastal ecosystem services.
<b>Q-</b> how the system operates	Defra Systematic Review (SR) and EA National Strategy <sup>iii</sup> set policy/strategy. Relevant coastal authorities develop/ implement strategy including schemes. Also, landowners work with nature to deliver flood resilience. Continuous monitoring and hazard forecasting are part of an effective system to know the condition of defences to make sure they work and understand how the system is changing. Local stakeholder input is important.	Traditionally operates by building a defence or a buffer: seawalls have been the dominant systems. Coastal schemes normally involve shifting the natural system: i.e. construction of engineering solutions using rocks or concrete, or using natural solutions, for flood/erosion control (e.g. holding water back, pumping water to prevent floods).	Follows guidance for developing coastal schemes: Understands coastal processes, models coastal behaviour, assesses benefits, engages with stakeholders, does environmental scoping and screening.
<b>R-</b> what the system aims to achieve (why)	To protect nature, achieve resilience, protect lives and infrastructure. To achieve multiple and balanced benefits including coastal adaptation, health and wellbeing, economic benefit. To become a system that is adaptable and flexible to future change and uncertainties (including climate change), shifting more towards approaches in harmony with natural processes and nature-based solutions. We need to achieve something affordable, so this requires cost benefit analysis, including analysis of long-term affordability to be sustainable. It needs to be something that the community wants and supports	To protect properties (or other infrastructures, or lands) from erosion or flooding. To minimise harm to valuable assets. To avoid impacts to habitats.	To reduce risk to properties from flooding and erosion, to maximise creation of habitats. To maximise return on investment. To Improve wellbeing. To deepen understanding of long-term change. To Improve long term sustainability of the UK coastal zone.
<b>T-</b> Transformation- (and what is being transformed)	Resilience is built [increased?] in coastal communities and coastal assets (homes, roads, business, supply chain, gas, electricity infrastructure), and environmental assets. The way we share Information is transformed. (Input siloed information. Output shared information). Understanding is transformed (Input partial understanding. Output, thorough, comprehensive understanding)	Level of risk (overall risk from coastal erosion and flooding) is transformed [reduced],  (Usually) A transformation or physical change in the location: e.g. coastline whether natural or manmade.	Sustainability of coastal SES [increased]. Exposure to risk [reduced]

<sup>iii</sup> Environment Agency (2020) National Flood and Coastal Erosion Risk Management Strategy for England. <https://www.gov.uk/government/publications/national-flood-and-coastal-erosion-risk-management-strategy-for-england--2>. See references p.23 for other national strategies.

The above analysis is combined to form a succinct final **root definition** created in the format “a system to do **P** by **Q** in order to achieve **R**”.

***Root Definition for Group A***

A system to manage the coast, protect properties and assets, save lives and support natural processes, while assuring long-term sustainability and flexibility with cost-effective FCERM measures, as well as deliver on environmental obligations to enhance habitats in an affordable way, via an approach which is adaptable and flexible to future changes, and monitors changes in assets and environmental conditions, in line with DEFRA/SG/WGSEPA/EA/NRW strategy and the resources available, including from other actors, that local stakeholders will accept or support, to achieve a resilient sustainable solution that protects nature, protects lives and infrastructure (a balance between these benefits).

***Root Definition for Group B***

A system to protect existing infrastructure (housing, property, transport links – things of value) by changing the physical coastline putting in place a defence or buffer, in order to reduce risk from erosion and flooding, whilst minimising any adverse effects of the scheme.

***Root Definition for Group C***

A system to better manage and apply different forms of interventions by refining and implementing a step-by-step process in order to improve long term sustainability of the UK coastal zone.

### 3.2 Exercise 2: Defining CATWOE

The second exercise is important to recognise that human activities take place in a wider context. These "things" that happen at the level above or around the system constrain or enable its functioning. For example, one obvious constraint is that programmes to develop new schemes are influenced by the amount of funding allocated to them.

CATWOE is a mnemonic to help foster reflection about these broader issues:

- **Customers (C) who are beneficiaries or victims of the system.**
- **Actors (A) who do the activities which make up T.**
- **Transformation - the conversion of some input into an output** (defined in 3.1 above)
- **Worldview (W) which makes the activity meaningful.**
  - These are underlying assumptions, held at the level of society, communities of practice or individuals.
- **Owners (O) people or groups who control, or who could stop or change the system.**
  - This might be by right of their legal powers or responsibilities, or by ability to influence actors or circumstances.
- **Constraints from the environment (E) external to the system.**
  - Such constraints are assumed to be givens, as changing them would be an activity beyond the focus of the 'Root definition' above about developing a coastal scheme. Nevertheless, such constraints may well need to be engaged with in order to improve the system.

The results of these definitions are shown in the table below. The workshop groups showed a relatively high degree of agreement. In many cases, such as brainstorming on key 'Actors', it proved relatively easy to identify key actors who are known due to their powers or legal duties being explicitly defined or because it is mandatory to consult them. Other categories also showed some similarities. Most groups ran out of time in the workshop to consider factors such as 'Worldviews', so further information was gathered through follow-up communications.

CATWOE:		Group A	Group B	Group C
<b>Actors (A) who do the activities which make up T</b>	National government ministries and statutory agencies DEFRA, SG, WAG, EA, NRW, SEPA. Local authorities (as coastal protection authorities, flood risk authorities), Owners of assets and landowners, Community groups (including in some places community councils), Members of the public	Local authority officers, Public and private landowners, Key agencies or departments- for permissions or funding (NE, MMO, Natural Resource Wales, NatureScot, SEPA, EA Scot/ Welsh government, DEFRA) Beneficiaries from the scheme (local partnerships, utilities, businesses, etc).	Regulators (EA, NE, Historic England, etc) Local authorities & local agency teams Government departments (Defra, BEIS, ...) and Politicians (local & national). Contractors, Suppliers, Consultants, Landowners, Communities, Businesses	
<b>Customers (C) who are beneficiaries or victims</b>	Members of the public, Local communities, Businesses, Wildlife (plants and animals).	<b>Beneficiaries:</b> Residents (households), Business owners, Land managers, Local authorities (less incidents to respond to, lower maintenance costs), Species, Nature. <b>Victims:</b> Nature, Species, People along the coast experiencing knock on impacts, Inshore recreation, People behind a line of defence who lose their view, MR farmers might lose land, Private landowners not defended.	General public at all scales (including tourists or visitors from outside the area), Businesses, Nature conservation community, Wildlife, Coastal asset owners.	
<b>Owners (O) who control or could stop</b>	Landowners (e.g. Private property owners, major coastal land/seabed owners such as Crown Estate, Ports and Harbours, Forestry Commission). Local authorities (coast protection, risk management, climate duties) Stakeholders who get involved in decisions.	Local planning authority, Government agencies (e.g. Natural England, Marine Management Organisation), Statutory conservation organisations, Politicians (Secretary of State/Minister as ultimate owner: Higher levels involved for very important schemes). In Wales: Natural Resources Wales undertake the combined functions of MMO, Natural England and Environment Agency in England.	Landowners, Local and national government (esp. local authorities), Coastal asset owners, Local communities, The environment itself.	
<b>Constraints from the environment (E) external to the system</b>	Funding for works, Time needed for approval of coastal scheme, Environmental and landscape designations, Lack of evidence to select optimal schemes, Constraints of licences required for works and time to get the licence, Lack of data and reliable ongoing monitoring on the behaviour of systems (i.e. not just reactive data), Cultural perspectives or assumptions about how to do things/best outcomes, Impact of coastal scheme to another nearby schemes (cumulative impact). Benefits to local society.	Funding, Lack of support, Conservation issues, Licencing, Policy framework (opportunity but also often a constraint), Public opinion (power of influence), Lobbying by groups.	Climate change, Funding from government, Legislation and compliance, The policy context (international, national, local), Political and community support, Global politics, Given location characteristics (i.e. protected status of sites, urban vs rural, historic environment)	
<b>Worldview (W) which makes the activity meaningful</b>	Climate change and sea level rise are global issues. That knowledge exchange about flood and coastal erosion solutions can help deliver better approaches.	The worldview centres on the notion of managing risk, and the history and understanding of risk in a place. Sometimes hard defences are the only viable option to reduce risk for those most at direct risk. There are expectations that those on the coast will be protected. Policy level worldviews are evolving towards the importance of nature-based solutions to manage risk. Stakeholder acceptance is viewed as an important consideration.	That adaptation is meaningful. That processes of planning and deliberation can influence the system and ways of working. That people can learn from others and be more informed/change their point of view.	



### 3.3 Exercise 3: Developing Human Activity Systems models

This exercise entailed the development of a conceptual model for the human activity system of decision-making for coastal schemes. This was done in two phases (individually and corporately). The model itself takes the form of a diagram (e.g. Figure 3 above) showing a series of activities that are interconnected. It is considered as a sketch of how the system works (or should work) and its purpose is to compare this idealisation with how the activity operates in the real world to provide a basis for improvement. It is not necessarily intended to define an optimal decision-making process.

The creation of the conceptual model was undertaken by the workshop delegates according to a series of phases:

1. Using verbs in the imperative, delegates brainstormed and wrote down the core activities, aiming for 7 +/-2 steps. (It is recognised that a complex process might entail many more steps, but the maximum number of 9 is used to make the diagramming cognitively manageable, further diagrams can be developed to show sub-steps within an individual step).
2. Delegates ordered activities according to their dependencies (i.e. those which depend on other steps being achieved being placed later in the list).
3. Delegates indicated the (multiple) dependencies with lines with arrowheads, showing how steps provide an output which becomes a necessary input into a following step
4. Delegates drew and redrew the activity steps as a 'blocks and arrows diagram', with blocks showing steps, and lines with arrowheads showing dependencies between steps, adding additional steps of 'monitoring' and 'control' for the total system.
5. A rapporteur sought to integrate the sketches made by a group of delegates into a single SSM model, removing duplicates and redundancies, and combining similarities. Delegates were presented with a new draft, discussing whether this combined model represented an adequate rendering of the 'root definition' made earlier.

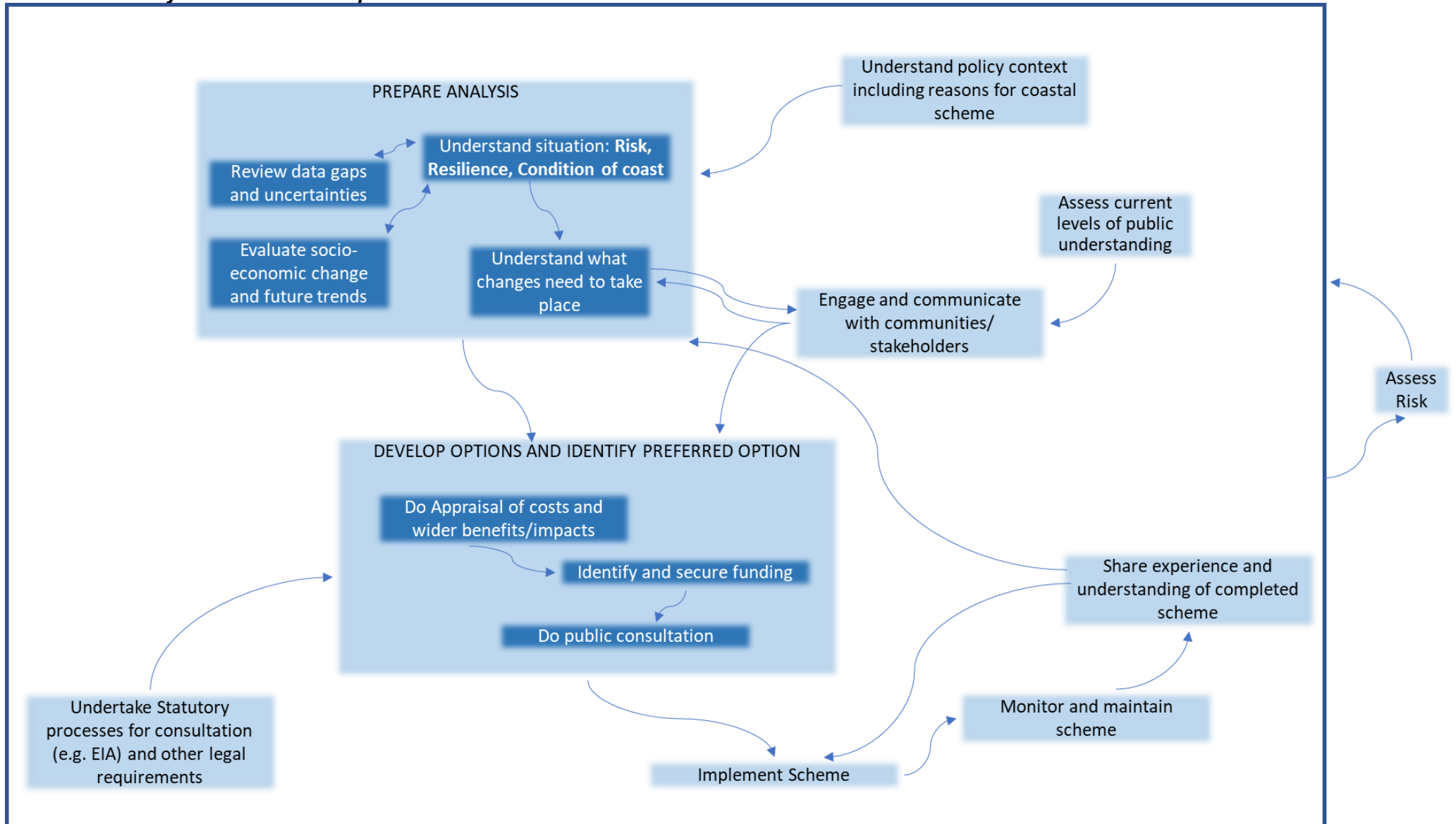
The three diagrams produced are presented in the following pages. Most of the individual models created by delegates were quite sequential and delegates reported difficulties in developing their models. In addition, delegates unfortunately did not have enough time during the workshop to agree on a complete and common version of their models. This was achieved through a process of feedback and refinement following the workshop.

The models of human activity showed similarities between the groups for many steps. These draw on key terms for generic planning processes. The groups refer in different ways to stakeholder and/or public engagement and two-way forms of communication. Certain steps highlight preparatory work to identify the issues, understand the situation and analyse the level of risk. All three groups agree that there is a scoping stage to identify and develop possible options or pathways. Considering and securing funding seems to be a cross-cutting issue, as is the implementation of the scheme. There are several references in the groups to learning and communication processes. These include: stakeholder and community engagement, sharing experiences of implementing a scheme and reflecting on previous experiences, and monitoring and evaluation processes.

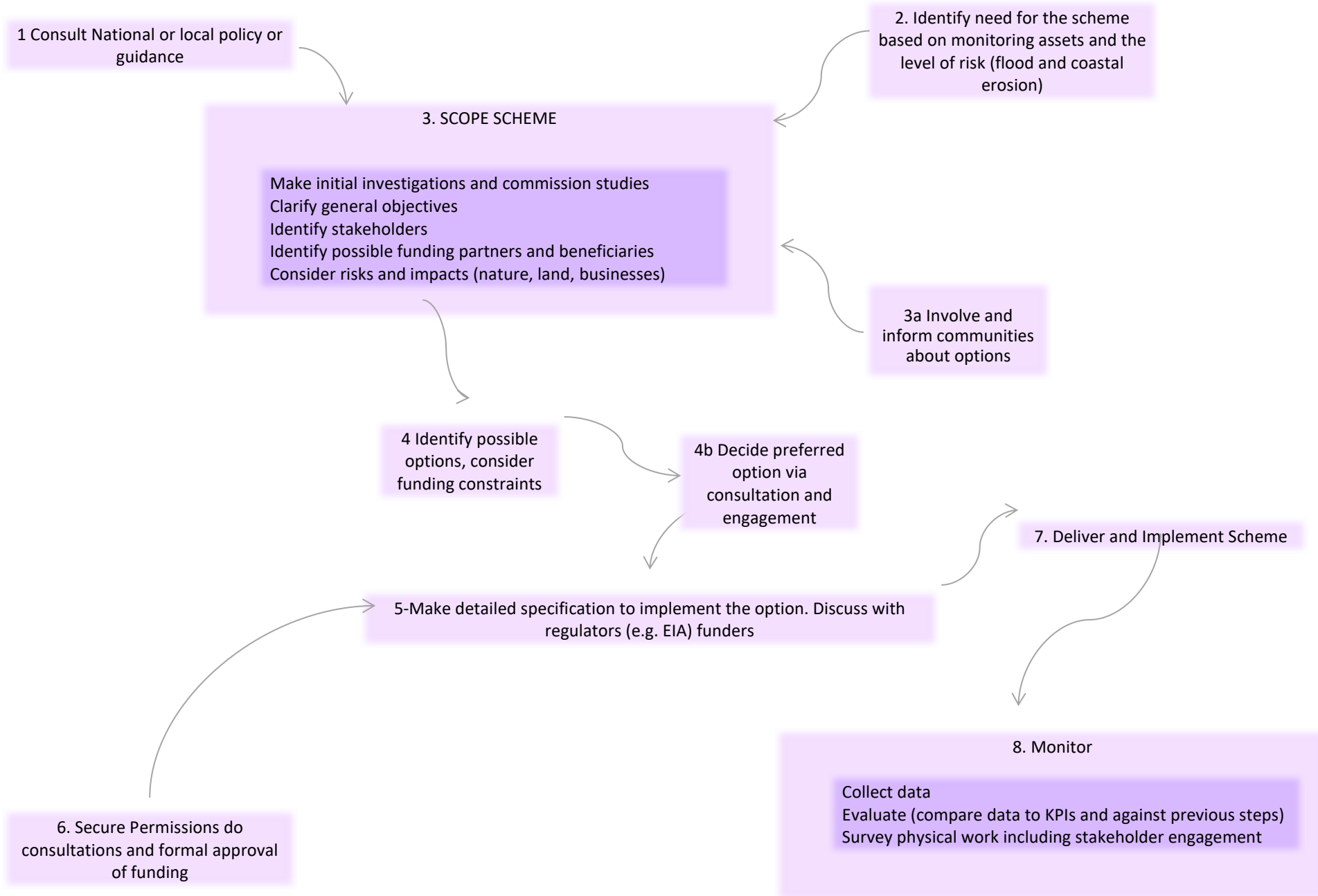
#### Other approaches

Additional heuristics for soft systems methodology which were **not** used in the workshop include: (i) Comparing the models with the real world; (ii) Role Analysis; (iii) Social system analysis; (iv) Political systems analysis; and (v) Planning for desirable and feasible changes to the real-world system. In the development of analysis ii-iv 'rich pictures' and diagramming are recommended techniques.

### 3.3.1 Soft Systems Model Group A



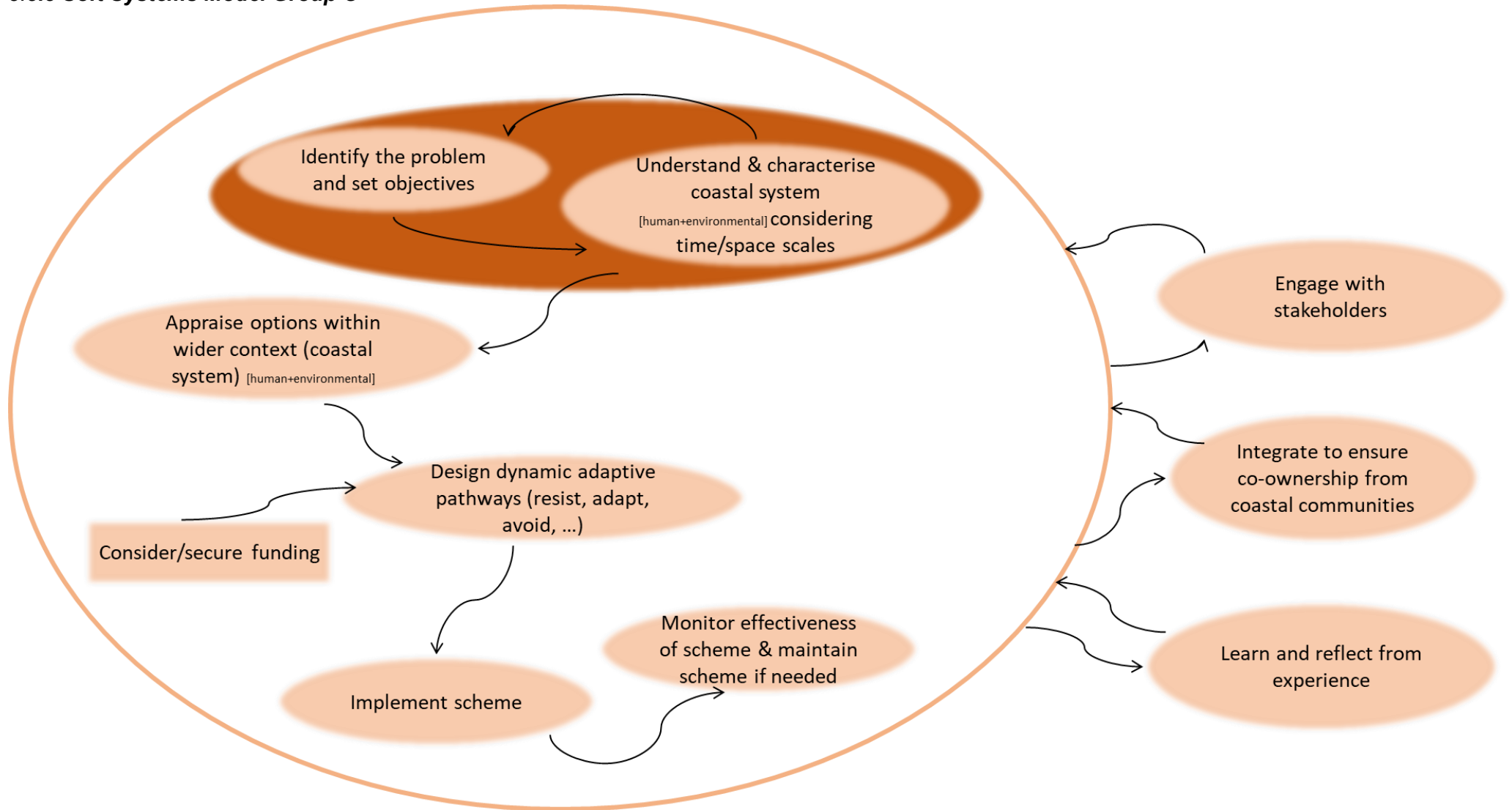
### 3.3.2 Soft Systems Model Group B



Original model elements for Group B were:

1. Implementation: Delivering Scheme
2. Secure permissions: including consultations because it might change the outcome, formal approval of funding its sources
3. Identify possible options: further investigations a long list of constraints considered against such as funding. when looking at options and constraints looking at green options. Knowing about cost- benefit of green solutions: not having confidence in the evidence and real costs and benefits makes Green solutions less considered. Real cost benefit analysis that is comparable with concrete walls.
4. Engagement and consultation and review of options: Making the decision about the preferred option. And specific outcomes should be identified.
5. Then a detailed specification to implement the option will be started. and specific outcomes should be identified. The discussion starts with regulators about issues such as EIA, funding.
6. Scoping the (potential) project: initial investigations, clarifying the general objectives, scale and areas of interest and who might be involved, identifying stakeholders, partners for possible funding and beneficiaries, risks and potential impacts (more broadly to natural environment, land, businesses: not very detailed just scoping. Need to undertake investigations and studies to inform the options and scheme. NBS being considered at scoping point, including their design. Acceptance of risks and ready to do modifications. Informing potential communities to be involved in the options. National and local policy. They need to add NBS as a possibility.
7. The need for a coastal scheme is identified (by national or local policy) based on monitoring of assets and the level of risk (e.g. flooding and coastal erosion on people and properties)
8. Monitoring (collecting data) and evaluation (comparing data to your KPIs and measuring what to expect) of all the previous steps: Monitoring physical work including stakeholder engagement during the work.

### 3.3.3 Soft Systems Model Group C<sup>iv</sup>



<sup>iv</sup> Group C SSM Model Comments: Delegates from Group C were insistent that the complexity of the decision-making system defied neat diagramming because all of its components are iterative. However, because it is a characteristic of systems that their component parts have linkages, the systems model presented above has been interpreted to show directional arrows- with the whole system having double loop connections for major ongoing iterative steps (engagement, integration, learning & reflection).



### 3.4 Combined Outputs of Workshop Exercises

This section presents a synthesis, undertaken by the workshop co-ordinators, of the outputs of the groupwork. It could be further refined by professional practitioners, benefitting from missing perspectives from the Environment Agency and other stakeholders. **Participants were asked to 'model the decision-making process for coastal schemes in the UK:**

**Root Definitions:** Group A's definition is highly detailed but arguably too wordy. Group B's definition is more succinct, but focusses on risk reduction. Group C's definition is expressed in very general terms. The detail provided on page 10 instructive. A possible synthesised definition is:

"A system to put in place a coastal scheme which balances reduction of exposure to risk with environmental enhancement, **so that** harm to communities, property, infrastructure and habitats is reduced, and the overall benefits to the coastal system are enhanced, **by** the design, collaborative appraisal and (if criteria are fulfilled) implementation of the scheme.

The following are not included in the above definition, but considered important:

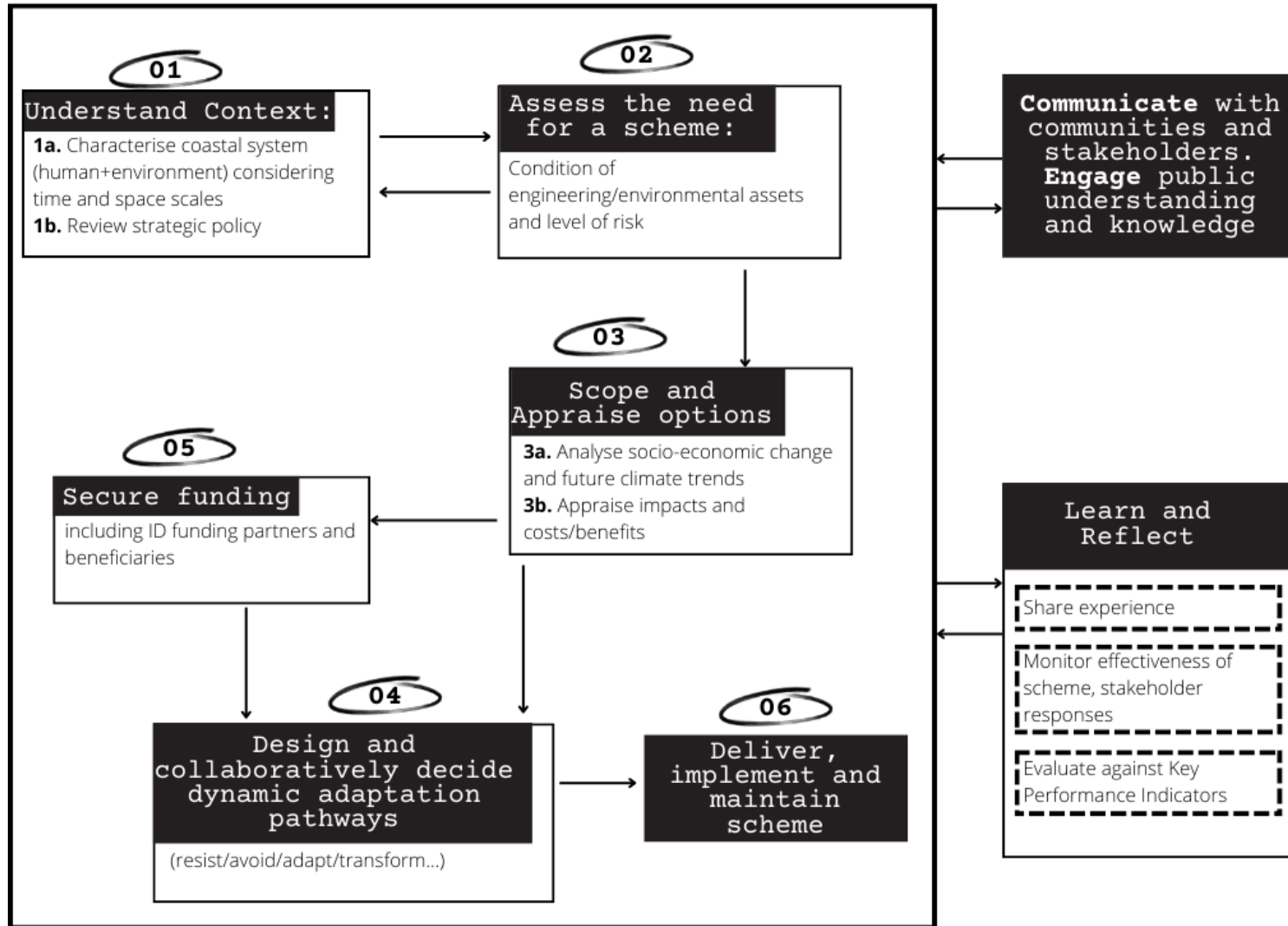
- The coastal scheme usually involves a physical transformation or change at the location, buffering flows of water. Other kinds of solution are possible such as warning or removing what is at risk.
- Buy-in and ownership from coastal communities is important for political support.
- Ongoing learning and reflection is required about coastal processes, coastal hazards, climate change projections and multi-functional stakeholder interests in the coastal zone. This knowledge is subject to uncertainty but decisions are still needed.
- Long term affordability is a key consideration.
- Strategic policy and best practice can provide guidance.
- Resilience/Adaptability/Sustainability are overall outcomes, but the relationship between these terms, and their meaning in a given context, requires further resolution. Furthermore there are tensions between the public interest and the interests of individuals, and continued contestation about the balance of protection vs risk management.

**CATWOE:** There is strong commonality across group definitions.

Synthesis of Group Outputs	
<b>Actors (A) who do the activities which make up T</b>	National government ministries and agencies (including local teams) Local authorities Land and asset owners Politicians (local & national) Contractors, Suppliers, Consultants Community groups and members of the public
<b>Customers (C) who are beneficiaries or victims</b>	Residents (households), Businesses, Landowners or managers (including farmers), Coastal asset owners Local authorities who commission work Wildlife (plants and animals) People along the coast experiencing knock-on impacts People behind a line of defence whose view is impacted General public at all scales (including recreationalists, tourists or visitors from outside the area)
<b>Owners (O) who control or could stop</b>	Landowners and asset owners Local authorities as planning or coast protection authorities Stakeholders who get involved in decisions Government statutory agencies as regulators or consultees Politicians (Secretary of State/Minister)
<b>Constraints from the environment (E) external to the system</b>	Funding; Timescales needed for approval; Requirements for legal compliance; Environmental and landscape designations; Given characteristics at the local site (i.e. protected status of sites, urban vs rural, historic environment); Lack of data and reliable ongoing monitoring on the behaviour of systems; Lack of evidence to select optimal schemes; Lack of support/ public opinion; Lobbying by groups; Policy framework- sometimes inflexible, sometimes offers a policy window/opportunity; Cultural perspectives or assumptions about how to do things or desired outcomes; Impact of coastal scheme on adjacent places and cumulative impacts.
<b>Worldview (W) which makes the activity meaningful</b>	The notion of managing risk, and the history and understanding of risk in a place Expectations of some on the coast that they will be protected That climate change and sea level rise are global issues and require meaningful adaptation Policy level worldviews which are evolving towards the importance of nature-based solutions That processes of planning and deliberation can influence the system and ways of working That people can learn from others and be more informed/change their point of view

## Human Activity System Model for decisions about Coastal Schemes:

Groups A, B and C had common key stages such as: 'scope', 'consult', 'assess risk', 'implement', and 'monitor'. These terms are common to many planning procedures. However, each group also had some unique terminology- where these added insight, they are included below. The interdependencies were represented in diverse ways- this suggests there are many possible approaches, however the approach of Group C to outline some cross-cutting steps which are ongoing iterative processes is helpful. A possible synthesis is shown below:



#### 4. Incorporating Nature-Based Solutions

The final part of the workshop was group discussion, sharing of ideas and debate about **how could decision making systems better account for nature-based solutions? Including:**

- What additional steps might be needed?
- What new forms of evidence might be required?
- What changes to CATWOE (reconsidering exercise 3.2) would facilitate this?

The following themes emerged from these discussions. Implications of the policy theme are considered in Appendix E.

##### **Policy Framework Restrictions on Nature Based Solutions**

1. Strategic national leadership is required on NBS.
2. NBS are not commonly considered enough within the range of coastal scheme options.
3. The current management system does not deal well with the uncertainties inherent in NBS (long lead times, less certainty about outcomes than engineered solutions- not well catered for by Prince2 project management approach).
  - a. Timescales of decision making which are short term and/or purely risk based don't work for NBS. Risk abatement decisions with risks as primary focus don't tend to include green solutions, and in high risk areas prefer hard engineered solutions. Schemes are generally brought forward because properties are at risk.
  - b. Instead, long-term planning is needed to incorporate NBS into coastal schemes considering what will be in place in 50/100 years; and NBS need planning in advance to consider issues such as options, construction, maintenance and durability.
4. Lots of policy drivers (Net Gain, Net Zero) and strategy drivers (Nature Conservation, Flood Risk Management) are in place to drive 'Working with Natural Processes', but whether this happens in a place seems to depend on complex social and political factors.
  - a. Net Gain theoretically should help extension of nature based solutions, but because NBS don't guarantee coastal protection 'now' that policy driver tends to be subverted.
5. Key Performance Indicators need to be changed to better account for NBS (covering ecological benefits and climate hazards)
6. Natural capital/ ecosystem service assessments are needed to feed into the decision-making process, so that there are a wider range of indicators than are currently considered (i.e. focus on risk to properties).
7. Approaches need to be flexible enough to deal with the variation in contexts at the local scale.
8. There is a need to train more coastal engineers, there is a lack of staff for coastal engineering in local authorities.
9. The value of community engagement is key in promoting NBS
10. A broader consideration of the whole coastal (social- ecological//human-environment) system is required.

##### **Valuation and Financing (Including Funding Constraints)**

11. Financing is a constraining factor given the cost of NBS and the total amount of funding dedicated to (coastal) schemes.
12. The amenity offer of managed realignment or NBS could improve its acceptability, but the costs of such aspects are not normally met by flood defence funding (only the capital expenditure of the flood scheme).
13. There is a lack of tools and well-developed methodologies to quantify the full benefits of NBS, or these tools are not sufficiently being applied.
  - a. Tools<sup>v</sup> like INVEST exist, but need to be improved and to better cover the coastal context.
  - b. Demonstrating a positive benefit cost ratio for NBS is challenging, but decision-makers want to know this because value for money is an important factor with limited budgets.
14. Some guidance at a national level (for options appraisal and full cost benefit) may not be particularly applicable or useful given the diversity of particular schemes.
15. A broader set of risk management options (not simply protecting *in situ*) might be explored if it was a practical option for people to be moved/relocated away from the coast, but there is not a proper funding mechanism for that. Therefore, there is a need for a new pot of funding for coastal re-location.

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<sup>v</sup> Other tools which seek to undertake comprehensive trade-offs assessment/evaluations similar to INVEST [https://invest-userguide.readthedocs.io/en/latest/coastal\\_vulnerability.html](https://invest-userguide.readthedocs.io/en/latest/coastal_vulnerability.html) are:

- **B&EST Benefits Estimate** Tool <https://www.susdrain.org/resources/best.html>
- **GI-Val** <https://www.merseyforest.org.uk/services/gi-val/>
- **Business Model** <https://www.uantwerpen.be/en/centres/environment-sustainable-development/research/projects/nature-smart-cities/page1/>

16. Austerity in local authorities often means there is a lack of staff in the units responsible for flood and coastal erosion risk management and coastal protection.

### ***Awareness and Understanding***

17. There is the need to raise awareness of communities that are at risk. There is the idea that consequences will happen far in the future, but big changes are forecast to happen in 10-15 years (c/f Dynamic Coast).
18. People are not sufficiently aware of Shoreline Management Plans- stakeholders need to know better what and SMP is and what it aims to do. Further, SMPs were designed before NBS were a priority- is this being addressed by the SMP refresh?
19. A fundamental understanding of the importance of sediment, its movement and importance to the coastal system is still absent.
20. There is a need to better engage, include and educate (about NBS) local councillors who have decision-making responsibilities on where the funding goes for coastal schemes.
21. There is a lack of coastal skills in local authorities, engineers get coastal remits as part of a larger portfolio, and people might not have training or experience in the coastal field.
22. NBS need to be on the training curricula for coastal engineering.
23. There is insufficient understanding of statutory duties by public authorities. Under the Environment Act 2021<sup>vi</sup> there is a duty to enhance the environment, also statutory duties with respect to national and international protected areas.
24. There might be a need for more significant nature restoration at broader scales beyond simply having beaches and coastal wetlands act as natural defences.
25. The overall issue of how to incorporate nature into coastal schemes could usefully be framed as sustainable land use management in the long term.
26. Overall there is a need for a more integrated approach and less siloed thinking, even within organisations let alone across organisations. People are very focussed on their job/remit- there are more opportunities for collaboration than are taken up. Broader processes are not considered. Short term (5 year) agendas work against green solutions.
27. The amount of evidence and considerations is complex, and it is a challenge to understand processes operating at a range of temporal and spatial scales. People don't necessarily have a systems wide view of the whole process.

#### **Other Overall Conclusions**

- A systematic approach to planning and management such as that encouraged by SSM is helpful, but sometimes it is more about responding in an agile way to major events or to policy opportunities.
- Soft systems methodology seems productive as a methodology. It draws on the strength of many minds. It seems to capture the messy detail and complexity. But it needs a fair amount of time to work through and bring it all together.

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<sup>vi</sup> Similar principles are reflected as duties for public authorities in the UK Withdrawal from the European Union (Continuity) (Scotland) Act 2021

## References and Links

- Bridges, T. S., J. K. King, J. D. Simm, M. W. Beck, G. Collins, Q. Lodder, and R. K. Mohan, eds. (2021). [Overview: International Guidelines on Natural and Nature-Based Features for Flood Risk Management](#). Vicksburg, MS: U.S. Army Engineer Research and Development Center.
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- Committee on Climate Change (2018) [Managing the coast in a changing climate](#). Report.
- DEFRA (2006) [Shoreline Management Plan Guidance](#). Volume 1 – Aims and Requirements and Volume 2. - Procedures.
- English Heritage (2006) [Shoreline Management Plan Review and the Historic Environment](#), English Heritage Guidance.
- Environment Agency (2014) [Framework and tools for local flood risk assessment](#). Project Report SC070059/R3. A report by JBA Consulting.
- Environment Agency (2020) [National Flood and Coastal Erosion Risk Management Strategy for England](#).
- HM Government (2022) [UK Climate Change Risk Assessment](#).
- House of Lords Select Committee on Science and Technology (2022) [Enquiry on nature based solutions](#). Reports, Oral Evidence, Written Evidence, Government Response.
- Natural England (2019) [Coastal Change Management Areas: Opportunities for sustainable solutions in areas subject to coastal change](#). Guidance. NECR275.
- NatureScot [SNH] (2019) [Looking ahead: planning for coastal change. Using coastal change information to plan for development and infrastructure around the coast](#). Guidance.
- Schoonees, T., Gijón Mancheño, A., Scheres, B. et al. (2019) [Hard Structures for Coastal Protection, Towards Greener Designs](#). *Estuaries and Coasts* 42, 1709-1729.
- Scottish Government (2015) [Flood Protection Schemes – Guidance for Local Authorities Chapter 5](#). Project Appraisal: Assessment of economic, environmental and social impacts.
- Stojanovic, T.A., Lymbery G., and Smith T. (2006) Workshop on Coastal Defence in North Wales and North West England: A Communication Strategy for Shoreline Management Plans. Rep. No. 4.6b. A report submitted to the EU Interreg 3B Programme by the COREPOINT Project.
- Welsh Government (2020) [Flood and Coastal Erosion Risk management. A national strategy for Wales](#).

## Websites and Resources

- Climate Central Coastal Risk Screening Tool <https://coastal.climatecentral.org/>
- CoOpt (Resilient Coasts) Project: <https://projects.noc.ac.uk/co-opt/>
- Department for Environment, Food and Rural Affairs <https://www.gov.uk/government/organisations/department-for-environment-food-rural-affairs> including [Flood and coastal erosion risk management Policy Statement](#)
- Dynamic Coast (2) <https://www.dynamiccoast.com/outputs>
- Environment Agency [www.environment-agency.gov.uk](http://www.environment-agency.gov.uk)
- Fairbourne: Decommissioning a Coastal town. <https://www.greenpeace.org.uk/news/fairbourne-village-lost-sea-climate-change/>
- FCERM research and development (DEFRA/UK) <https://www.gov.uk/government/organisations/flood-and-coastal-erosion-risk-management-research-and-development-programme>
- Ministry of Housing, Communities and Local Government (Planning for coastal change) <https://www.gov.uk/guidance/flood-risk-and-coastal-change>
- Natural England <https://www.gov.uk/government/organisations/natural-england>
- Natural Resources Wales (Nature based solutions and adaptation at the coast) <https://naturalresources.wales/about-us/area-statements/marine-area-statement/nature-based-solutions-and-adaptation-at-the-coast/?lang=en>
- NatureScot (Planning for coastal change) <https://www.nature.scot/professional-advice/planning-and-development/planning-and-development-advice/planning-and-development-coastal-change>
- Pacco (Promoting Adaptation to Changing Coasts) <https://www.pacco-interreg.com/>
- Project CLIFF <https://world-habitat.org/world-habitat-awards/winners-and-finalists/community-led-infrastructure-finance-facility-cliff/>
- SARCC (Sustainable and Resilient Coastal Cities) <https://www.sarcc.eu/>
- Scottish Environmental Protection Agency <https://www.sepa.org.uk/>
- Scottish Government (Managing Flood Risk) <https://www.gov.scot/policies/water/managing-flood-risk/>
- UK Government <https://www.gov.uk/environment>
- Welsh Government (Flooding and coastal erosion) <https://gov.wales/flooding-coastal-erosion>



## Appendices

- A. Agenda
- B. Shoreline Management Planning in the UK
- C. List of Participants
- D. Implications of NBS issues
- E. CoOpt Project Overview

**Workshop: - How should decisions be made for coastal schemes (related to flood and coastal erosion)?**

0900	<b>Welcome</b>	Dr Leonie Robinson, University of Liverpool
0905	<b>Introduction 1: Approaches to shoreline planning: coastal schemes</b>	Dr Tim Stojanovic, University of St Andrews
0910	<b>Introduction 2: Soft Systems Methodology:</b>	Dr Tim Stojanovic, University of St Andrews
0920	<b>Small Group Exercises</b>	Breakout Groups Briefing
0925	<b>Exercise 1: PQR+ Transformation</b>	Breakout Groups with Convenors
0950	<b>Exercise 2: CATWOE</b>	Breakout Groups with Convenors
1015	<b>Comfort Break</b>	
1030	<b>Exercise 3: Human Activity System for Coastal Schemes</b>	Breakout Groups with Convenors
1045	<b>Individual Modelling</b>	Delegates
1115	<b>Comfort Break</b>	
1130	<b>Group Modelling</b>	Breakout Groups with Convenors
1200	<b>Workshop Discussion “How could decision making systems better account for nature-based solutions?”</b>	<ul style="list-style-type: none"> <li>• What additional steps might be needed?</li> <li>• What new forms of evidence might be required?</li> <li>• What changes to CATWOE (return to exercise 2) would facilitate this?</li> </ul>
1220	<b>Outro: Plenary feedback and thankyou.</b>	

Convenors Group A: Dr Elina Apine (University of St Andrews), Dr Marta Payo Payo (National Oceanography Centre, UK)

Convenors Group B: Dr Marta Meschini (University of Liverpool), Dr Sara Kaffashi (Cranfield University)

Convenors Group C: Dr Amani Becker (National Oceanography Centre, UK), Prof Laurent Amoudry (National Oceanography Centre, UK)

## B. Shoreline Management Planning in the UK

Coastal Group	SMP2	Lead	Lead Developer	Year Published
North East	SMP 1 Scottish border to the River Tyne (Northumberland and North Tyneside)	Northumberland County Council	Royal Haskoning	2007
North East	SMP 2 The Tyne to Flamborough Head (North East)	Scarborough Borough Council	Royal Haskoning	2009
North East	SMP 3 Flamborough Head to Gibraltar Point	East Riding Yorkshire Council	Scott Wilson	2010
East Anglian	SMP 4 Gibraltar Point to Hunstanton (The Wash)	Environment Agency	Royal Haskoning	2010
East Anglian	SMP 5 Hunstanton to Kelling Hard (North Norfolk)	Environment Agency	Royal Haskoning	2010
East Anglian	SMP 6 Kelling Hard to Lowestoft (Kelling to Lowestoft)	North Norfolk District Council	AECOM	2009
East Anglian	SMP 7 Lowestoft to Felixstowe (Lowestoft Ness to Felixstowe Languard)	Suffolk Coastal District Council	Royal Haskoning/ Terry Oakes Assoc	2010
East Anglian	SMP 8 Essex and South Suffolk	Environment Agency	Royal Haskoning	2010
South Eastern	SMP 9 River Medway & Swale Estuary	Environment Agency	Halcrow	2009
South Eastern	SMP 10 Isle of Grain to South Foreland	Canterbury County Council	Halcrow	2008
South Eastern	SMP 11 South Foreland to Beachy Head	Shepway District Council	South East Coastal Group	2006
South Eastern	SMP 12 Beachy Head to Selsey Bill (South Downs)	Arun District Council	South Downs Coastal Group	2006
Southern	SMP 13 Selsey Bill to Hurst Spit (North Solent)	New Forest District Council	New Forest District Council/ Channel Coastal Observatory	2010
Southern	SMP 14 Isle of Wight	Isle of Wight Council	Royal Haskoning	2010
Southern	SMP 15 Hurst Spit to Durlston Head(Poole & Christchurch Bays)	Bournemouth Borough Council	Royal Haskoning	2011
South West	SMP 16 Durlston Head to Rame Head	Teignbridge District Council	Halcrow	2011
South West	SMP 17 Rame Head to Hartland Point (Cornwall & Isles of Scilly)	Caradon District Council	Royal Haskoning	2011
South West	SMP 18 Hartland Point to Anchor Head (North Devon & Somerset)	North Devon District Council	Halcrow	2010
South West	SMP 19 Anchor Head to Lavernock Point (Severn Estuary)	Monmouthshire Council	Atkins	2010
South Wales	SMP 20 Lavernock Point to St Ann's Head (South Wales)	Carmarthenshire Council	Halcrow	2012
West of Wales	SMP 21 St Ann's Head to Great Ormes Head (West of Wales)	Pembrokeshire Council	Royal Haskoning	2012
North West + North Wales	SMP 22 Great Ormes Head to Scotland (North West England and North Wales)	Blackpool Borough Council	Halcrow	2011
(Scotland)	Fife	Fife Council	Mouchel	2011
(Scotland)	Angus	Angus Council	CH2M (Halcrow)	2017
(Scotland)	North and South Ayrshire	North and South Ayrshire	RPS (Planning Consultancy)	2018
(Scotland)	Dumfries and Galloway	Dumfries and Galloway	RPS (Planning Consultancy)	2022

### ***C. List of Participants***

Delegates representing or based at the following organisations were present at the workshop:

- British Geological Survey
- Coastal Partnership Network
- Cornwall Wildlife Trust
- Cranfield University
- Dynamic Coast
- EDF UK R&D
- Fife Coast and Countryside Trust
- Lancashire Wildlife Trust
- Local Government Association Coastal Special Interest Group
- National Oceanography Centre UK
- Natural England
- Natural Resources Wales
- NatureScot
- Northwest Coastal Forum
- Scottish Government
- Sefton Council
- University of Liverpool
- University of St Andrews
- University of the West of England, Bristol

### **D. Implications of NBS Solutions.**

<b>Issue</b>	<b>Implication</b>
1. Strategic national leadership is required on NBS.	CATWOE-challenge owners
2. NBS are not commonly considered enough within the range of coastal scheme options.	Key step in conceptual model?
3. The current management system does not deal well with the uncertainties inherent in NBS (long lead times, less certainty about outcomes than engineered solutions- not well catered for by Prince2 project management approach).	Change Prince2
<ul style="list-style-type: none"> <li>a. Timescales of decision making which are short term and/or purely risk based don't work for NBS. Risk abatement decisions with risks as primary focus don't tend to include green solutions, and in high-risk areas prefer hard engineered solutions. Schemes are generally brought forward because properties are at risk.</li> <li>b. Rather, long-term planning is needed to incorporate NBS into coastal schemes considering what will be in place in 50/100 years; and NBS need planning in advance to consider issues such as options, construction, maintenance and durability.</li> </ul>	?
4. Lots of policy drivers (Net Gain, Net Zero) and strategy drivers (Nature Conservation, Flood Risk Management) are in place to drive 'Working with Natural Processes', but whether this happens in a place seems to depend on complex and social and political factors.	CATWOE engage with customers and owners
<ul style="list-style-type: none"> <li>a. Net Gain theoretically should help extension of green based solution, but practice it doesn't because Net Gain doesn't guarantee coastal protection now.</li> </ul>	?
5. Key Performance Indicators need to be changed to better account for NBS (covering ecological benefits and climate hazards)	New Evidence
6. Natural capital/ ecosystem service assessments are needed to feed into the decision-making process, so that there are a wider range of indicators than are currently considered (focussed on risk to properties).	New Evidence
7. Approaches need to be flexible enough to deal with the variation in contexts at the local scale.	?
8. There is a need to train more coastal engineers, there is a lack of staff for coastal engineering in local authorities.	CATWOE change Actors
9. The value of community engagement is key in promoting NBS	Key step in conceptual model?
10. A broader consideration of the whole coastal (social- ecological/human-environment) system is required.	CATWOE change Worldview

## ***E. CoOpt project Overview***

The sea and society interact most strongly on the coast, where communities both benefit from and are threatened by the marine environment. Coastal hazards will increase over the next century, mainly due to inevitable sea level rise. At the same time, the UK has committed to reach net zero carbon emissions by 2050.

It is therefore essential to ensure that the UK's coasts are managed so that coastal protection is resilient to future climate and the net zero ambition is achieved. Shoreline management can be delivered by maintaining hard 'grey' defences or by softer 'green' solutions that work with nature, are multifunctional and can provide additional benefits.

The CoOpt research project (Resilient Coasts: Optimising co-benefit solutions) will provide a scalable and adaptable solution to support coastal management and policy development. The project has been co-designed with project partners who are critical to the implementation and delivery of coastal and shoreline management. It will address their specific needs, including the development of thorough cost-benefit analyses and recommendations for action plans when policy changes are preferred. Co-Opt will further benefit the broad coastal science base by supporting a more integrated and interdisciplinary characterisation of the complex coastal human-environment system.

[CoOpt](#) (2021 - 2024) is an interdisciplinary project involving natural and social scientists from the Universities of Liverpool, Cranfield and St Andrews and the National Oceanography Centre, and professional practitioners from government agencies and local authorities across the UK.