London School of Economics and Political Sciences

Inter-Sector Partnerships: Complex Dynamics and Patterns of Behaviour

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A thesis submitted to the Department of Social Policy at the London School of Economics for the degree of Doctor of Philosophy, London,

December 2013

Declaration of Authorship

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Thesis Abstract

This thesis examines inter-sector partnership processes from a complex dynamical systems perspective. Inter-sector partnerships is increasingly researched both as new forms of government and policy making, and in the sustainability field. The theories traditionally used to analyse this topic fail to confront their dynamics as a whole. Recent approaches draw on complexity theory but, by pre-defining the principles for analysis, constrain the complete understanding of these phenomena. This thesis combines an inductive and deductive approach to explore the complex principles that drive agents' interactions both at an emergent level (macro), process level (meso) and a causality level (micro). This aims at 1) providing a theoretical and methodological framework to study inter-sector partnerships as complex dynamical processes; and 2) advancing the understanding of social dynamics in the field of complexity theory. This work is based on two case studies collected during fieldwork in Brazil and Ecuador using participatory inquiry and semi-structured interviews to account for the multiple agents, perspectives and components of these processes. These experiences reflect dissimilar topics of collaboration and context conditions intended to provide various scenarios of work and highlight regularities through cross-examination.

The results show that, despite the differences, a common pattern of behaviour governs the creation and evolution of multi-stakeholder processes in both case studies. This pattern shows five stages driven by different complex principles: 1) the creation of niche opportunities; 2) the occupation of this niche by a new agent; 3) the emergence of collective behaviour and inter-sector partnerships; 4) the influence of the collaborative process in the system dynamic; and 5) the expansion of a new dynamic in the system. The results provide new insights into the functioning of complex social systems and show that multi-stakeholder processes represent (1) a phase transition in the system dynamics; and 2) a poised state in the system dynamic at the complex regime or edge of chaos, state where the system optimises its capacity to adapt to change, innovate and perform complex tasks. These findings have a direct practical implication by providing practitioners and policy makers with a tool (qualitative dynamical modelling) to promote or reinforce inter-sector partnerships, and to drive social systems to this intermediate regime of optimal performance, the edge of chaos.

Acknowledgements

Anthony Hall from the Department of Social Policy and Eve Mitleton-Kelly Director of the Complexity Research Programme, both at the London School of Economics and Political Science (LSE), for supervising and guiding my work. Sarabajaya Kumar from the LSE Teaching and Learning Centre for giving me the support for completion.

AVINA Stiftung for the resources to make this thesis more than an academic work. Stephan Schmidheiny for his courage to 'walk the talk' of Sustainability and his generosity to society. Finally, I am deeply grateful to Peter Fuchs for sharing his wisdon on social change and encouranging me to follow my ideas.

All the informants from the four case studies collected for this work, even if just two appear here due to academic constraints. These are: the Mandú Alliance (Piauí State, Brazil), the FONAG (Quito, Ecuador), Primeira Infancia (Pedro Leopoldo, MG, Brazil), and First Agrarian Contract of the Biosphere Reserve (Menorca, Spain).

The innumerable people that try to make a difference in their parts of the world, who over the years, have shaped my ideas and inspired this work. This research comes from your strength and aims to reinforce your efforts.

Most of all, I would like to thank my family, both from France and Spain, who have travelled to London so many times over the years to help me to complete this work: Merci beaucoup, Muchas Gracias. An eternal thank you to my friends for their constant support. The most special thanks goes to Thomas, Louis and Simon for being my loves.

To all of you and those who search for more sustainable pathways in society, I dedicate this thesis.

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ACRONYMS

ABDL	Brazilian Association for Leadership Development
BID	Inter-American Development Bank
CAS	Complex Adaptive Systems
CI	CARE International
CSR	Corporate Social Responsibility
COSUDE	Swiss Development Cooperation
CONAIE	Pan-Ecuadorian Indigenous Nations Confederation
DFID	Department for International Development (UK)
EEQ	Electric Power Company of Quito
EMAAP-Q	Quito Public Enterprise for Water Supply
EMBRAPA	Brazilian Public Enterprise for Agricultural and Livestock Research
FFLA	Foundation for the Future of Latin America
FONAG	Fund for the Preservation of Water Resources
GTZ	Deutsche Gesellschaft fur Technische Zusammenarbeit (German Bilateral Cooperation Agency).
HDI	Human Development Index
INAMI	Hydro-Meteorological Institute
IMF	International Monetary Fund
ISP	Inter-sector partnerships
IOR	Inter-Organization Relationship
IWMP	Integrated Water Management Plan
MIDUVI	Ministry of Urban Development and Habitation
NGO	Non-for-profit Organization
IUCN	International Union for the Conservation of Nature
UEP	Parnaiba Research Unit
UN	United Nations
UFPI	Piauí Federal University
PPSJ	Susana Jacobs Childcare Post
PSA	Environmental Sanitary Unit
SEMAR	Brazil's Environment and Hydrological Resources Secretary
SENAGUA	Water Secretariat

TNC	The Nature Conservancy
QMD	Quito Metropolitan District

Chapter 1

Introduction

The rise of inter-sector partnerships as an international phenomenon results from several factors stemming from the different fields of socio-political life (Seddon *et al.* 2004; Robinson *et al.* 2000). Inter-sector partnerships are generally understood as a process that brings together actors from the State, market and civil society to achieve mutual agreement on an issue, and to negotiate and implement mutually agreeable plans for tackling that issue (Brown and Kalegaonkar 2000; Waddell 1999; Brown and Waddell 1997).

Extensive literature from social and political theory relates the emergence of inter-sector partnerships with the crisis of the modernity paradigm and the failure of the roles assigned to state and market to provide social services (De Souza Santos 2003; Edwards 2004; Giddens 2008). According to De Souza Santos (2003) none of the regulatory principles, neither the market nor the state or community, seem to be capable of regulating the social contract separately. As a result, the traditional sectorial boundaries have become blurred and choice policies have variable effects across sectors, organisations and individuals (Anderson 1994; Seddon *et al.* 2004)

From a governmental perspective, debates in the academic and public management worlds are currently emphasising the benefits that collaborative, inter-agency partnerships can offer as a means of achieving public policy goals. This theoretical work coming from public management and governance theories reflects the interest of the social science community in shifting the governing model. Following this rationale, Huxham and Vangen (2005) present the idea of 'collaborative advantage' to represent an alternative strategy to the quasi-market and contractual-based relationships that have dominated the public management movement internationally in the past decade. It also encourages further progress away from the large-scale, bureaucratic and paternalistic public organisations, which were developed to deliver welfare state programmes in the third quarter of this century (Robinson *et al.* 2000).

These ideas, stemming from public management theory, also have their equivalents in governance theory. A governance[1] perspective not only recognises increasing complicated systems of government, it also draws attention to a shift in responsibility, a stepping back of the State and a transfer of responsibilities to the private and voluntary sectors and, more broadly, citizens (Stoker 1998; Rhodes 1997; Brunner *et al.* 2005). In the words of Kooiman and Van Vliet (1993: 64), "the concept of governance points to the creation of a structure or an order which cannot be externally imposed but is the result of the interaction of a multiplicity of governing and each other influencing actors". In practical terms, governance recognises the interdependence of public, private and voluntary sectors in an interactive process that involves various forms of partnerships (Stoker 1998; Ostrom and Ostrom 1965).

Moving away from the State to civil society or the third sector, there are several trends that explain the rise of inter-sector partnerships as an international phenomenon. The first ideas of *civil society* start to appear between 1750 and 1850 in response to a perceived crisis in the ruling social order. At national and local level, networks of intermediary associations act as a counterweight to vested interests, promote institutional accountability among states and markets, and negotiate the social contract between governments and citizens. At a transnational level, a 'global civil society' arises as a mechanism by which new global norms are developed and cemented around notions of universal human rights, international cooperation and the peaceful resolution of differences in the global arena (Edwards 2004).

In the private for-profit sector, the rise of philanthropy and Corporate Social Responsibility (CSR) as social services providers also reflects changes in the role of the private sector. In the nineteenth century, the idea of community philanthropy emerged in parallel with industrialisation as an ideological movement intended to legitimise the power of large corporations. Literature in this field claims the lack of a clear definition of CSR. However, both managers and researchers often agree that community philanthropy represents the obligation a business assumes towards society, while to be socially responsible is more than the provision of goods to worthy causes. The concept of community philanthropy also maximises positive effects on society and minimises negative ones, as well as finding creative ways to improve the

[1] Governance is used in a range of practitioner and academic settings in an attempt to capture a shift in political thinking and ways of working in Western and developing countries policy arena (Stoker 1998).

quality of life of the firm's employees and the local community (Capoava 2005; Fisher and Falconer 1999; Austin 2000).

In the last two decades, new concepts such as 'good governance', 'social action', 'sustainability index' and 'partnerships' have determined corporations' CSR agendas. Furthermore, as a response to mass mobilisation around social issues and the crisis of trust by the string of corporate scandals in the USA and elsewhere, corporations have developed more community-linked partnerships (Kamel and Wood 2004). At the same time, developing partnerships with civil society groups has become a common strategy for both State and corporate interest, which use the sector's positive public image to clean up their reputation (Robinson *et al.* 2000).

Within the international aid field, relationships between bilateral donors and government departments are developing in many places into forms of concerted donor action around commonly agreed approaches. This can be seen as a shift from aid-based to rules-based development, which requires the involvement of many parties and in which skills of negotiation become more significant (Rihani 2002; Leach *et al.* 2010; Robinson *et al.* 2000). The provision of funds from aid projects has taken a backseat as donors, governments and increasingly, other partners, move their focus to defining sector-wide programmes and stimulating macro-level change.

Most of the international development agencies state their belief in partnership as a collaborative effort that enables developing countries to increase their capacities to do things by themselves (OECD 1996; Department of International Development (DFID) 1997). Nevertheless, several authors argue that the widespread use of 'partnership' in current development discourse and the ways language twists, has not only eroded the usefulness of the term but current trends toward contracting in the aid systems are turning NGDOs [non-governmental development organisations] away from the concept (Robinson *et al.* 2000).

Brazil and Ecuador are clear examples where all these factors are behind the emergence of inter-sector partnerships. Since their independence from Portugal and Spain in 1822 and 1830, respectively, changes in the political context have determined the relationship between the different social agents. In the 1980s and 1990s, the increase of civil participation and private investment in social affairs led to a new non-governmental public dimension, the so-called Third Sector, which contributed towards a re-definition of State and market roles. In the 1990s, corporations started to participate in social issues, particularly through their own

foundations and institutes, becoming a 'social investor' and a 'development agent' both at national and local level, which made the State take a back seat in attending social issues. It is in this context that ISPs arose in these countries, particularly in Brazil, in search of coordinating efforts and as a way to counter vested interests to tackle social needs (Fisher and Falconer 1999; Fisher *et al.* 1998; Capoava 2005). The more recent left-orientated governments in these countries, from Lula da Silva in Brazil and Rafael Correa in Ecuador, have also boosted the expansion of ISPs at all administration levels.

Therefore, these two countries contain two main criteria to undertake this research: 1) ISPs have been taking place in these countries for enough time to be able to study their 'processes' of construction and evolution; and 2) the countries offer a diversity of context conditions (political, environmental, social, cultural and the like) to allow for the examination of the interrelation between context conditions and ISP's dynamics. According to these criteria, the case studies selected are first, a multi-stakeholder process to create an integrated water management scheme in the Quito metropolitan area (Ecuador). The second case study presents the process that led to the creation of the Mandú Alliance as a means of delivering more effective actions in relation to the professional opportunities young people have in several coastal communities in the Parnaiba region (Brazil).

These case studies represent two different processes of inter-sector collaboration, which attends to another key criterion of this research, to examine different topics of collaboration. In this sense, the Mandú Alliance (Piauí - Brazil) case study reflects a process where a multiplicity of social agents stemming from a variety of social sectors (public research centre, academy, international foundation, local communities, local NGOS, business companies, etc) respond to a shared opportunity, i.e. the entrance of international funds in the region. This case study illustrates how by working collaboratively, the Alliance members benefit both individually and collectively from providing a social service to a vulnerable social group, i.e. young people from coastal communities.

Differently, the Quito case study represents a collective effort to respond to a common threat, the outlook of a major water crisis. This case study reflects the multiple interactions that stem not only from the interaction of multiple social sectors but also from the variety of levels of the system involved in the process. Both case studies illustrate how the topics of collaboration are usually too complex to be tackled

effectively by a single agent. Consequently, collaborative actions can provide more innovative and effective solutions to social issues at the same time that they provide a crucial added value, i.e. social capital. Other criteria used for the selection of case studies are presented in Chapter 3.

The multiplicity of factors, forms, purposes and levels of occurrence under which inter-organisational partnerships can manifest themselves, as partially represented by the case study selected for this research, is discussed in the literature (Gray and Wood 1991; Huxham and Vangen 2005; Brown and Waddell 1997). This versatility explains the plurality of descriptive terminology found in the literature to refer to partnerships: collaborative or cooperative relationships, inter-organisational relationships (IOR), strategic alliance, multi-stakeholder partnerships, federations, networks, and so on. Related to the elements of interaction, there are also different terms present in the literature to refer to them, such as sector (public, private and civil society), actors (state, corporations and NGOs), agencies (political, economic and social), and institution (state, market and civil society).

Brown and Waddell (1997) discuss how inter-organisational cooperation can take two forms. The first form of partnership involves the exchange of information and resources as the main reason for one organisation to join with a third organisation, to strengthen the partners' individual activities. A second form involves the creation of a new organisation to develop a specific activity. This may require activities quite different from the core activities of either partner and to take on a more formal structure with a separate legal entity. There are many variations and combinations of these forms.

In relation to the driving forces or motivations behind inter-organisation partnerships, Lowndes and Skelcher (1998) discuss different kinds. The first type arises in response to threats from competitors - current or potential - a perceived opportunity to expand domains, and to extend influence and secure new resources. The second type can be a particularly well-suited strategy for solving development problems at political, economic and social dimensions, as many of these problems are too complex for any single agency to tackle effectively (Brown and Waddell 1997). On many occasions the idea of inter-sectoral collaboration emerges from frustration and lack of success with other approaches by a sector or organisation acting independently. Additionally, Brown and Kalegaonkar (2000) note how inter-sectoral collaboration can lead to innovative solutions to persistent problems, having a

catalytic effect that results in broader and more sustainable social change, creating multi-sector social capital. The two case studies in this research belong to this last source of action, as further discussed in Chapters 4 and 6.

Regarding the institutional costs that inter-organisational cooperation may involve, Schermerhorn (1975) notes three main potential costs that managers must be aware of: 1) a loss of decision-making autonomy; 2) unfavourable ramifications for organisational image or identity; and 3) the direct expenditure of scarce organisational resources (Lowndes and Skelcher 1998).

The outcomes that arise from collaboration among the sectors reflect roles and levels of influence that is impossible for them working independently, such as: coordination of efforts and activities aiming for common goals, greater innovation and unusually creative solutions. These outcomes reflect the synergic nature of inter-organisational collaborations, where the whole is more than the sum of the parts (Lowndes and Skelcher 1998; Brown and Kalegaonkar 2000; Edwards 2004; Huxham 1996).

An analysis across this multiplicity of manifestations of inter-organisational collaboration without the lenses of a particular theoretical framework- i.e. governance, policy-making or development strategies - shows some generic features of these processes: they are *adaptive,* as they respond to a multiplicity of contextual conditions and goals; *synergic,* as they produce outcomes that go beyond the contribution of the parts; and *dynamic*, as they change and adapt over time.

This research argues that these features and the synergistic nature of inter-sectoral collaborations noted above, reflect the fact that societies behave as complex adaptive systems (Sawyer 2005; Luhmann 1995; Buckleys 1998; Bertalanffy 1968; Castells 2011; Cilliers 2002; Maturana and Varela 1980); then, this research argues that inter-sectoral collaboration represents a process, a dynamical construct, within the complex adaptive systems or society where these are [2]embedded.

Brinkerhoff's (2002a) definition of partnership provides another example to illustrate how inter-organisation collaborations display features of complex adaptive systems:

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[2] A complex system according to Mitchell (2009: 13) is "a system in which large networks of components with no central control and simple rules operation give rise to complex collective behaviour, sophisticated information processing, and adaptation via learning or evolution".

> "Partnership is a dynamic relationship amongst diverse actors, based on mutuality agreed objectives, pursued through a shared understanding of the most rational division of labour based on the respective comparative advantages of each partner. Partnership encompasses mutual influence with a careful balance between synergy and respective autonomy, mutual respect, equal participation in decision-making and mutual accountability and transparency." (p. 21).

The reference to the "dynamical relationship" in this definition based on 'mutually agreed objectives, pursued through a shared understanding', notes the collective construct of inter-sector or multi-stakeholder partnerships, one of their main features; 'rational division of labour based on the respective comparative advantages of each partner' points to the distribution of roles in the partnership, which enables to optimise the individual capacities in the benefit of the collective goals (fitness distribution); 'Partnership encompasses mutual influence' hints at the co-evolutionary nature of these dynamics; 'with a careful balance between synergy and respective autonomy', notes the property of 'multi-functionality'; and 'mutual respect, equal participation in decision-making and mutual accountability and transparency' point to building blocks of sustained collective action.

This definition illustrates how the processes of collaboration exhibit various features and mechanisms of complex dynamical systems, such as those stemming from Brinkerhoff's (2002) definition: dynamical construct, dynamical process or phase transition, co-evolution, fitness distribution, multi-functionality and building blocks (Kauffman 1993; Holland 1995; Goldstein 1999; Loorbach 2007; Leach *et al.* 2007). Is this enough to illustrate that the processes of inter-sector partnerships are driven by complex dynamics? This research defines 'complex dynamic' as a property of the society as a social system and not an adjective to describe it.

An analysis of the theoretical frameworks that have most influenced the study of inter-sector collaborations according to Robinson and co-workers (2000) also provides another argument that sustains this working hypothesis. Nevertheless, it is important to note that the majority of academic research on partnerships until very recently has focused primarily on bi-sector partnerships between business and non-profits (Bendell 2000; Sagawa and Segal 2000), the construct (Austin 2000), partnership stages and typologies, and practitioner interests (Nelson 2002).

Given the prominence of collaboration, it is not surprising that it has been extensively researched by multiple disciplines such as sociology, business policy,

economics, economic geography, public policy, politics and management. These disciplines are derived from a large number of theoretical frameworks including institutional theory, social network analysis, evolutionary theory, resource-dependence theory, transaction-cost economics and critical management studies (Huxham and Vangen 2005).

In the particular domain of inter-organisational collaboration, the locus of this research, organisational sociology theory and resource dependence theory provide an understanding of how environmental conditions influence inter-organisational collaborations. The first theoretical framework examines the *environmental situation* and *contingent factors* that explain the formation and structure of cooperative inter-organisational relationships (Aldrich and Whetten 1981; Galaskiewicz 1985; Oliver 1990; Van de Ven 1976; authors cited in Robinson *et al.* 2000). The latter focuses on minimising inter-organisational *dependencies* to achieve stability and reduce uncertainty with respect to the environment without increasing dependence on other organisations (Gray and Wood 1991). From a complex systems approach, while organisational sociology theory provides useful insights into how the contextual conditions determine the *emergence* of inter-organisational collaborations; resource dependence theory recognises the *connectivity* and *dependence* of these relationships within their context and on other agents and how these processes can be tuned to reduce variability.

Although these two theories make a meaningful contribution to understanding the network structure of IORs and the dynamics of interrelation within the context in which they are embedded, they fail to address the core questions of these processes, such as how do they emerge? How do they evolve? And how do they influence the context? These questions relate to the mechanisms of historicity, path-dependence, co-evolution, self-organisation, emergence and self-organised criticality, as discussed in Chapter 8 of this dissertation.

From these two theoretical approaches, alliances between organisations arise in response to current or potential threats from competitors, and to perceived opportunities to expand influence and secure new resources (Alter and Hage 1993). These ideas refer to possible path-dependence and internal structures that can drive the complex nature of collaborative dynamics. They reflect, however, just a possible configuration of a system, and cannot be considered a generic feature of all inter-sector collaborations.

In contrast to the competitive imperatives implicit in resource dependence theory, collaboration theory is characterised by a notion of synergetic gain and programme enhancement from sharing resources, risks and rewards and the prioritising of collaborative rather than collective advantage (Huxham 1996). From a complex systemic perspective to IORs, both resource dependence theory and collaboration theory provide interesting insights for understanding the positive and negative feedback that characterise these processes. Nevertheless, according to Juarrero (2000: 37) "an important feature that defines the complex dynamic of social systems is that their current state is in part dependent on their prior states, so feedback processes incorporate the past into the system's present structure". Hence, collaboration theory fails to explain how past events influence the dynamics of the partnership process though the mechanisms of historicity and path-dependence.

Robinson et al (2000) note that the most influential theoretical perspective so far in the study of inter-sector partnerships has been transaction cost economy theory. This theory is based on the transaction decisions for a single transaction between two firms. Both options have two transition costs: price and overheads. Making such choices, then, is based on a calculation of what is the lowest-cost option. Other theories closely related to transaction cost theory are industrial economics and organisational economics. The first is based on the analysis of economies of scale, scope, specialisation and experience to explain incomplete forms of vertical and horizontal integration in firms and in the process of internationalisation of firms. Organisational economics, on the other hand, stresses the reduction in costs of governance in inter-organisational relationships that hybrid forms of market and hierarchy can obtain under certain circumstances

These theories contribute to understanding the complex nature of inter-sector partnerships by revealing another variable (transaction cost) that influences the flow of resources within a collaboration, and reinforces the importance of efficiency as a governing principal of agents' behaviour. Their main focus, however, is on the analysis of firms and economic variables, which fail to tackle other variables that also influence the complex dynamics of inter-sector collaborations.

A final major advancement at a theoretical level is the shift from transition cost theory to the recognition of the network structure behind inter-sector interactions, made by network theory. While the former reflects a hierarchical perspective represented by the primacy of monetary incentives as a regulatory principle of firms'

collaborations, the latter examines issues such as how economic exchange is correlated with social exchange based on unspecified trust. Additionally, network theory stresses the importance of resource development over time such as access to and use of information, learning and social capital, in state of the one-off arrangements of transaction cost theory. Robinson *et al.* (2000: 61) discuss the fact that network theory provides key arguments about "how networks are a distinctive form to be added to the established forms of market and hierarchy, and how these two aspects are incomplete specifications of the real world". Although network theory has been an influential framework in the study of system dynamics, it fails to explain other important features of complex social systems such as self-organisation, co-evolution and emergence.

The relevance of considering the various institutional backgrounds for the analysis of inter-sector partnerships has been noted in the literature (Gray and Wood 1991). In this regard, strategic alliance theory represents a good example of a sector's perspective (firm perspective) in the study of inter-organisational dynamics. Although this theory is an extension of transaction cost economics, as market and hierarchy are still viewed as the key forms of transactions governance (Robinson *et al.* 2000), it approaches strategic alliances as voluntary, enduring relationships that involve resource sharing and joint decision making. This theory, part of orthodox management thinking, provides an interesting analysis of the inter-organisational process dynamics (Chilc and Faulkner 1998; Gray 1989; Kanter 1994; authors cited in Austin 2000). However, its focus on the firm's perspective fails to provide a comprehensive explanatory framework for the analysis of other sectoral journeys to the inter-sector processes.

This analysis shows how these theoretical frameworks underline various features of complex adaptive systems without a specific reference to this conceptualisation. These are: network structure; the interconnectivity and inter-dependence between agents; the influence of the context conditions; how the agents' internal configuration and background shape their dynamics; and the implication that all these elements have in the flow of resources between agents, additionally to the transaction cost noted by traditional theories. Despite this, that inter-organisational relations are complex is often noted in the literature of this field (Stoker 1998; Wood and Gray 1991; Robinson *et al.* 2000). In this rationale, Schemerhorn already identified the inter-dependence nature of this phenomenon in 1975, while looking for

communalities across the main concepts around inter-organisational cooperation. Similarly, Ostrom and Ostrom already claimed the need for a systemic approach to study of inter-organisational relationships in 1965.

However, while some authors have applied a systemic approach to this topic (Stewart 2002; Stoker 1998; Rhodes 1996, 1997), these theoretical approaches and works have failed to explain the emergent (synergistic) and complex dynamic of these processes. Therefore, questions arise such as how do inter-sector partnerships work? What forces drive their complex dynamic and evolution? How are its synergic outcomes created? They still fail to have a complete answer. This research does not claim that these approaches are wrong or unnecessary, however, as they advance the knowledge of specific components of inter-organisational collaboration. The claim is that a conceptual framework is needed which is capable of tackling the complex, systemic and dynamical nature of inter-sector partnerships; that is, a framework capable of addressing these elements not just as adjectives to qualify their functioning, but as properties and governing principles for analysis.

This research claims that the interactions behind inter-sector collaborations that aim to deliver integrated social policies exhibit a specific complex dynamic that has not yet been revealed. This research proposes that the advance of complexity theory in recent decades has provided a new set of ideas and theories potentially capable of exploring the dynamics of these collaborative processes. This theory claims that the idea of a system as interrelated parts emphasises that while all systems can be analytically broken down for the purposes of scientific study, their essence can only be identified when the system is viewed as a whole. This is because the interdependence of the parts produces features and characteristics that are unique to the system as a whole (Holland 1995; Buckley 1998; Hatch 1997).

Complexity theory is fundamentally different from former and traditional theoretical approaches to the study of inter-sector organisations, as instead of searching for laws that apply to any reality; complexity theory provides rules of interaction between the individual entities comprising a reality or system according to its specific context conditions (Stacey, 2003). This shift in the paradigm of theorising reflects the fact that no miracle hand controls collective behaviour from outside the system, as do deterministic theories (Arthur 1997, 2013; Robinson *et al.* 2000; Leach *et al.* 2010; Rihani 2002). Instead, collective behaviour is the emergent result of interactions, of multiple individual and collective entities that at a lower level give

rise to macro patterns of interaction. The science or theory of complexity focuses on these interactions, how they work, the different types and the dynamical patterns they exhibit.

Various reasons explain why the new science of complexity has had little influence on current sociology, however, as discussed in Chapter 2. Despite the intricate journey that these ideas have had within social sciences, two works require special attention for being closer to this research approach and topic: Loorbach's theory of transition management (2007) and Leach and co-workers' pathways approach to sustainable development (2010).

Loorbach (2007) proposes transition management as a framework for long-term structural changes as the basis for governance of any societal system and particularly to guide transitions towards sustainability. The authors refer to these periods of change as 'transitions'. Loorbach's (2007: 22) work presents itself as "a new area of explorative research closely link to innovative practice", as he takes general patterns of complex systems dynamics and a systemic approach to the analysis of the complex dynamics of transitions.

While this research shares Loorbach's (2007) new research approach, it presents two major differences. First, the research subject is different. While Loorbach explores governance processes, this research examines collaborative processes. While inter-sector or multi-stakeholder collaborations could be seen as a form of governance, the opposite it is not true. Secondly, these works also differ in the analytical approach. Loorbach's work explores the complex dynamics of governance processes as 'phase transitions' in the system (societal) behaviour. Differently to this, this research explores inter-sector partnerships collaborations as 'dynamical constructs'. While there is an overlap in these concepts as they are part of the same phenomenon, the former has a broader focus on the role and influence of these processes in the systems where they are embedded; and the latter takes a deeper and more detailed look at the internal dynamics of collaboration.

A second major contribution in the use of complexity theory to the analysis of social dynamics under the perspective of social change is the work of Leach *et al.* (2010). These authors create a pathway[3] approach to sustainability based on the understanding that an adaptive and flexible approach to action is needed to take

[3] Leach et al. (2010: 5) define 'pathways' as the "alternative possible trajectories for knowledge, intervention and change, which prioritize different goals, values and functions".

account of the dynamic nature and complex behaviour of society. In their work, they draw on four case studies to show the contradictions between dominant approaches and the dynamic realities of these experiences. They argue how a pathway approach provides new questions, unpacks problems and identifies alternative ways forward in these cases.

This book and the work of the STEPS Centre are a reference point for the shift of paradigm in the understanding of sustainability - its appraisal, governance, design and influence on policy-making - and its re-conceptualisation from a complex dynamics perspective. Despite the convergence in research approach and conceptualisation of sustainability, this research provides an additional dimension to the discussion; it offers two examples of the use of complexity theory as an explanatory and analytical framework of the complex dynamics of the social process. This research provides two innovations. First, it provides a reference to the 'route-map' of complex principles or mechanisms that can guide inter-sector partnerships in different contexts, to advance further research and practice. Second, it contributes to a better understanding of the complex behaviour of social systems both though the particular scenarios of two empirical case studies and through a discussion of how the main complex mechanism present in these cases functions. Finally, this research also offers an additional insight and discussion, which is how inter-sector collaborations help to bring social systems to a state of maximum innovation and responsive capacity, the edge of chaos or complex regime (Kauffman 1993).

The present research proposes a different approach to the study of inter-sector partnerships. It departs from the assumption that the behaviour of societies as complex dynamical systems determines the complex behaviour observed behind inter-organisational collaboration processes. Thus, this research sets out to explore inter-sector partnership processes as a dynamical construct of complex social systems. Figure 1 represents the process of study.

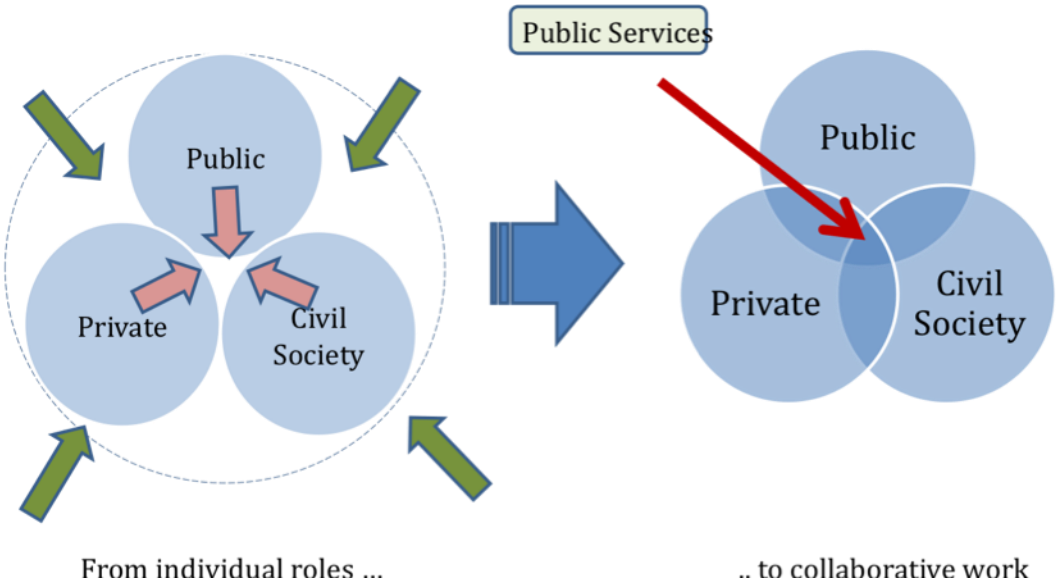

Figure 1- Process of study: the transition from individual or sector work, to collective work, as a complex dynamical construct.

To explore this assumption, this research uses a complex dynamical systems theory approach, and related ideas from complexity theory, as an analytical and explanatory framework for the study of inter-sector partnership processes. The application of this framework addresses three research questions. The first research question is: what are the complex dynamics behind the inter-sector collaboration process of each case of study? This question aims to explore the applicability of a complex dynamic systems approach as an explanatory framework of two different empirical processes of collaboration. Additionally, the aim of this question is to provide two examples of scenarios that describe the mechanisms and processes that drive the complex dynamics of these experiences. A subsidiary question is: how do the various agents institutional backgrounds[4] involved in these processes influence their journeys towards collaboration? This question attempts to address both the processes common to all types of agents involved in the collaborative process as well as the specificities of each type of agent. The second research question is: what are the generic principles that contribute to the construction of inter-sector partnerships from a complex dynamical systems approach? This question aims to draw out both a common construction and evolution process of inter-sector collaborations among the

[4] By `background´ this work means the different vision of reality, institutional culture, language, etc that organisations coming from different social sectors present.

cases of study, and the common complex mechanisms and principles behind this pattern.

This research is based on the analysis of two empirical case studies that reflect two different processes of inter-sector collaboration in two different countries. To understand the patterns underlying a particular complex behaviour, dissimilar features need to be considered for the purpose of comparison (Holland 1995). The ultimate goal of this research is to provide a reference point that contributes to advancing the understanding and appraising of social change as complex dynamical systems. Here social change is understood in a broad sense, as social processes of any kind and not just in terms of sustainability. Furthermore, this research aims to provide an innovation approach to existing research by bringing more comprehensive answers to current challenges of our societies.

The thesis moves from this introductory discussion to presenting complex dynamical systems theory and related ideas from complexity theory in Chapter 2. This section starts offering a definition of what a 'complex system' is, the different terms used in the literature and the various disciplines that have shaped this interdisciplinary field of enquiry. An overview of the various waves that systems' ideas have had in the domain of social science is presented. In this chapter the main concepts of complex dynamical system theory and related ideas that drive the dynamics of change in the two social systems of study are presented. These are: self-organisation, emergence, co-evolution and self-organised criticality. Finally, this section describes the various types of complex behaviour – ordered regime, chaotic behaviour and edge of chaos - and introduces the main properties of complex adaptive systems according to John Holland. Examples of how these concepts serve to explain the behaviour observed in the empirical data are provided. The major criticisms that the transfer of ideas from the sciences of complexity to the social arena are also noted in this chapter; and the innovations that this research includes to overcome them are presented.

Chapter 3 introduces the methodology design and strategy used in undertaking this research. This chapter argues that a new methodology approach is necessary, one that moves away from both the discipline approaches traditionally used to study inter-organisation collaboration and the modelling tools normally used in the field of complexity sciences. This chapter presents and argues that a qualitative approach in the use of complexity theory that includes some specific innovations seems the most adequate and accurate methodology for the purposes of this research. The

methodology strategy based on various stages of inductive and deductive work, case studies and empirical research is then presented. This work refers to this methodology strategy as 'qualitative dynamical modelling'. The selection of the methods for data collection, participatory inquiry and semi-structured interviews, is discussed. The analytical framework and structure for data processing and analysis based on various levels of analysis and cross-examination of case studies is introduced. Finally, this chapter examines the difficulties and limitations of this methodological approach and reviews the ethical issues involved in undertaking this research.

The fourth chapter presents the first case study, the creation and evolution process of the Mandú Alliance in Brazil. This chapter presents the Mandú Alliance as a multi-stakeholder collaboration between the Piauí Federal University, EMBRAPA[5], Flora Vida Institute[6] and CARE Brazil[7]. This inter-sector partnership was created to promote professional opportunities for young people in the coastal communities of Piauí State, northeast Brazil. This chapter presents the background information of this cases study and examines the main events that have enabled or hindered the collaboration process, and their causes. The journey and challenges that the institutions from the various sectors involved (public, private and non-for-profit) faced when engaging in collaborative work are included. Ultimately, this chapter presents empirical evidence of how this collaborative process increases the adaptability of the community to change.

Chapter 5 presents the Mandú Alliance case study from a complex dynamical systems perspective. This chapter is structured in two parts. The first part presents the analysis of the dynamics behind the emergence of the Mandú Alliance and its collective behaviour at a macro level within the system. This section starts featuring the starting conditions of the system that enabled this collaborative process to emerge. It then investigates the various mechanisms that allow this research to explain the emergence of the Mandú Alliance: self-organisation, co-evolution and emergence, and how they are intertwined. The second part examines the dynamics at a micro level or agent level. Here, the adaptation process, changes in the agents' internal

[5] EMBRAPA is the Brazilian Public Research Enterprise for Agricultural and Livestock.

[6] The Flora Vida Institute is the local branch of the chemical company Vege Flora Group.

[7] CARE Brazil is the regional branch of the International non-for-profit organisation CARE International.

configuration (attributes and attitudes), and changes in the organisation structure and dynamic are analysed for each agent. Finally, this chapter analyses what capacity the new regime (inter-sector partnership) has built into the system both at an agent and community level.

Chapter 6 introduces the second case study, the multi-stakeholder process to build an integrated water management plan for the Quito Metropolitan Area (QMQ), in Ecuador. It describes the creation of the Fund for the Protection of Water Resources (FONAG) and the effort made by multiple water users to collectively construct a new governance model and plans to better manage water resources in this region. The main participants in this process are the created Fund for the Preservation of Water Resources (FONAG), government agencies at a national level (SENAGUA-Water Secretariat; Secretariat for the Environment; MIDUVI- Ministry of Urban Development and Habitation), the public enterprise for water provision in the urban area of Quito (EMAAP-Q); local level structures of water management (Municipalities, Water Councils; Drinking Water Councils); intermediate organisations (FFLA, Randi Group), and the academy (Salesian University).

Chapter 7 presents the analysis of the Quito experience in creating an integrated water management plan presented in the former chapter from a complex dynamical systems perspective. Similarly to the former analytical chapter (5), this chapter is spilt in two parts. The first part explores the mechanisms and procedures that explain the process of interaction and collective construction presented in the former chapter. The second part examines the mechanisms and sub-processes that lie behind agents' interactions at a lower level (micro level) and that explain the process (meso level) and the properties observed at a macro level. This chapter, unlike the former analytical chapter, examines the dynamics by social sector. These are: public sector, community representatives and private sector. Here, the two elements of analysis are what the changes are occurring in the sector dynamic and structure during the process of study, how the connectivity of the sector with the rest of the system has shifted, and what changes have happened in the governance model of each sector.

The following Chapter (8) presents a cross-comparison of the two case studies explored above. This comparative analysis examines the similarities and differences between the two processes studied. This aims at identifying both common patterns in relation to the dynamics of collaboration and also to the complex principles that lie behind this dynamic. This chapter is structured in two parts following the other

analytical chapters. First, it gives an overview of the mechanisms that explain the emergence of collective properties in the systems studied. Here the mechanisms examined are: gap formation and niche opportunity, the emergence of inter-connectivity, the influence of path-dependence and historicity in the systems' dynamics, co-evolutionary dynamics, inter-sector partnerships as a poised state, properties of the complex regime (resilience and robustness), emergence as a dynamical construct and a phase transition and self-organised criticality. The second part explores the similarities and differences elements from a micro level or agent perspective. In this section, the elements discussed are the agents' specialisation process, the agents' distribution in the system network, and the influence of the institutional background in the fitness distribution.

A final chapter, the conclusion, summarises the main arguments and insights from each chapter. This section also examines the answers that the research outcomes provide to the research questions. Additionally, unexpected outcomes from this research relevant to a better understanding of the former insights and complex social behaviour are also presented. This section also analyses the applicability and limitations of complex dynamical systems theory as an explanatory framework for studying the dynamics of social change such as inter-sector collaboration processes. Finally, the main practical implications of this research approach and research work and lines for future research are noted.

Chapter 2

Complexity Theory

Introduction

No one really knows how a community of social entities - such as ants, termites, and human beings - come together to collectively build an elaborate structure that increases the probability of survival for the community as a whole. Equally unknown is how the intricate machinery of the immune system fights disease; how a group of cells organises itself to be an eye or a brain; how independent members of an economy, each working chiefly for his/her own gain produce complex but structured global markets; or, most mysteriously, how the phenomena we call 'intelligence' and 'consciousness' emerge from non-intelligent, non-conscious material substrates (Mitchell 2009).

These topics are the focus of the interdisciplinary field of research known as complexity theory. This theory seeks to explain complex systems - how large numbers of relatively simpler entities organise themselves without the benefit of any central controller into a collective whole that uses information, creates patterns and, in some cases, evolves and learns (Kauffman 1995; Castellani and Hafferty 2009; Mitchell 2009). According to Mitchell (2009: 4), "the word *complex* comes from the Latin root *plectere*: to weave, entwine". The concept of *system* is defined by Buckley (1998: 35) as "a complex of elements or components directly or indirectly related in a network of interrelations of various kinds, such that it constitutes a dynamic whole with emergent properties". In complex systems, many simple parts are irreducibly entwined, and the field of complexity is itself an entwining of many different fields (Lewin 1999: Waldrop 1992, Mitchell 2009).

While there is not a unified definition of a complex system, Melanie Mitchell, author of the first effort to encompass the main ideas of complexity in her book 'Complexity: A Guided Tour' (2009: 13), proposes a definition that encloses all the

components included in other definitions: “a complex system is a system in which large networks of components with no central control and simple rules operation give rise to complex collective behaviour, sophisticated information processing, and adaptation via learning or evolution”.

Literature in this field sometimes uses indistinctively the terms complex *adaptive* systems, complex *evolving* system or complex *co-evolving* systems to refer to the same system. This indicates the strategy that the system plays in the response to environmental changes: adaptation, evolution and co-evolution (Mitchell 2009, Castellani and Hafferty 2009). There are other kinds of complex systems that do not show any particular strategy in response to their environment, such as hurricane or turbulent rushing rivers. These systems are called *non-adaptive complex systems*. These kinds of systems are not the focus of this research; hence their functioning is not considered in this chapter.

This range of names to refer to complex systems reflects the range of concepts and terms that encompass complexity theory. In fact, as emphasised by several authors, there is not one single theory of complexity but several theories arising from various disciplines of natural sciences studying complex systems, such as physics, biology, mathematics, chemistry (Castellani and Hafferty 2009, Mitleton-Kelly 2003a, Sawyer 2005). The main core ideas of the so-called complexity theory stems mainly from the work undertaken over the past five decades by scientists associated with the Santa Fe Institute (Santa Fe, New Mexico, USA) and particularly that of Stuart Kauffman (1993, 1995, 2000), John Holland (1995, 1998), Chris Langton (Waldrop 1992) and Murray Gell-Mann (1994) on complex adaptive systems. Although this is considered the birthplace of complexity science (Lewin 1992; Waldrop 1992), the ideas of complexity theory build upon the former development of general system theory and cybernetics, back in the 1940s and 1950s (for a map with the chronology of complexity science see Castellani and Hafferty 2009).

Scholars from Europe, however, have also made a significant contribution to the development of complexity theory. The main example of this is the Nobel Prize work of Ilya Prigogine on dissipative structures; Humberto Maturana, Francisco Varela and Niklaus Luhmann’s (1995) research on autopoeisis; the work of Gleick (1987) on chaos theory; Brian Arthur’s contribution to economics (1994, 1997, 2013) and many works in the field of modelling and computer simulation. These names

illustrate the role that not just scientists from the natural sciences play, but also that of those from the social sciences and the important role that they have played in the advance of complexity science, as explained below in this chapter. This also reflects the increasing number of scholars that consider the advances of complex dynamic system theory as a well-suited theoretical framework for sociological explanation (Luhmann 1995; Maturana and Varela 1980; Sawyer 2005; Mitleton-Kelly 2003a; Allen 1998; Castellani and Hafferty 2009; Marion, 1999).

The general picture of inter-sector partnerships (ISPs) drawn in the Introduction shows how these collaborative processes exhibit features of complex systems, as per the evidence provided by the theories traditionally used for their study. These theories, however, have failed not just to address the study of ISPs considering all these variables together and their interactions, but also to take into account the own nature of society as a complex system and how its dynamic shapes these collaborative processes. This research seeks to advance the use of complexity theory in the field of social science by considering society as a complex dynamical system and using complex dynamic system theory and other related ideas from the field of complexity theory, to study the construction and evolution process of inter-sector partnerships.

To achieve this goal, this chapter outlines first the history of complexity theory in social science. Secondly it reviews the major criticisms made of this transfer of ideas and the main considerations that this research has included to overcome such criticisms. A third section frames the main ideas of so called '*Complex Adaptive Systems Theory'* or '*Complex Dynamic Systems Theory'*, mainly through the work of its main theoretical author, Stuart Kauffman (1993, 1995, 2000). This section also introduces other ideas stemming from the field of complexity theory that were relevant to explain the complex behaviour observed in the two case studies that comprise this research. A final section presents the most comprehensive compilation of properties common to all complex adaptive systems that also support the analysis of the empirical data as presented in the three analytical chapters of this research (Chapter 5, 7 and 8).

2.1. Complexity Theory and Social Sciences

According to Castellani and Hafferty "…since its formal emergence in the mid-1800s [Western Sociology] and, more specifically, since its establishment within the modern universities of Europe and North America at the turn of the previous century, the major challenge of sociology has been complexity" (Baehr 2002; Collins 1994; Merton 1968, 1996; Coser 1977, cited in Castellani and Hafferty 2009: 4). Other authors even make the remark that the study of society is the study of complexity (Buckley 1998; Luhmann 1995; Urry 2003, 2005).

The changes brought by the industrial revolution from the mid-1700s to early 1900s meant that the western world has been transformed into a type of society that did not exist previously (Castells, 2011; Castellani and Hafferty 2009; Urry, 2003). Castellani and Hafferty (2009) note how during this period urban centres and cities emerged, massive waves of emigration and immigration took place throughout Europe and North America; multiple ethnicities were forced to interact with one another; major innovations in technology, science and philosophy took place; democratic governments of various forms emerged, as did new forms of economic, political and cultural inequality, domination, oppressions, conflict, and struggle (Hunt *et al.* 2004; McKay *et al.* 2003; Wiesner *et al.* 2003, cited in Castellani and Hafferty 2009: 5).

Various authors agree that the evolution of systems ideas in sociology[8] has gone through three major stages (Sawyer 2005; Castellani and Hafferty 2009; Mitleton-Kelly 2003a). The first wave of social systems theory is Parson's structural functionalism. The second wave is derived from the general systems theory of the 1960s through to the 1980s. The third wave is based on the complex dynamic systems theory developed in the 1990s.

2.1.1. First Wave

Many scholars in the social sciences associate systems theory with Talcott Parson's mid-century idea of structural functionalism (Castellani and Hafferty 2009; Sawyer

[8] The term sociology is used in this context to refer to the heterogeneous network of scholars, theories, concepts, methods, intellectual traditions and schools of thought generally associated with the study of society.

2005). Parson's influential structural-functional theory of society was famously based on systems concepts derived from cybernetics. Cybernetics was a popular interdisciplinary effort that became the model for all contemporary systems theory as it searched to understand "control and communication in the animal and the machine" (Wiener 1948, cited in Sawyer 2005: 12). Modern complexity scientists such as Stuart Kauffman (1993: 76) consider that complexity started with the "cybernetics revolution". Parsons was the first, however, to apply the systems theory ideas stemming from cybernetics to sociology, hence his theory is referred to as the first wave of sociological system thinking (Castellani and Hafferty 2009; Sawyer 2005).

Parson considered systems as structures therefore he assumed they were hierarchical and decompose entities. For that author, the properties and behaviour of the component parts of social systems were intrinsically determined despite the fact that they interact (Sawyer 2005). Functional localisability was another assumption that Parsons' theory made of social systems. As Parson states "there is the same order of relationship between roles and functions relative to the system in social systems, as there is between organs and functions relative to organism" (Parsons 1951: 190-197).

According to Castellani and Hafferty (2009) and Sawyer (2005) Parson's structural functionalism received strong criticism, mainly in relation to the lack of explanatory power of Parsons' ideas; his highly conservative and overly normative proposals; his ignorance of Karl Marx and his misinterpretation of the concepts of many European sociologists. These criticisms led structural functionalism to a cul-de-sac in the history of systems theory in sociology. Nevertheless, key concepts from Parson remain important nowadays.

2.1.2. Second Wave

A second wave of systems thinking in sociology emerged in the 1960s and 1970s with the advance of cybernetics and related systems theories. This wave's major hallmarks are the development of general system theory (GST) and chaos theory during the 1980s and 1990s. Literature agrees on the influence that these new theoretical frameworks had on the development of artificial intelligence, game theory, the internet and informatics, systems biology, machine intelligence, and new advances in

modern mathematics (Castellani and Hafferty 2009; Byrne 2002; Kauffman 1993; Sawyer 2005; Urry 2003).

This wave is considered as the period when scientists such as Cowan, Gell-Man, Prigogine and E.O.Wilson – who, building on mathematics, physics and biology during the 1970s and 1980s - advanced the tools from cybernetics and systems sciences to study society as a complex system. So the name of this network of scholars, as we know, is complexity science (Lewin 1992; Waldrop 1992; Capra 1996; Castellani and Hafferty 2009). Sawyer (2005) explains how second wave advocates, both in GST and chaos theory, searched for the universal principles and laws that would apply to systems at any level of analysis (Bertalanffy 1968; Miller 1978). This same approach is present with many scholars who define complexity as the search for the algorithms and principles displayed in nature and present across many levels of organisation.

Buckley's book *Sociology and Modern System Theory*, published in 1967, represents the first major influence of system thinking on sociology in this second wave. His major innovation was to introduce the ideas of dynamics and change as a counterbalance to the first wave's ideas of structure and stability. This work was followed by a number of influential sociologists who, during this second wave, begun to integrate the tools of complexity science into their work. Examples of this include Immanuel Wallerstein (2005) who integrated the work of Prigogine into his world systems theory; Andrew Abbott (2001) who applied fractals, self-similarity and chaos to the structure and dynamics of social science; Manuel Castells (2000) who developed a theory of globalisation using the concept of network; and Niklas Luhmann (1995), who built upon the concept of 'autopoesis' developed in biology by Humberto Maturana and Francisco Varela (1980), developed one the best-known second-wave social systems theories (Castellani and Hafferty 2009; Sawyer 2005).

In the late 1990s, a community of scholars spread out over Europe and North America created what is called as SACS - *Sociology and Complexity Science*. These scholars, initially within the mainstream of sociology, started to apply systems thinking and its naturalistic views: cybernetics, systems science, evolutionism, organicism, and so on. Urry (2005) refers to this transfer of ideas as the *complexity turn* in sociology. According to Castellani and Hafferty (2009: 27), "the consequence of this effort was that systems thinking in sociology became an island of intellectual

inquiry". In the late 1990s, the areas of work of SACS included (1) computational sociology; (2) complex social network analysis; (3) sociocybernetics; (4) the Luhmann School of Complexity (LSC); and (5) the reconstruction of a post-disciplinary sociology grounded in complexity science, which is called the *British-based school of Complexity* (BBC) (Castellani and Hafferty 2009).

This second wave, however, was not considered an unified body of work but rather "a scientific amalgam, an accretion of ideas" (Thritt 1999, cited in Sawyer 2005: 15). Nevertheless, cybernetics and systems science were criticised for many of the same issues as Parsons (Capra 1996; Klir 2001). According to Sawyer (2005), one of the main criticisms was that

> "complexity theory has not incorporated the unique properties of human social systems; rather, models are develop for systems composed of much simpler entities (neurons in the brain, ants in colonies) and are then applied by analogy to social systems, with the explicit assumption that social systems are not qualitatively different from these simpler complex systems" (p.19).

The main reasons that Sawyer gives for explaining this criticism is that this approach has been nurtured by the fact that (1) the Santa Fe Institute main areas of research are biology, physics and mathematics; and (2) many of the economists and political scientists affiliated with this institute have not participated in the development of the second wave of systems theories. This has been accused of and refused by contemporary sociologists for being a modern variant of nineteenth century organicism[9].

These criticisms, together with the fact that the contribution of social science to this second-wave of systems theory has come from a methodologically individualist social scientist, has left severe weaknesses in the application to sociology of the new system theory ideas (Sawyer 2005). Castellani and Hafferty (2009) also explains how the way sociologists dealt with criticisms by abandoning the ideas being criticised - that this author refers as "do away", as opposed to natural scientists who tend to face the criticisms, an idea that this author refers as "staying

[9] Organicism, as explained by Sawyer (2005: 20), "was the school of thought that proposed that society as analogous to a biological organism (proponents of this view were Paul von Lilienfeld, Albert Schäffle, and Herbert Spencer)".

with them" - resulted in the natural sciences being at the forefront of complexity science (Casti 1999; Cilliers 1998, cited in Castellani and Hafferty 2009: 16).

Whereas second wave social systems theory drew on chaos theory, the third wave builds upon complex adaptive system theory (Sawyer 2005). In some circles, particularly in social sciences, this theory is sometimes referred to as 'complexity theory', although this term conflates with second and third waves and elides important methodological distinctions (Sawyer 2005).

2.1.3. Third Wave

According to Sawyer (2005), second wave theorists were distinguished from the first wave by their emphasis on dynamics drawing on the ideas of Maturana and Varela (1980) of autopoeisis, *nonlinearity*, *attractor* and *emergence*, inspired by the chaos theory of the 1980s, and, *open systems* and *far-from-equilibrium*, drawing from Ilya Prigogine's work on dissipative structures. However, second-wave scientists were less successful at representing adaptation and explanation of the detailed evolution of the process.

Third wave theorists built upon these ideas of dynamic systems - systems that are in constant change over time. Furthermore, while the literature agrees that complexity theory (second-wave) has provided many useful metaphors, it has not helped social scientists to understand these micro-social interactions and how they contribute to social emergence. Third-wave systems theorists are, in contrast, fundamentally concerned with emergence, component interactions, and relations between levels; and many of them examine the unique features of human social systems, such as Sawyer, who argues that "societies are uniquely complex systems because of the complex properties of human language" (Sawyer 2005: 23). This third wave is known as 'complex adaptive systems theory' or 'complex dynamical systems theory' and is misleadingly referred as complexity theory (Sawyer 2005; Kauffman 1993).

In sociology, it is widely acknowledged that social theory must be centrally concerned with process and mechanisms (Abbot 1995; Giddens 1984; Archer 1995; Hedström and Swedberg 1998, cited in Sawyer 2005). Nonetheless, Sawyer (2005) states that

> "sociologists have found it difficult to develop an adequate theory for capturing social processes, and even more difficult has been the empirical study of social processes. As a result much of modern sociology neglects process" (Cederman 2002; Gilbert 1997) (p. 23).

Many authors agree that *complex adaptive system theory* or *complex dynamic system theory*[10] can provide tools for exploring social processes (Arthur 1997; Kauffman 1993, 1995; Holland 1995; Stacey 1995, 1996, 2003, 2007; Mitleton-Kelly 2003a, 2003c; Sawyer 2005). Economists have been the social scientists most enamoured with complex system thinking and the study of social systems. An example of this is Waldrop (1992), from the Santa Fe Institute, who has been applying dynamic systems theory to the study of social system since the late 1980s. In the field of economists, another reference is Brian Arthur (also a Santa Fe Institute member) who has created a new research stream away from neoclassical economics based on the application of a complex dynamical systems approach to the analysis of economic behaviour. From this approach, Arthur coined the term 'complexity economics' (2013). Organisational theory is another field of social science where complex system thinking has had a profound influence. Scientists such as Stacey (1996, 2007), McKelvey (2002) and Mitleton-Kelly (2003c) are exploring organisational dynamics as complex evolving systems providing a new theoretical framework and tools for strategic management. Governance Theory is another sociological domain where the ideas of complexity theory are producing a better understanding of new forms of government (Loorbach 2007; Ronald *et al.* 2005). Finally, Development studies are another field in the social arena where complex system thinking is making a fundamental conceptual shift. Here the most prominent works come from the STEPS Centre, located in Sussex University (UK) under the direction of Melissa Leach (Leach *et al.* 2010). Other relevant works in this field include: Ramalingam *et al.* 2009; Dorcas *et al.* 2000).

On the topic of collaboration, in the field of complexity science, the most prominent research has been undertaken by Robert Axelrod (1997), who developed an agent-based model of competition and cooperation. Similarly, Axelrod's work uses modelling tools, third-wave methodology, and a different set of concepts (Game

[10] The reference to 'complex dynamical systems' is because these systems change over time; and 'complex adaptive systems is because these systems respond to their environment, as explained above. The difference lies in the type of response.

Theory), to investigate the prisoner's dilemma. However, although the prisoner's dilemma offers interesting insights for this research as it investigates the conditions under which collaboration can emerge, the use of 'limited choice' of agents' behaviour (defeat or cooperate) in line with game theory, doesn't account for the conditions present in the case studies investigated in this research.

2.1.4. Criticism to this Theoretical Transfer

The transfer of the ideas from complexity science to the social domain is not free from criticism, as noted above. The major criticisms concern the fact that complex dynamic systems theory emerges from chaos theory. The mathematical formalism of chaos theory is considered exceedingly difficult to apply to social sciences and it does not explore the emergence process of the micro-macro link (Sawyer 2005). Stacey (2007: 222) also explains that, "chaos theory is a theory of deterministic systems but human actions is not deterministic".

Another major criticism is in relation to the transfer of ideas stemming from cybernetic agents to human agents, a discussion that arose during the second wave of systemic thinking in sociology. Stacey (2007: 229-231) analyses the transfer of the ideas of complexity science to the study of organisational behaviour. This author points out four major questions for this transfer: 1) the nature of interactions; 2) the nature of human beings; 3) methodology and paradox and 4) focusing attention. Stacey (2007) discusses these four questions in the light of various applications of complexity science to study organisation dynamics, using both quantitative and qualitative methods (Marion 1999; Allen 1998; Morgan 1997; Thietart and Forgues 1995; Sanders 1998; Eisenhardt and Brown 1998; Pascale *et al.* 2000, and others cited in Stacey 2007: 213-227); and makes a comparison between the use these authors make of complexity theory with the orthodox scientific paradigm.

To overcome these two major criticisms, this research includes three major innovations. First, complexity theory is used as an experimental theoretical framework to explain empirical evidence or processes. This deductive approach differs from the inductive tools of modelling, traditionally used in complexity science were the programmer introduces the 'simple rules' for the cybernetic agents to reproduce a specific behaviour. This deductive approach of real life processes,

provided it is a suitable framework, enables us to validate the applicability of this theoretical transfer at the same time that it would contribute to advance the knowledge of complex social systems behaviour and their dynamics of change.

A second differential element of this transfer of knowledge is in relation to the focus and level of investigations of this work. As the object of study for this work is the construction process of a specific social dynamic (inter-sector collaborations), its focus is the emergent, dynamical and evolving behaviour of these processes. However, these collective processes stem from the interaction of social agents, such as social sectors, organisations and individuals. The level of analysis of this work is therefore fundamentally different from other works as it considers the dynamics occurring both at a collective or macro level and at a micro or agent level, and explains the intertwined relationship between these two levels of analysis. Also differentially, the analysis at an agent level is concerned with the attributes[11], principles and mechanisms, and contextual elements that influence the specific behaviour of heterogeneous agents in relation to the dynamic of study. In other words, the focus of this research is the dynamics of social change, which moves away from the explanation of human behaviour through the narrow lens of the properties and behaviour of other simpler entities studied in complexity sciences, such as neurons or ants, as occurred before.

A third and final element that this research includes to overcome the difficulties of the mathematical formalism and deterministic approach of chaos theory, is the use of a qualitative approach and strategy. This approach has a fundamental difference from other uses of complexity theory as an explanatory framework as it attends a double objective: 1) to borrow the ideas of complexity theory as an analogy to advance the production of knowledge specific to the dynamics and behaviour of social systems; and 2) to transfer the ideas stemming from complexity theory to the practice of social systems from the new knowledge produced or available, and not directly from the models from where they were produced without them being validated and reviewed in the light of the particular features of complex system and human agents (Stacey, 2007). The next chapter includes further explanation of the elements that this research has considered at a methodological level

[11] Holland (1998) refers to attributes as the internal structures that shape the agent behaviour.

to attend to this new notion of studying social dynamics from a complexity theory perspective.

This strategy is consistent with Stacey's (2007) analysis of the transfer of ideas from complexity theory to organisational theory. This author states that "one can, therefore, explore the transfer of abstract relationships from the model domain (from complexity theory) to the human domain and this require some kind of interpretation that adds human attributes" (Stacey 2007: 256). As main attributes, this author considers the evolving nature of human agents, and their capacity to perceive and articulate desired macro level scenarios, or 'population-wide patterns' as Stacey refers to this level of analysis. He also argues that this transfer is possible as the object of study at the macro level is the emergent result of agents' interactions, where the diversity of agents and their creativity are the key variables for novelty and order creation. Therefore, according to this author, studying social systems composed of human agents such as organisations, the notion of agents being autonomous independent individuals of orthodox approaches needs to be shifted by the notion of agents as being "fundamentally and inescapably interdependent"; and that, "individuals are formed by social interactions as they form such social interactions at the same time" (Stacey 2007: 238). For this author, the distinction between physiology and sociology is dissolved.

Based on this discussion on the applicability of complexity science to social sciences, this research proposes to use complexity theory to explain a specific pattern of agents' interrelations (inter-sector partnerships) and the specific attributes that human agents display while interacting individually or within organisations, in relation to this particular pattern. The following sections present the main ideas and concepts from the science of complexity and so set up the theoretical framework to analyse the complex dynamics of two empirical processes of inter-sector collaborations.

2.2. Complex Dynamical Systems Theory

Included in the different streams of work of the emergent complexity science presented above is the work of Stuart Kauffman (1993, 1995, 2000) who has compiled the broadest and deepest theoretical explanation of the dynamics of complex co-evolving systems and how these dynamics evolve over time. According to

Kauffman (1993: 175), "the most natural language for describing the behaviour of an integrated system is dynamical system theory".

Kauffman's differential starting point in his research with 'fitness landscapes' is the idea that while evolving, organisms alter their landscape and that of the other species in their ecosystem. This new approach has had profound consequences for science as it transforms the idea of evolution into co-evolution, and unveils the reproductive mechanism of a cell or a colony as 'propagating organisation' (Kauffman 1993, 2000). This research also led him to a major discovery in the new science of complexity, the discovery of the 'edge of chaos' (Lewin 1999), and the role that selection plays in systems' evolution. He explains: "the target that selection achieves is complex systems poised on the complex regime on the boundary between order and chaos. Such systems, it begins to appear, harbour behaviour which is the most flexible, complex, and adaptable" (Kauffman 1993: 30). Kauffman's research also revealed a universal law in biology relating the mutual implications and interpretations between self-organisation and selection, as he discovers that some of the sources of order lie outside selection. He states: "many of the highly ordered properties of genetic regulatory systems are spontaneous, self-organised features of complex control systems which requires almost no selection at all" (Kauffman 1993: 408). This reflects Kauffman's main argument that self-organisation is the second-ordering principle, and why he attaches greater importance to it than to random mutation or natural selection (Stacey 2007).

These ideas have no statement in modern physics and biology science therefore they challenge and complete former ideas of natural selection and evolutionary biology and also have notable implications for other fields of science such as biotechnology and medicine (Kauffman 1993). This is why Kauffman' findings on *The Origins of Order* (1993) represent the cornerstone of the emergent complexity theory and are considered the most comprehensive framework for studying dynamical processes and the evolution of this dynamics (Stacey 1995, 2000; Castellani and Hafferty 2009; Lewin 1999)

This section explores the mechanisms[12] that give rise to the creation of order, its evolution and how the change it introduces percolates across the system lattice. This aims at setting up the conceptual framework and language to analyse the complex dynamics presented in the two case studies of this research. For this, Kauffman's main ideas in relation to these mechanisms are reviewed and completed with the contributions of the main authors in the field. As a starting point the relationship between the system structure and dynamic is introduced.

2.2.1. The Emergence of Spontaneous Behaviour

Kauffman's (1993, 1995) investigations into the emergence of spontaneously ordered behaviour in parallel-processing systems form the crucial ideas that serve to explain the emergence of collaborative work from the multiple interactions of agents from different sectors (inter-sector interactions). However, before exploring the various behaviours or regimes these kinds of system can exhibit, the two main mechanisms that account for the emergence of spontaneous order are briefly examined: self-organisation and emergence.

Self-Organisation:

A fundamental search in the history of science has been in relation to what motivates agents to interact and to create new ways of organisation. Cells interact with cells to create organisms; organisms interact with organisms to create ecosystems; social agents interact to create societies and economies (Kauffman 1993, 1995; Camazine *et al.* 2003; Arthur 1997, 2003; De Wolf and Holvoet 2004; Levin 2005, Corning 1995). For more than a century, however, the only theory that science has offered to explain how this order arose is natural selection (Kauffman 1993, 1995). Complexity theorists consider this view as incomplete: "evolution may be impossible without the privilege of working with systems that already exhibit internal order" (Kauffman 1995: 185). Although natural selection is important, another source - *self-organisation* - is the root source of order (Kauffman 1993, 1995).

[12] This work uses the term 'mechanism' as used by Holland (1998: 6) beyond the mechanical understanding of the term but as "the mechanisms for mediating interactions".

Whereas there is not a unified definition of self-organisation, there is a consensus that the term refers to a wide range of pattern-formation processes both in physical and biological systems (Camazine *et al.* 2003; Kauffman 1993, 1995; Levin 2005). Camazine *et al.* (2003: 8) provide the following definition: "Self-organisation is a process in which pattern at a global level of a system emerges solely from numerous interactions among the lower-level components of the system". A basic feature of self-organisation reflected in this definition is that pattern formation occurs through interactions internal to the system, without external direction, manipulation, or control. Hence, the nature of this mechanism is known to be spontaneous or autocatalytic.

For these internal interactions to occur, however, a critical diversity of agents must be reached in the system. As Kauffman (1995: 64) explains: "as a threshold diversity is crossed, a giant web of catalyzed reactions crystallizes in a phase transition. The catalyzed reaction sub-graph goes from having many disconnected tiny components to having a giant component and some smaller, isolated components".

In the context of this research, self-organisation enables us to explain how the interaction between participants in the two cases studies go through a phase transition - from individual behaviour to collective behaviour. This reflects Kauffman's above idea of a transition from tiny disconnected components to a giant component with some smaller isolated ones. Therefore, while self-organisation is the internal source of spontaneous behaviour that allows this work to explain a core process behind the construction of inter-sector collaborations, the following section explores the mechanism that drives this force to the actual creation of new order: emergence.

Emergence:

Emergence is known as the raising of novel and coherent structures, patterns, and properties from the interaction of the system component parts (Holland 1998; Goldstein 1999; Halley *et al.* 2008; Hodgson 2000; Levin 2005; Mitleton-Kelly 2007). Since this phenomenon is neither reducible to, nor predictable from the properties of individual system components, emergence is described as a property of the system (Halley and Winkler 2008; Goldstein 1999; Holland 1998; Camazine 2003).

Goldstein (1999: 49) states, however, that "emergent phenomena appears differently in different types of system, e.g. whether they occur in physical systems or in computer simulations, they share certain interrelated, common properties that identify them as emergent". These properties are: 1) that emergent patterns present features that are not previously observed in the complex system under observation, and hence show radical novelty. This novelty is the source of the claim that emergence is neither predictable nor deducible from the lower or micro-level components; 2) that emergent patterns show coherence or correlation as they appear as integrated wholes that tend to maintain some sense of identity over time; 3) that emergence phenomena occur at a macro level in contrast to the micro level locus of their component parts; 4) that emergence is a dynamical construct and is associated with the arising of new attractors[13] in dynamical systems; and finally 5) that Goldstein states that emergent phenomena are recognisable and different to some degree from previous emergent phenomena.

These two sections illustrate how emergence is the process that creates new order, emergent properties, qualities, patterns and structures as they arise from the spontaneous interactions of individual elements (Kauffman 1993, 1995; Holland 1995, 1998; Mitleton-Kelly 2003a; Stacey 2005). At the same time, Goldstein's (1999) properties of emergence across different kinds of systems provide a framework to identify what is an emergent phenomenon, and to distinguish it from self-organisation processes in the social systems of study.

For Kauffman (1993, 1995), the core idea of emergence lies behind the question as to how an autocatalytic set[14] can be created. The core of his theory is that "as the ratio of reactions to polymers increases, it must eventually become large enough that the number of red catalyzed reactions [type of reaction] is larger than the number of polymers whose formation requires catalysis" (1993: 309). He goes on to explain: "as the ratio of *catalyzed* [Kauffman's italics] reactions to polymers

[13] An attractor is a set towards which a variable, moving according to the dictates of a dynamical system, evolves over time (Ruelle 1981, cited in Bak 1988).

[14] An autocatalytic set "is a set of self-consistent set of catalyzed balls [Kauffman's uses the term balls in the sense of clusters] and has the property that, for the proper substrates offered to each ball and for the proper products of the corresponding reaction, the union of substrates and products catalyzes the same set of balls in task space" (Kauffman 1993: 333).

increases, some threshold will be reached when a connected reflexively autocatalytic set of transformations will "crystallize" (1993: 309). Beyond this threshold, Kauffman argues that the probability that a subsystem of the polymers exists becomes very high. In short, he claims that almost any sufficiently complex set of catalytic polymers will be expected to be collectively autocatalytic.

These ideas provide a framework to explain first, the process which led the inter-sector collaborations studied to 'crystallise' in some kind of collective agreement, i. e. a project or institution, for example, the creation of the Mandú Alliance in Brazil's case study or the FONAG (Fund for the Preservation of Water Resources) in Ecuador's case study. Secondly, it explains why this collective autocatalytic process led to different outcomes at a collective or macro level in the cases studied. This is why while in the Brazilian case study the multi-stakeholder process led to the creation of the Mandú Alliance, in the Quito case, a collective agreement was not reached. In the analytical chapters (5, 7 and 8), this work argues that, as Kauffman explains, as the number of effective interactions (reactions) is larger than the number of agents (polymers) in the alliance example, hence, a critical threshold value is crossed for this 'crystallisation' or collective outcome to emerge: the Mandú Alliance. Finally, these ideas allow an explanation of why and how inter-sector collaborations endure and evolve over time, as further discussed below.

Going further in the exploration of the autocatalytic processes, Kauffman (1993) explains that this process of increased reactions between metabolities'[15] interactions reflects a phase transition between two possible regimes of a system: subcritical and supracritical. The subcritical regime is the one in which polymer catalysis of reactions that form polymers from some initial food set of monomers and small polymers can increase to produce only a finite variety of polymers. In contrast, in the supracritical regime, polymer catalysis of the formation of polymers from an initial food set can increase to produce an infinite variety of polymers. This phase transition is characterised then by two parameters: the probability of catalysis, *P*, and the complexity of the food set. Kauffman's (1993) results show that the critical

[15] Metabolites are the intermediates and products of metabolism. The term *metabolite* is usually restricted to small molecules. Metabolites have various functions, including fuel, structure, signaling, stimulatory and inhibitory effects on enzymes, catalytic activity of their own, defense, and interactions with other organisms (Demain, 1980).

number of maintained food species scales inversely as the square root of the probability of catalysis. That is,

> "(1) that connected metabolisms emerge because the ratio of number of reactions among metabolites to the number of metabolites present increases as the number of atoms per metabolite increases and (2) that the vast number of reactions constitute a target web to be catalyzed by potentially catalytic polymers" (p. 354).

When this ratio is low, a few reactions occur per number of polymers (metabolites), so more points are isolated and a few pairs are connected (referring to the graph (network) representation of metabolites as points). As the ratio increases, the sizes of connected components grow larger and their numbers decrease as small components become connected to larger ones. Therefore, the transition from a supracritical to subcritical system yields similar typically average connectivity properties (Kauffman 1993: 353). The connectivity requirements allowing an autocatalytic set of polymers to exist are that each member of the set must be catalysed by at least one member of the subsystem (set), hence they are autocatalytic and would reproduce collectively.

In the context of this research, these ideas provide again a conceptual framework to test and advance their applicability in complex social systems, as it is the existence of two kinds of regimes or behaviours and the variables that determine this phase transition. This research argues that these two types of behaviour are observed in the cases studied, referred as individual and collective behaviour; and how these same variables, together with other more specific present in the system studied, account for explaining a phase transition from individual to collective behaviour, in collaborative processes.

To understand this graph representation referred to by Kauffman above, it is important to note that a network is the underlying structure for the interaction between species (Albert and Barabási 2002; Bartolozzi *et al.* 2006; Kauffman 1993, 1995). By adopting this type of structure each species or agent within a system has a different boundary value for the global fitness, since $0 \leq Fi \leq$ ki (Bartolozzi *et al.* 2006). This inequality has a straightforward interpretation which is fundamental to analysing how inter-sector collaborations increase the resilience capacity of their participants and communities: species with a large number of connections will have a higher barrier

against environmental changes because they can rely on numerous resources. Furthermore, this illustrates an elementary feature for the analysis of complex dynamical systems, as changes in the system's structure lead to changes in the system's behaviour as also observed and analysed in both case studies (Kauffman 1993, 1995; Holland 1995, 1998)

Finally, Kauffman (1993) states that for a set of protoenzymes (in his example) to increase its catalytic efficiency, the autocatalytic collection of catalysts should simultaneously evolve with increased specificity. This specificity, in turn, will (ultimately) transform a supracritical autocatalytic set into a subcritical one. This means that there is a correlation between the specificity and the velocity with which a protoenzyme catalyses a reaction. Based on this assumption, the subsystem that would grow fastest would be that which simultaneously maintains the requirement of catalytic closure and which has the most highly specific protoenzymes in the system. Kacser and Beeby (1984, cited in Kauffman, 1993: 335) also proved this same evidence on thermodynamic grounds.

According to this hypothesis, in growing autocatalytic systems that start from a supracritical regime, natural selection should lead to more focused (specific) systems with increased specificity of the mutually-necessary connected cycles of enzymes. As this focusing or specialisation process occurs, side reactions not needed for catalytic closure and reproduction of the given food set are simultaneously being trimmed away. To sustain these hypotheses, Kauffman explores the work done in immune network theory (Jerne 1974, 1984; Dwyer *et al.* 1988; Hoffman *et al.* 1988, all cited in Kauffman 1993).

The implications of these ideas for this research are threefold. First, this proves that "the achievement of catalytic closure required for the creation of new order or self-reproduction is an emergent collective property in any sufficient complex set of catalytic polymers" (Kauffman 1993: 310). Furthermore, since the possession of a genome capable of heritable modifications is considered by many to be the hallmark of Darwinian evolution, Kauffman's investigation of the capacity of autocatalytic sets to evolve without a genome are of general importance to understanding not just the construction process of inter-sector partnerships but also its evolution and influence on the overall system's dynamic and structure. Secondly, Kauffman's ideas set the framework for understanding the existence of different

regimes in the systems of study and to explore the conditions (variables) that enable them to reach or not a collective agreement (catalytic closure), as discussed above. Thirdly, the specialisation process that underlines the transition phase from supracritical to subcritical behaviour provides an analogy to explain the specialisation process, that at a micro level social agents from different sectors face to engage in inter-sector collaborations, as discussed in the second sections of the analytical chapters (5, 7 and 8).

The next section examines the various regimes or behaviours a system can exhibit according to the underlying nature of these interactions.

2.2.2. Types of Complex Behaviour

Building upon the previous ideas behind the formation of autocatalytic sets, Kauffman (1993) elucidates three broad regimes that a parallel-processing system can exhibit: ordered, complex and chaotic. He explains that the ordered regime is characterised by the creation of a large connected set of system components (agents) that is poised around fixed activities. This set percolates (spans) across the system leaving behind isolated non-poised set of agents free to vary activities in complex ways. The chaotic regime, Kauffman explains, corresponds to the case where the poised set of agents do not percolate across the system, rather, the non-poised ones span the system leaving behind isolated poised sets embedded in a constantly changing environment. Transition back and forth between these two regimes corresponds to a phase transition during which the poised sets begin to melt and the non-poised ones begin to coalesce; this phase-transition region is the complex regime. Kauffman (1993: 30) states "The most complex but controllable behaviour arises in parallel-processing systems poised in this complex regime on the boundary between order and chaos".

For Kauffman (1993), the possibility of a system showing different behaviour reveals the ways in which selection can alter the ruggedness of fitness landscapes[16].

[16] Kauffman borrows the hill-climbing framework, with minor modifications, from Wright (1931, 1932, cited in Kauffman 1993: 33), who introduced the concept of a *space*[16] *of possible* genotypes. For Wright each genotype has a *fitness*, as does any other component of a system. The distribution of fitness values over the space of genotypes constitutes a *fitness*

For this research, the fact that a system can display different regimes enables us (1) to explain the various behaviours observed in the two systems of study; (2) to understand how and why a particular behaviour defines the adaptation and evolution process agents have according to the systems conditions. Chapter 8 argues how this evolution process is determined partly by the influence of selection, as discussed by Kauffman (1993); and (3), to feature the dynamics more likely to be present in the system according to the type of regime, as for instance, capacity to perform complex tasks, to innovate, or for a particular influence (mutation in Kauffman's terms) to percolate throughout the system lattice.

Kauffman explains that networks (systems) in the ordered regime adapt to very smooth landscapes; those in the chaotic regime adapt to very rugged landscapes; and those in the complex regime, near the edge of chaos, adapt to mixed rugged landscapes. In this last complex regime, some mutations[17] cause massive alterations in behaviour, while most cause minor alterations. This mixture provides buffering against large and small deformations in fitness landscapes. From Kauffman's description the conclusion can be drawn that the behaviour of an adaptive[18] population depends on: (1) how mountainous the fitness landscape is; (2) how large the population is; and (3) what its mutation rate is, which moves an individual from one genotype to another in the space. In other words, Kauffman's findings explain how the changes of behaviour in a system are related to the alterations of its structure and dynamics, which he pictures as the ruggedness of a fitness landscape; and how these conditions define the space of possible niches or scenarios to which an agent (species) or a system can evolve.

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landscape. Depending on the distribution of the fitness values, the fitness landscape can be more or less mountainous or rugged.

[17] Mutation is the process by which an individual or its offspring moves to neighbouring points in the space, representing neighbouring genotypes (Kauffman 1993)

[18] Adaptation, in biological terms, is the process whereby an organism fits itself to its environment (Holland 1995: 9). Complex adaptive systems (CAS) are systems composed of interacting agents described in terms of rules. These agents adapt by changing their rules as experience accumulates, therefore adaptation involves learning and other related processes, so that as time passes the organism makes better use of its environment for its own ends.

Based on this evidence, Kauffman (1993) sets a fundamental hypothesis to understand the behaviour of dynamical systems; a complex system selection seeks to achieve a poised stage in the complex boundary between chaos and order. To sustain this, he argues that systems poised in the complex regime appear to harbour behaviour that is the most flexible, complex and adaptable. Further selection at this poised stage would then be unable to avoid the typical features of this poised ensemble, whose generic features would emerge as additional potential universals (attractor) (Kauffman 1993; Ruelle 1981). Another argument is that organisms, which are internally constructed so that they are in the solid regime (orderly regime) but near the edge of chaos, appear to be best able to perform complex tasks and to adapt.

Poised State:

A poised state is a steady state attractor that Kauffman (1993, 1995) also refers to as Nash equilibrium, based on an analogy from game theory. The Nash equilibrium was introduced by Nash (1951) to refer to a combination of actions by a set of agents whereby each agent its state is granted as far as the other agents do not alter their own actions, therefore this action is considered an optimal. In other words, a Nash equilibrium is a local combination of actions or strategies whereby each agent is locally happier as long as other agents do not deviate from their own fixed strategy (Axelrod 1997).

Kauffman's investigation on 'poised state' as point attractor between different possible regimes of a system serves as an analogy for this research when explaining the following questions: (1) Why are social agents involved in multi-stakeholder collaborations?; (2) What are the payoffs agents get from this strategy?; and (3) What is the influence that this strategy - inter-sector partnerships - have in the overall system dynamic? The following sections lay down the concepts and arguments for addressing these questions for each case study in Chapters 5 and 7. A common principle arise from this analysis, a main insight from this research, inter-sector partnerships represent a poised state in the system dynamics (see Chapter 8 for full discussion).

The reason why Kauffman (1993, 1995) borrows this term is because a pure Nash equilibrium[19] assumes that each agent can, at each moment, choose any one of its possible actions. The analogy is then the understanding that such equilibrium is with respect to a search range. Neumman struggled to formulate a version of game theory for evolutionary biology by generalising the idea of a Nash equilibrium so it reformulates the term into evolutionary stable strategy (ESS) (Kauffman 1993, 1995). This concept seems to be more appropriate for the study of complex adaptive systems as it accounts for the interaction between the agents and their context, a main criticism of game theory.

Nash equilibrium, however, does not necessarily mean that "such an equilibrium is particularly good for the players caught in its local sway, either relative to the set of possible alternative equilibria or, more dramatically, relative to possible chaotic flow in the space of actions" (Kauffman 1993: 241). These are cases where, for all players, Nash equilibria is a lower fitness state than alternative behaviours. An example of this is the 'prisoner's dilemma' where the only Nash equilibrium is when both players defect (Axelrod 1997). In this case, collaboration is not an equilibrium state because it pays either player to defect assuming the remaining player continues to collaborate.

Nevertheless, complex theorists have proven that as the ecosystem climbs towards ESS equilibrium or poised state, agents' average fitness increases (Kaufmann 1993, 1995). Based on these ideas Kauffman (1993: 241) asserts "selection attains the system that is poised both internally and collectively, as it optimizes the capacity to evolve thanks to an attractor of the selective dynamics, a generalized 'poised state'". A poised state is, however, just one of two evolutionary options of a system as explained further below. The question to explore now is how a system reaches a poised state and what forces drive the system towards this evolutionary path?

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[19] According to Kauffman (1993: 245) the limitations of the Game Theory models that explore co-evolutionary dynamics are that they have not been built yet to take into account three issues: "the statistical ruggedness of the landscape of the coevolving partners, the richness of couplings of those landscapes, and the implications of those features on co-evolution ".

2.2.3. Co-Evolution: the Meta-Dynamics of Selection and Evolution

Formal and informal types of interactions have been studied in sociology for many years, although the term co-evolution was not used (Scott 1987; McKelvey 2002; Lazaric 2000). McKelvey (2002: 3) proposes the use of co-evolution in the context of organisational studies in a state of "mutual influence"- an idea first coined by Ehrlich and Raven in 1964, since evolutionary processes are reactive and not predictive causal.

In complex adaptive systems (CAS) co-evolution is a key principle, as adaptive agents are constantly adapting to other adaptive agents (Holland 1995; Kauffman 1993, 1995). Therefore, the study of complex system dynamics is understood as the reciprocal influence that agents exert each other as a result of these interactions and that ultimately change the behaviour of the interacting entities (Scott 1987; McKelvey 2002; Mitleton-Kelly 2003a). The self-reinforcing nature of this kind of interaction places co-evolution at the heart of self-organisation processes (Kauffman 1995, Camazine *et al.* 2003).

For Kauffman (1993: 250) co-evolution extends beyond mutualism and symbiosis and appears to be a powerful aspect of biological evolution, as "a coevolving system of species may collectively tune the parameters governing its own co-evolution". For this reason, he considers that co-evolution is the selective metadynamic that leads the coevolving system jointly to a poised state at the edge of chaos. To sustain this argument, Kauffman (1993) explores what the implications are of co-evolution of the ruggedness of fitness landscapes for each of the partners, and how much an adaptive move by one partner deforms the landscapes of others (for a detailed explanation of this mechanism see Kauffman 1993: 237-255).

As a result, Kauffman (1993) states that for coevolving systems just two alternative behaviours can occur as result of co-evolutionary dynamics. First, in the chaotic regime, co-evolution is viewed "as resulting in an unceasing evolutionary process in which all species in a coupled system continue to change" (Kauffman 1993: 242). Here the entire system is chaotic due to the intertwined process of change over time. This model has variously been called the Rat Race (see Rosenzweig 1973, cited in Kauffman 1993: 242) and the Red Queen Hypothesis (Van Valen 1973, cited in Kauffman 1993: 242). A second type, ordered regime, has led to the idea of

evolutionary stable strategies (ESS) (Maynard Smith and Price 1973), "in which the phenotypes of the coevolving species stop changing at a balance which is stable in the sense that any other mixture of phenotypes attempted by any species in the ecosystem will be less fit" (Kauffman 1993: 242). In other words, in this steady state (poised state) the local optimum of each partner is consistent with the local optimum of all the other partners. It is on this basis that Kauffman states that coevolving systems tend to reach a poised state because this state appears to sustain the highest fitness.

Nevertheless, Kauffman's (1993:) bold hypothesis is that

> "just at the boundary between frozen order and chaotic wandering, just at the edge of chaos when some, but not all, partners cease changing and form a percolating frozen component, leaving isolated island of partners that continue to co-evolve and change, the coevolving system reaches a structure where all partners attain the highest expected sustained fitness" (p.31).

This is what he calls the complex regime or edge of chaos. For this to happen, the system's components have tuned the structure of their fitness landscape and couplings to other members so that the entire ecosystem is poised at the edge of chaos. In that sense, Kauffman (1993, 1995) argues that selection and adaptation, through the selective metadynamics of co-evolution, can alter the landscape structure driving the systems to the edge of chaos. According to Kauffman (1993: 30): "The most complex but controllable behaviour arises in parallel-processing systems poised in the complex regime on the boundary between order and chaos".

In summary, Kauffman argues that a system exhibits an ordered regime (ESS), a chaotic regime (Red Queen) or complex regime (edge of chaos) depending on the structure of the fitness landscapes and how readily each is deformed as populations move across. On this last point, the strength of coupling between species is what defines how much the adaptive move by one species will project onto the fitness landscape of the other species and alter them (Kauffman, 1993**,** 1995). These ideas are crucial for this research, as explained above, to understanding (1) the different dynamics behind the various co-evolutionary processes observed in the case studies; (2) the motivations for agents to engage in inter-sector partnerships; and (3) what forces drive these different co-evolutionary processes, because as Kauffman (1993: 280) notes, "the capacity to co-evolve successfully is not trivial". Based on the understanding of these mechanisms or principles that so far account for explaining

complex dynamic systems, the question that needs to be tackled now at this conceptual level to complete the study of the phenomena observed in the case studies is: How does change percolate across the system? For this, the concept of self-organise criticality (SOC) is presented in the following section.

2.2.4. Self-Organised Criticality

Since the discovery of self-organised criticality (SOC) by Bak, Tang and Wisenfeld (BTW) in 1987, the phenomenon has received enormous attention, particularly in the physical realm (Bak *et al.* 1988; Bak 1996; Brunk 2000, 2002; Fronczak *et al.* 2008; Paczuski *et al.* 1996; Frigg 2003). However, this concept has been overlooked by social scientists, mainly because of the difficulty of understanding and transferring these ideas from the physical realm to the social domain (Brunk 2000, 2002; Frigg 2003). Complexity cascades of self-organised criticality take the form of riots, wars, strikes, economic depressions, collapses of government, and a multiple of other well-known events (Arthur 2013; Brunk 2002; Frigg 2003).

In the context of this research, self-organised criticality enables us to explain why and how the systems of study attained or evolved into a poised state (Kauffman 1993) or critical state (Bak *et al.* 1988); how this relates to the creation of a new attractor (collaborative culture) in the dynamic of the systems studied; and to understand what other implications the presence of this principle have for the hosting systems. This section presents the main concepts behind this organising principle or mechanism and discusses the relationship it has with Kauffman's ideas.

Bak *et al*. (1988) argues and demonstrates numerically that dynamical systems with both temporal and spatial degrees of freedom[20], in two or three dimensions, naturally evolve into self-organised critical states. Bak and co-workers (1988: 365) define critical state as the state where the system "is barely stable with respect to further perturbations". By self-organised they mean that, "the systems evolve naturally towards a *critical state* (referred author italics), with no intrinsic time or length scale" (Bak *et al.* 1988: 364); this is, without detailed specification of the initial conditions. It is in this sense that these authors also refer to a critical state: "as

[20] In physical systems the 'degrees of freedom' refers to the dimensions of a phase space, however, such a feature is also common in biological and social systems as well as in physical systems (Bak, 1988).

an attractor to the dynamics" (Bak *et al.* 1988: 365). They carry on explaining that: "the emergence of self-organised critical state provides the connection between nonlinear dynamics, the appearance of spatial self-similarity, and 1/*f* noise in a natural and robust way" (Bak *et al.* 1988: 364). Interestingly, Kauffman refers to this critical state as a poised state (1993, 1995).

System seeks a critical state in order to show robustness to small changes, which in physical systems are referred to as 'noise' (Bak *et al.* 1988; Fronczak 2008). This is the reason behind Bak *et al.*'s description of critical state as an attractor of the dynamics and where systems show its highest average fitness (Bak *et al.* 1988; Kauffman 1993). As cooperative critical phenomena is well known in the context of phase transitions in equilibrium statistical mechanisms (Bak *et al.* 1988), self-organised criticality enables us to explain this phenomena in the systems with two or more degrees of freedom such as complex social systems.

Fine-tuning a parameter of the system is the only way a critical point can be attained, for example, temperature in the case of a physical system (Bak *et al.* 1988). Due to this, the boundary conditions and topology of network are essential to the nature of the critical state, though not the existence (Fronczak *et al.* 2008; Arthur 2013), "since the dynamics and the physical situation is largely defined by the properties at the boundaries", as clarified Bak *et al.* (1988: 367).

Activity in the self-organised critical state takes place in terms of bursts, or avalanches[21] (Bak *et al.* 1988; Fronczak 2008; Paczuski 1995) or complexity cascades (Brunk 2000, 2002). One of the main signs of the presence of this complex principle is the presence of these chain-reaction phenomena in both case studies, as discussed in Chapters 5 and 7. As this allows the addressing of the key question as to how change propagates throughout the system, the nature of this dynamic is conceptually explored here.

The initiation of a new avalanche in the critical state can be viewed as the injection of a single particle into the system. This points to the aggregative capacity of the system components for the key feature to trigger self-organised criticality

[21] An avalanches is when a perturbation is propagate to the neighbours, then to their neighbours, in a chain reaction ever amplifying since the sites are generally connected, and eventually propagating throughout the entire lattice (Bak, 1988).

behaviour. A perturbation, however, can lead to anything from a shift of a single unit to an avalanche according to the connectivity properties of the system, one of the main features of the network topology (Paczuski 1995; Bak *et al.* 1988; Brunk 2000). For the avalanche to occur, however, all sites in the system need to have (random) numbers above the threshold of the tuning parameter. The avalanche would stop when all sites in the system again have random numbers above the threshold, then a new avalanche will start somewhere else in the system in a chain effect (Paczuski 1995). According to Paczuski (1995: 4255) "In the stationary, critical state, the average number of active sites created and destroyed by […] avalanche must be equal". As a result, avalanches redistribute the energy introduced by the perturbation or disturbance across the system lattice (Bak *et al.* 1988).

Avalanches take the form of burst-like dynamics with long periods of relatively little activity interrupted by narrow intervals, or bursts of large activity (Bartolozzi 2006; Paczuski 1995). This apparent punctuated equilibrium behaviour enables us to explain both mass events (e.g. mass extinction events) and the behaviour of a single species. This indicates that both single and mass behaviour are sides of the same coin, and that collective effects are the result of many interacting degrees of freedom (Bartolozzi 2006; Frigg 2003; Paczuski 1995) that occur as a result of an aggregate-level human behaviour (Brunk 2000). The nature and dynamic of avalanches are crucial to understanding the most crucial phase transition behind inter-sector partnerships, and the transition from individual to collective behaviour, as argued in Chapter 5, 7 and 8.

Kauffman's ideas on co-evolutionary processes converge with Bak *et al.*'s theory in two main respects. First, B Bak *et al.*'s study of avalanches shows the same characteristic distribution between size scale and frequency that Kauffman proves in co-evolutionary ecosystem, a power law distribution. In this sense what Kauffman (1993: 255) refers as "packets" (Kauffman's punctuation) of co-evolutionary change are similar to Bak *et al.*'s idea of the burst-like nature of avalanches. Secondly, for Kauffman (1993) avalanches are associated with fluctuations of low fitness, a reason why they may engender both extinction and speciation events. Extinction events would be expected because of low fitness, while specialisation events might be expected at low fitness according to the number of directions of improvement.

The convergence of these authors' ideas is crucial to explaining the presence of self-organised criticality behaviour in the complex social systems of study as it appears under different sets of conditions. In the Brazilian case study, this principle allows to spread in the region the partnership culture created over the multi-stakeholder process that led to the creation of the Mandú Alliance; while in the Ecuadorian case study, it redistributed the energy created during the multi-stakeholder process throughout the system, causing the collaborative agreements to lose momentum. Nevertheless, these principles enable us to sustain this research argument that a collaborative partnership represents a poised state in the system dynamics and allows the spread of a more sustainable dynamic in the system (attractor), as reflected by the Brazilian case study.

Overall, the third section of this chapter has explored the main mechanisms and ideas that shape the so-called complex dynamical systems theory and that enable us to explain the behaviour observed in the case studies at a macro level. However, the empirical data reveals that this behaviour at a macro or collective level is caused by the interactions and another range of dynamical processes occurring at a micro level. The following section explores, therefore, the main properties and processes that complex adaptive systems display at a micro or agent level.

2.3. Properties of Complex Adaptive Systems (CAS)

Complexity scientists assert that different complex systems in nature, such as insect colonies, immune systems, brains and economies, despite the fact they do not *resemble* each other, still share some fundamental properties (Lewin 1992; Holland 1998; Mitchell 2009; Waldrop 1992). Various authors have made an effort to draw characteristics that are similar to various kinds of complex adaptive systems (CAS) (Castellani and Hafferty 2009; Holland 1995; Mitchell 2009; Mitleton-Kelly 2003a). Examples of these are Mitchell's (2009) general three properties common to all complex system displays: complex collective behaviour, signalling and information processing, and adaptation. Mitleton-Kelly (2003a) outlines ten generic principles of complex evolving systems (CES) that relate to social systems and organisations: self-organisation, emergence, connectivity, interdependence, feedback, far from

equilibrium, space of possibilities, co-evolution, historicity and time, and path dependence.

John H. Holland (1995), however, presents the most comprehensive compilation of properties common to all complex adaptive systems. In his investigation to understand how adaptation builds complexity, Holland lays down seven commonalities for all complex adaptive systems drawn from cross-disciplinarily comparison: aggregation; tagging; nonlinearity; flows; diversity; internal models; and building blocks (1995: 10-40). Furthermore, Holland argues that these properties appear simultaneously in all kinds of complex adaptive systems. This section presents these properties and explains how they underpin the analysis undertaken in this research.

2.3.1. Aggregation

According to Holland (1995), the property of *aggregation* enters into the study of CAS in two senses: (1) as a way to aggregate similar things into categories; and (2) in the sense that complex large-scale behaviour emerges from the aggregate interactions of less complex agents. While the first sense of aggregation refers to *what* CAS can do, Holland (1995) explains, the latter refers to *how* CAS does it.

In the context of this research, while the first type enables us to understand the formation of clusters such as the various social sectors, different organisations and cultural identities involved in the processes of study; the second aspect of aggregation is crucial for understanding the concept of *emergence* and *self-organised criticality* in the context of this research.

The study of CAS, according to Holland (1995: 12), "turns to the ability to discern the mechanisms that enable simple agents to form highly adaptive aggregates". This research, however, illustrates that the study of social change also requires an understanding of how this aggregation percolates through the system. However: what kind of processes and boundaries demarcate these adaptive aggregates?

2.3.2. Tagging

The answer to this question comes from Holland's second communality, tagging, as this is "a mechanism that consistently facilitates the formation of aggregates" (1995: 12). Tagging facilitates selective matching as for instance in animals, logos, trademarks that facilitate commercial interaction and the like. This mechanism is "a persuasive means for aggregation and boundary formation in CAS", explains Holland (1995: 13).

The degree of adhesion between two agents is therefore determined by the degree of matching between their adhesion tags. Adhesion provides a way of forming multi-agent[22] aggregates, this is, agents selectively adhere to each other and even form layers, which enables them to move and interact as units. Here, agents tend to specialise within the aggregate to play different roles. Once an aggregate starts to form and survive, interactions and exchanges can evolve into ever more sophisticated configurations (Holland 1995).

In this research, tagging is crucial to explain the selective matching, aggregative process and boundary formation behind the construction of multi-stakeholder partnerships and new multi-agent entities. Examples of this are the creation of the FONAG (Fund for the Preservation of Water Resources), in the Ecuadorian case study; and the creation of the Mandú Alliance, in the Brazilian case study, as discussed in Chapters 5 and 7.

The configuration induced by the adhesion between two or numerous agents depends on an additional mechanism: boundary formation. Boundaries provide a simple way of aggregating agents into layers and they are used to constrain agent interactions (Holland 1995; Kauffman 1993, 1995). The set of agents with which a given agent can interact is called its domain of interaction. Initially, an agent can only interact with agents belonging to the same boundary, or with agents belonging to adjacent (directly exterior to) boundaries. Only agents in the outermost boundary of an aggregate have a domain of interaction that includes other aggregates at the site. The boundary an agent belongs to is decided via the adhesion match at the time it is formed from its parent.

[22] A multi-agent is when agents with a fixed structure will be aggregated into a more complex variable structure (Holland, 1995).

These ideas of boundary formation and domain of interaction are relevant to understanding the construction process of social entities and how any disturbance such as information, knowledge and also change, percolates across the system.

2.3.3. Non-Linearity

Non-linear behaviour is more specifically defined by Per Bak (1988). Bak *et al.* explain how nonlinearity stems from the threshold nature of the system's dimensions. This means that the outcome that an influence has in the system varies according to (1) the threshold condition of that particular dimension or set of dimensions at that particular time; and (2) the strength of coupling that this 'target' dimension(s) has with other neighbour dimensions (Bak *et al*. 1988). These two variables influence the direction and the intensity of response a particular dimension has to a specific perturbation.

This property is what enables us to open 'the black box' (Arthur 2013) or to tackle the 'intractable nature' of complex behaviour as discussed when examining the emergence of the multi-stakeholder processes as an international phenomenon (see Part I of Chapters 5 and 7).

2.3.4. Flow

Holland (1995: 23) explains that this property "extends beyond the movement of fluids…to flow over a network of nodes and connectors". The basic configuration of this property occurs when a processor (agent) is connected to another processor (agent) through a connector. The connectors designate the possible interactions. This property is what Michelle Mitchell (2009: 13) refers to as "signalling and information processing", one of three properties that she proposes. In this research work, the processors or nodes are social agents - individuals or organisations - and the connectors are the interactions between them.

In complex adaptive systems (CAS), the flow through the network varies over time. Moreover, nodes and connections can appear and disappear as the agents adapt or fail to adapt, as further explained in the next section. Thus neither the flows nor the networks are fixed in time (Holland 1995; Albert and Barabási 2002, 2002; Watts

2003). It is in this context that tags can be better understood as they define the network by delimiting the critical interactions and the web of connections.

For this research, this property enables us to assess how resources flow throughout the system and how this relates to the network structure of the system. This property, however, has a major implication for the study of complex social systems as selection prioritises tags that mediate useful interactions and against tags that cause malfunctions (Holland 1995; Kauffman 1993, 1995).

2.3.5. Diversity

This property refers to the number of kinds of agents contained in a system. To understand this property, Holland (1995: 27) explains the basic process of agent creation: "Each kind of agent fills in a niche that is defined by the interactions focusing on that agent. If we remove one kind of agent from the system, creating a "hole", the system typically responds with a cascade of adaptations resulting in a new agent that "fills in the hole". Holland (1995: 28) carries on explaining that "diversity also arises when the spread of an agent opens a new niche - opportunities for new interactions - that can be exploited by modifications of other agents". These two ideas are known in biological terms as *convergence* and *mimicry*, respectively.

Therefore, diversity of CAS is neither accidental nor random but a dynamic pattern that evolves over time as a result of progressive adaptations; each new adaptation opens the possibility for further interactions and new niches (Holland 1995; Kauffman 1993)

This property and the related processes of hole formation and niche opportunity that determine this dynamic pattern are crucial for understanding the initial stages of collaborative processes and the cascade of adaptation they produce in their systems, as analysed in Chapters 5 and 7.

2.3.6. Internal Models

This property refers to the mechanism of anticipation, and is a hallmark of all CAS. Holland (1995) explains that the basic manoeuvre for constructing internal models is aggregation and the action of eliminating details so that selected patterns are emphasised. Furthermore, as internal models "are interior to the agent, the agent must

select patterns in the torrent of inputs it receives and then must convert those patterns into changes in its internal structure" (Holland 1995: 31).

Holland (1998) also refers to these internal structures that shape the agent behaviour as attributes. Changes in the internal structure or attributes are the ones that must enable the agent to anticipate the consequences that follow when that pattern is encountered again.

For this work, this mechanism is crucial for exploring collaborative processes at a micro level as it enables us to tackle the question of what drives agents' behaviour to engage in collaboration work, and to explain how this behaviour evolves over the multi-stakeholder processes of study, as discussed in Part II of Chapters 5 and 7.

2.3.7. Building Blocks

Humans have "the ability to decompose a complex scene into parts", for instance as Holland explains, a human face into hair, forehead, eyebrows, eyes, and so on (1995: 34). These parts or building blocks can be used and reused in a great variety of combinations according to our learning (Holland 1995).

Social agents gain experience by the repeated used of building blocks, even though they may never twice appear in exactly the same combination. Holland (1995: 36) states that this mechanism provides social agents with a "significant advantage when we can reduce the building blocks at one level to interactions and combinations of building blocks at a lower level; the laws at the higher level derive from the laws of the lower-level building blocks".

In the context of this research, this mechanism provides the foundations to understand the concept of *emergence* presented above and discussed in Chapters 5, 7 and 8.

Conclusions

This chapter has presented the main ideas of complexity theory that comprise the research theoretical framework. It has started by presenting the focus of complexity science and clarifying the various terms used to refer to complex systems according to the strategy used to respond to environmental changes. These are complex *adaptive*

systems, complex *evolving* systems or complex *co-evolving* systems, (Mitchell 2009, Castellani and Hafferty 2009). The central position that complexity plays in western sociology was outlined (Buckley 1998; Luhmann 1995; Urry 2003, 2005), as was how the evolution of these ideas has influenced social science throughout three different stages or waves (Sawyer 2005; Castellani and Hafferty 2009). These various waves show the fact that the literature in the sociological arena has already explored the idea of societies as complex systems since the last century. This is fundamental to supporting both the main premise and argument of this investigation: inter-sector partnerships display features that are intrinsic to the nature of societies as complex dynamical systems. The limited expansion of systems' thinking in sociology also helps to explain the existing gap in the literature of multi-stakeholder collaborations in the use of these ideas, as is also discussed in the previous chapter.

Based on the literature revision both in the field of inter-sector collaborations and complexity theory, the research main objective has been established. That is, to explore the applicability of complexity theory in the field of inter-sector collaboration as a new theoretical framework for studying the dynamics of social change. As per the description of these waves or periods of influence of systems thinking in sociology, this research shares the concerns that the third wave has with emergence, component interactions, and relations between levels of the system (collective and agent level). In this vein, this research draws on the ideas already developed by second-wave theorists about dynamical systems such as self-organising, non-linear behaviour, attractor and far-from-equilibrium, among others. Furthermore, it builds upon the work of Stuart Kauffman (1993, 1995, 2000), and his influential work in building the complex dynamical system theory, the focus of third wave theorists. Other ideas stemming from the science of complexity such as Holland's (1995) definition of generic properties for CAS, and the concept of self-organised criticality (Bak *et al.* 1988; Bak 1996; Brunk 2000, 2002; Fronczak *et al.* 2008; Paczuski *et al.* 1996; Frigg 2003), have also been crucial for the purpose of this research.

In the first part of this theoretical description, the emergence of spontaneous behaviour is explored through the concepts of self-organisation and emergence. Following that, the various types of complex behaviour, ordered and chaotic behaviour and the concept of poised state are presented. After that, the concept of co-evolution as the meta-dynamic of selection and evolution as a self-reinforcing force is

discussed. Finally, the mechanism of self-organised criticality is introduced and its relevance, despite the low inclusion in the social sciences, is discussed. A final section introduces the properties of complex adaptive systems (CAS). This section presents Holland's (1995) features of CAS drawn from cross-disciplinary comparison and discusses their applicability in explaining the dynamics observed in the case studies used for this research. These are aggregation, tagging, nonlinearity, flows, diversity, internal models, and building blocks (Holland, 1995: 10-40).

The main criticisms of the transfer of the ideas from complexity theory to social sciences have been noted for each period of expansion or wave. The two major criticisms that nowadays shade this transfer of ideas, and the innovations that this research presents to overcome them, are presented in a specific section in this chapter. These innovations are first, to use a deductive approach for the collection and analysis of empirical evidence of complex behaviour presented in the form of two case studies. A second innovation is in relation to the focus and level of investigation of this research. Here it is argued that the focus of this study is the *dynamics* underlying inter-sector partnerships; and level of analysis is both at a macro and a micro level, as opposed to other orthodox approaches. The last innovation is in relation to the use of complexity theory as an analogy. This comprises two main ideas: 1) to use the original ideas of complexity theory to produce new knowledge specific to social and human behaviour; and 2) to use this new knowledge as a basis for practical application, and not to transfer the ideas of complexity theory directly from the original models without validating and reviewing them in the light of the study of social dynamics. Finally, this section argues that these innovations are consistent with Stacey's (2007) revision of the use of complexity theory in organisational studies.

Based on this discussion on the applicability of complexity science to social sciences, this research proposes the use of complexity theory to explain a specific pattern of agents' interrelations (inter-sector partnerships) and the specific attributes that human agents display while interacting individually or within organisations, in relation to this particular pattern. The results will contribute to advance both the application of complexity theory in the sociological realm, particularly in the understanding of inter-organizations collaborations; and the understanding of complex dynamics in social systems. The next chapter includes further explanation of the elements that this research has considered at a methodological level, to attend to

this new notion of studying social dynamics from the perspective of complex dynamical systems theory.

Chapter 3

Methodology

Introduction

This research investigates the construction process of inter-sector partnerships with a focus on their emergent, dynamical and evolving behaviour. These processes involve multiple agents representing various social sectors that, from multiple locations of the system, interact to produce a collective emergent outcome: a social policy, programme or partnership.

The former chapters discussed how the way these interactions occur exhibit a specific complex dynamic that has not yet been revealed either in the literature of inter-organisation collaborations or in the literature on complexity theory. Likewise, they argued how the advance of complexity science, particularly in relation to dynamical behaviour, and the understanding of societies as a complex adaptive system set the grounds for this research to study inter-sector collaborations from a complex dynamical systems perspective.

A major challenge is however to develop a methodology approach that is both scientifically accurate to the purpose of theorising and adequate to inform policy makers and guide practitioners interested in working collaboratively. This methodology needs, however, to move away from the fragmented perspectives of the theories traditionally used to study inter-sector collaborations. This is first of all because these theories have proven to be inadequate in addressing the complex, synergetic and dynamic nature of these processes, as discussed in Chapter 1. Secondly, because most useful tools for generalising observations into theory such as trend analysis, determination of equilibria, sample means and so on, are badly blunted to account for the non-linearities that societies exhibit as complex adaptive systems (Castellani and Hafferty 2009; Kauffman 1993, Holland 1998). Overall, the fundamental difference is that these theories respond to the scientific paradigm that by adding up the set of rules that each theoretical approach produces, the description of

the total behaviour can be reached (Brunk 2002), which differs from the holistic and systemic approach necessary for studying complex behaviour.

This work proposes a qualitative methodology that combines an inductive and deductive approach to the use of complex dynamical systems' theory as an overarching conceptual framework to investigate complex social behaviour and change (Ramalingam *et al.* 2009; Reynoso 2006). This theoretical framework also draws on concepts stemming from complexity theory and other theories related to the subject of study, i.e. inter-sector partnerships, in order to investigate and advance the understanding of their complex dynamics. In addition to an inter-disciplinary framework, this work argues that a combination of an inductive and deductive approach is necessary in the research methodology in order to account for 1) the exploratory nature of this investigation both at a theoretical and methodological level, and 2) the complex unpredictable behaviour of social systems.

The research methodology therefore applies first, an inductive approach to go from the level of information to the observed systemic behaviour drawing on complex dynamical systems theory to structure the data collection. The complex systemic nature of the objects of study (two case studies of inter-sector collaborations processes) requires a time line approach, to discern the various levels of the system and to map interactions between main events. Also, the nature of social systems requires methods that are capable of representing all the agents of the system and building their narratives from their own perspectives, as further discussed below. For this, a set of qualitative methods involving participatory inquiry and semi-structured interviews are used for data collection.

Secondly, this methodology proposes a deductive approach in two separate stages for the task of theorising. A first stage involves a general analysis of empirical data using the conceptual framework detailed above to gain new insights of the complex dynamics for each processes of study. A second stage consists of deducing regularities of behaviour or patterns from cross-examination of the processes of study. Finally, an inductive approach is proposed to transfer the patterns drawn from cross-examination as tentative hypothesis to inform and guide the design of actions adapted to the new particular context in the field of study, i.e. multi-stakeholder collaborations.

While drawing patterns of behaviour to sustain future human action relates to the idea of 'models' (Ramalingam *et al.* 2009) a complexity approach to the study of social change processes requires, however, two fundamental features in the formulation and application of these patterns into models. First, the non-linear nature of social systems would mean that these patterns of behaviour play out differently in different context conditions or settings. Secondly, the dynamic evolving nature of social systems requires models to be constantly adjusted and recalibrated to significantly different settings from those where they were created, and to be reviewed when applied to the similar setting after a period of time. This means that the 'flexibility' of adapting to different space and time conditions must be the prime feature of any kind of model that reproduces social complex dynamical behaviour. Holland (1998: 45) refers to a 'dynamical model' as a "model with changing configurations". He explains: "the object of constructing a dynamical model is to find unchanging laws that generate the changing conditions" (p.45). This author explains that for constructing a dynamical model three elements are crucial: i) selecting a level of detail that is useful, then ii) capturing the laws of change at that level that he refers to as 'transition function'[23], and iii) interacting the use of transition function so that future possibilities can be explored. Despite the fact that complex-based models fit within this category of dynamical models, this research aims to set the basis for another kind of model more suited to explore complex social change processes, i.e. a 'qualitative dynamical modelling' (QDM)[24].

This methodological approach differs from other qualitative and quantitative uses of complexity theory. Mathematical formulation and modelling (quantitative approach) is the mainstream methodological trend of complexity science (Mitchell 2009; Holland 1995, 1998; Lewin 1999). These mathematical models enable us to deduce mathematical rules that explain the complex behaviour of large and highly complex issues in a much-simplified artificial environment. This research method, however, diverges from the purpose of this research in two aspects. First, complex social dynamics are context and history specific; hence all the details around the

[23] According to Holland (1998) a transition function provides the different correspondence between each possible input and the state that results. He explains, "transition function is reminiscent of the function that defines a strategy" (p.48).

[24] Qualitative dynamical model is used in this research to reflect this methodological approach and strategy.

processes of study are relevant and cannot be sheared away as assumed by mathematical modelling tools (Holland 1998; Wolfram 2002; Stacey 2007). Consequently, as stated by Stacey (2007: 220): "mathematical models cannot deal with the full diversity of human behaviour". Secondly then, to account for the diversity of behaviour possible in social systems, this research explores real life complex dynamics using a qualitative approach.

Other qualitative uses of complexity theory have received criticisms because of the way these ideas have been transferred to human action; that is, directly from the models from where they originated without considering the different nature of the agents where they are transferred (Stacey 2007; Ramalingam *et al.* 2009). To overcome this criticism, this research approach makes a different use of complexity theory..To begin with, this uses the ideas of complexity theory as an analogy to investigate inter-sector collaborations. Secondly, from the patterns of behaviour drawn from cross-analysis of various case studies (second level of deductive analysis), it suggests the transfer of ideas to guide human action, with the particularities explained above for the applicability of this model.

Therefore, this research seeks to set the basis for the creation of qualitative dynamical models by 1) drawing the 'transition function' (Holland 1998) of two empirical experiences of inter-sector partnerships (ISPs), and 2) drawing a common pattern of behaviour between these transition functions that would account for a first set of 'laws of change' (Holland 1998) of a qualitative dynamical model for ISPs. This set of laws of change or pattern of behaviour would then be recommended to guide the practice of ISPs and would represent the basis for further calibrating the model with other empirical experiences of ISPs in the same or different context conditions.

The following sections present (I) the methodology design to attend to the research questions; (II) the data processing and analysis, and (III) risk and limitations of the methodology. The criteria for selection of the case studies and methods for data collection are included in the first section. The ethical issues related to this methodology strategy are discussed in the conclusions of this chapter.

3.1. Methodology Design

To attend to the methodology approach of 'qualitative dynamical models', this research is structured in three stages: (1) a description of empirical evidence of complex processes of multi-stakeholder collaborations, in the form of case studies (data collection and processing); (2) an analysis of the systems' dynamics and behaviour observed for each case study using a complex dynamical systems approach and other set of concepts (data analysis by case study); and (3) cross-examination of case studies to draw a common pattern of behaviour and underlying complex principles (comparative analysis). This rationale also underpins the design of the research questions: 1) What is the complex dynamic behind the inter-sector collaboration process of each case of study?, and the subsidiary question: How does the agents' institutional background influence their journey to collaborative work?; and 2) What are the main generic principles that underpin the construction of inter-sector partnerships using a complexity dynamical systems approach?

To attend the research goals and questions this work uses the methodology strategy on case studies and the methods of participatory inquiry (Chambers 1994; Selener 1997) and semi-structured interviews (Longhurst 2003; Wengraf 2001), as further explained below. Information triangulation in group discussions and individual interviews were used for data validation. The use of case studies facilitates the double task of providing the real life data for the purpose of theorising (Yin 1994), and scenarios of collaborations to support the practical application of the common pattern of behaviour and underlying complex principles (generic principles), as part of the first research questions. Both case studies are presented in a descriptive chapter (Chapters 4 and 6) to be later analysed from a complex dynamical systems perspective (Chapters 5 and 7). Drawing on these analytical chapters, a comparative analysis is undertaken to draw patterns and principles intended to answer the second research question.

3.1.1. Selection of Case Studies

The use of real life experiences as case studies represents the most accurate and adequate research strategy to access complete and objective data of the system and object of study (Yin 1994; Eckstein 2000, Anderson *et al.* 2005).

The criteria for the selection of case studies were as follows: First, the search for experiences that display standing collective work behind the inter-sector collaboration. Organisational coalitions or those where the inter-sector partnership was a short cut for some kind of vested interest were dismissed. A second criterion is the degree of interest expressed by those involved in the experience, in taking part of in the research. This interest was measured either from the perspective of the subject of study - how inter-sector partnerships work in real life; or the research approach – how to explore and manage the complex dynamics of these processes. Looking for a mutual interest was a strategy intended to guarantee access to the volume of sensitive data required. Furthermore, these criteria hoped to explore ways of bridging theory and practice (Leach *et al.* 2010; Loorbach 2007) and making research more practice-oriented (Huxham 1996; Leach *et al.* 2010), as further explained below. A third criterion for selecting the case studies was location. This attended to a double goal: 1) to allow for a diversity of conditions between case studies - different cultural backgrounds, topics of collaboration, contextual conditions, and the like - that would enable to draw common principles between different complex behaviours; and 2) locations where the language and cultural background were familiar to the researcher to reduce the distance between researcher and object of study (Reynoso 2006).

Applying these criteria, 15 experiences of inter-sector partnerships were initially investigated using different sources of information such as the researcher's professional network (main source) and Internet. These experiences were over four continents: Asia (India), Africa (Senegal), Latin America (Brazil (2), Ecuador, Chile, Argentina) and Europe (Spain). From these initial experiences, six projects were selected for further examination based on potential interest and travel costs, those in Latin America and Europe. At this stage interviews were held by phone or Skype with the main informant(s) to 1) create a whole picture of the collaborative process - the parties involved, process evolution and main events, current conflicts and challenges of the process -; and 2) assess the potential contribution and/or interference that this research could produce. The information obtained from these interviews was cross-referenced with third parties in the region and even case studies, to validate and explore hidden risks. This validation turned out to be crucial for the final selection of case studies as all the experiences contacted showed interest in taking part in this research and their accounts of their stories sounded too idealistic. From here, two case studies were selected for fieldwork, both in Brazil: the 'Mandú Alliance' in Piaui

(northeast Brazil) and the 'First Childhood' project in Pedro Leopoldo (Minas Gerais - Centre Brazil). However, this selection represented two risks: 1) collecting the same number of cases as the number of experiences intended to be analysed left no room for unforeseen issues with the data collection[25]; and 2) the Pedro Leopoldo case study was not the best second choice, but failing to get funds for field-work forced the researcher to select the two case studies within the same country.

Fieldwork in Brazil was undertaken between April and August 2009. Initial suspicions of the Pedro Leopoldo case study were borne out. The partnership showed an important dependence on private funds and thus a conflict of interest biased most of the parties' narratives of the process. To overcome this situation, the researcher sought for additional funds and a second round of fieldwork was undertaken between September and January 2010 in Spain (Menorca) and Ecuador (Quito). With data sets from four case studies, the research had no more risks in terms of access to qualitative data for analysis. The Ecuador experience is one of the case studies included in this research describing a multi-stakeholder and inter-sector effort to create an integrated water management for the Quito Metropolitan Area. The Spanish case study represented the fight of various local agents, from different sectors, to promote a more sustainable model of agro-business as an alternative to the crisis produced by the past European Community Agrarian Policies on the island.

The case studies finally selected were the Ecuador (Quito) and the Piauí (northeast Brazil) experiences. The criteria for the final selection were: 1) the duration of the process - giving priority to those of longer duration; and 2) the complexity of the processes involved - choosing those that were more complicated and challenging. According to these criteria, the case study from Spain (Menorca) represented a very interesting process, but was the less evolved of the three. Therefore, the case studies chosen for analysis were the Quito (Ecuador) and the Mandú Alliance (Brazil) projects.

Fieldwork took over a year, including planning, search for case studies and data collection. Despite this process being tedious with a high demand on time and cost, it turned out to be successful and two high quality case studies for this research goal became possible. The key elements for this positive outcome were having a clear

[25] The research panel that approved this research at the end of the first year limited the number of case studies for analysis to two.

idea of the criteria for data collection, and validating tentative cases with third sources, risk assessment and strategies to overcome these risks.

Chapter 4 presents the experience of the Mandú Alliance in northeast Brazil. This process reflects the collective effort made by the community people, CARE Brazil, the Piauí University, the main agricultural research centre in Brazil (EMBRAPA) and the Floravida Institute, in order to develop actions that promote professional opportunities for young people from those coastal communities which are threatened with displacement by tourism. Chapter 5 introduces the multi-stakeholder process that involves all water users of the Quito metropolitan area, from governmental agencies at a national to a local level, to water companies, state enterprise, indigenous groups, the Salesian University, other intermediate agents and the new Fund for the Preservation of Water Resources (FONAG). This process is intended to create a new water management and governance model to remove the prospect of a major water crisis in Quito.

3.1.2. Methods for Data Collection

This research used participatory tools combined with semi-structured interviews to shed light on the multiple perspectives involved in the processes of collaboration and to delve into crucial information and agents' roles (Leach *et al.* 2010).

The reason for this selection is that social behaviour, such as inter-sector partnerships emerges from the interaction of the system's components (social agents and structural rules), hence, this requires complete and equal representation of all the perspectives. Therefore, this research used a combination of participatory inquiry and semi-structured interviews as the most accurate strategy to collect all the agents' perspectives of the system and to represent the context-specific nature of the social dynamics of study. Particular attention was paid to the most hidden or most disadvantaged perspectives for the purpose of accuracy and scientific rigour, as well as for a matter of social justice and to enhance the sustainability of the actions designed (Blackburn *et al.* 2000; Leach *et al.* 2010).

Participatory methods are intended to recreate the different and specific narratives of the main agents involved in the systems of study, with two substantial differences from other methods of enquiry. First, they allow a reflection of the agents' own perspectives on the object of study and not that of the observer. To bring the

agents' perspectives to the front of the narrative construction represents an important shift in the scientific construction (Waltner-Toews *et al.* 2003; Chambers 1994; Selener 1997; Leach *et al.* 2010). This scientific shift enables us to reduce the distance between the object and subject of study that traditionally has interfered with the qualitative approach (Reynoso 2006). In this research, the subject and object of study are the same as the researcher takes on a different role; instead of creating the narrative, the researcher facilitates its creation. This scientific shift also helps to counterbalance some ethical barriers of scientific enquiry as discussed below. A second difference that participatory inquiry provides is that bringing people's perspectives to the forefront of the narrative construction enables us to build local capacity through reflection on their own experience. This ultimately reinforces the capacity of the social phenomena studied to be managed from the inside out.

Another major reason for this selection of methods is that the use of participatory inquiry enables us to create a collective level of analysis that goes beyond the individual descriptions of the phenomenon of study (Chambers 1994; Stacey 2007; Leach *et al.* 2010). Complexity scientists assert that the task of formulating theory around complex adaptive systems is more than usually difficult because the behaviour of these systems as a whole is more than a simple sum of the behaviour of its parts (Holland 1995; Goldstein 1999; Kauffman 1993). Sawyer (2005) explains how Parsons (second-wave of systems thinking into sociology) was criticised for failing to explain that social systems could not be reduced to individual-level explanations. In opposition to this, non-reductionist thinking emerged, claiming the need for a collective level of analysis and going against reductionism of social system behaviour to its explanation in terms of individuals. Therefore, to create a collective narrative is fundamental for understanding the emergent nature of inter-sector partnerships and exploring their properties as a whole. This methodological approach represents a profound shift from the theories and methods traditionally used to study inter-sector partnership processes. To achieve this goal, group discussions using participatory tools were undertaken to reproduce both the multiple perspectives and narratives of the inter-sector partnership and also to build a macro-narrative or macro-structure of the collaborative processes. These two types of group discussion are referred to in this research as 'sector workshops' and 'inter-sector workshops',

respectively, as further explained below. These group discussions or workshops also served as a source for validating information.

The use of semi-structured interviews responds to the need to 'deepen down' into specific information to complement the 'broadening out' generated by participatory tools (Leach *et al.* 2010). This method of data collection enables the particular task of detailed examination of events, facts and agents' opinions relevant to the processes of study (Longhurst 2003; Wengraf 2001). Semi-structured interviews were also used in this research as a gateway to validate the data collected by cross-information.

In terms of adequacy, the use of these qualitative methods also helps to bridge the existing gap between theory and practice (Leach *et al.* 2010; Reynoso 2006). That is, qualitative methods provide a more familiar language for policymakers than mathematical formulations (Stacey 2007; Reynoso 2006), and also, they enable to build social capacity as a result of the scientific construct, as further discussed below.

3.2. Data Collection

Data from four examples of inter-sector partnerships were collected to comprise four case studies: 1) the 'Mandú Alliance' in Parnaiba (Piaui State, north Brazil); 2) the 'First Childhood' project in Pedro Leopoldo (Minas Gerais State, Centre Brazil); 3) the 'Menorca agro-business reform' in Menorca (Spain); and 4) the design of an integrated water management plan for the Quito Metropolitan Area (Quito, Ecuador). Fieldwork took place in two stages, from April to August 2009 in Brazil; and from September 2009 to January 2010, in Spain and Ecuador.

The strategy for data collection was based first on 'sector workshops' held with representatives[26] of each type of agent or sector taking part in each case study. Sector workshops were intended to create the various processes and narratives of the process of study ('agent map'). These 'sector workshops' used participatory tools to allow a collective level of discussion from each specific type of agent. The workshops were structured to represent the events that most hindered or enabled each agent's journey to collaboration work following a chronological order. For this, details from

[26] Representatives include those that were part or are still part of the process

the initial conditions that enabled the first interactions up to the current state of the process were collected for each type of agent or sector interviewed. The tools used for the participatory discussions were cards and markers of different colours to represent the multiple variables and levels involved in each case study. A wall was used for hanging the cards. Tape was used to represent the causality relationship and interactions (see Pictures Appendix 7). These workshops enabled this research not only to collect the multiple perspectives of the process of study but also to produce a collective narrative within each of these perspectives or types of agents. Furthermore, they enabled the exploration as to how the agents' dissimilar institutional backgrounds influenced their journey to collaborations.

'Sector workshops' were followed by 'inter-sector workshops', which involved attendants from the former workshops. These workshops aimed at creating a collective multi-stakeholder narrative and macro structure of the process of study ('process map'), also through the use of participatory tools. A first round of data processing and analysis was undertaken after each 'sector workshop' and a first 'process map' was produced as a result. This was discussed with the research assistant and some key informants in preparation for the 'inter-sector workshop', together with other details such the language[27] and strategy for the collective discussion. The methodology for the inter-sector discussions varied according to the attendants and conditions encountered at each case study. The 'process map' drafted was presented as the basis for the inter-sector discussions for completion and validation. This reflected the main events that drove the construction and emergence of inter-sector partnerships for each case study. Finally, semi-structured interviews were used to complete and validate information with key informants.

The strategy for validating the accuracy of the data collected was based on two components. First, questions were included over the sector workshops and interviews to cross-check information on crucial variables, roles and events in the process of study. Secondly, the inter-sector workshops also enabled the corroboration of the information stemming from the individual narratives.

[27] Stacey (2007) reinforces the importance of language in human agents' interactions, differently from the digital symbols of computing modelling. Therefore, the capacity to adapt to the diversity of languages present in an inter-sector process was an important variable in this research.

All interviews and workshops, both sector and inter-sector, were audio recorded and pictures were taken. Appendix 1 presents the questions that guided the participatory discussions. Appendix 2 illustrates the type of questions used for the semi-structured interviews. Both set of questions were re-formulated and adapted for each sector workshop and interview to respond to the institutional language and background of the interviewee. Appendices 3 and 4 present the common maps of the process of study: the Mandú Alliance case study (Appendix 3) and the Quito experience (Appendix 4).

The following Figure 2 represents the rationale for data collection and analysis in order to attend to the research questions.

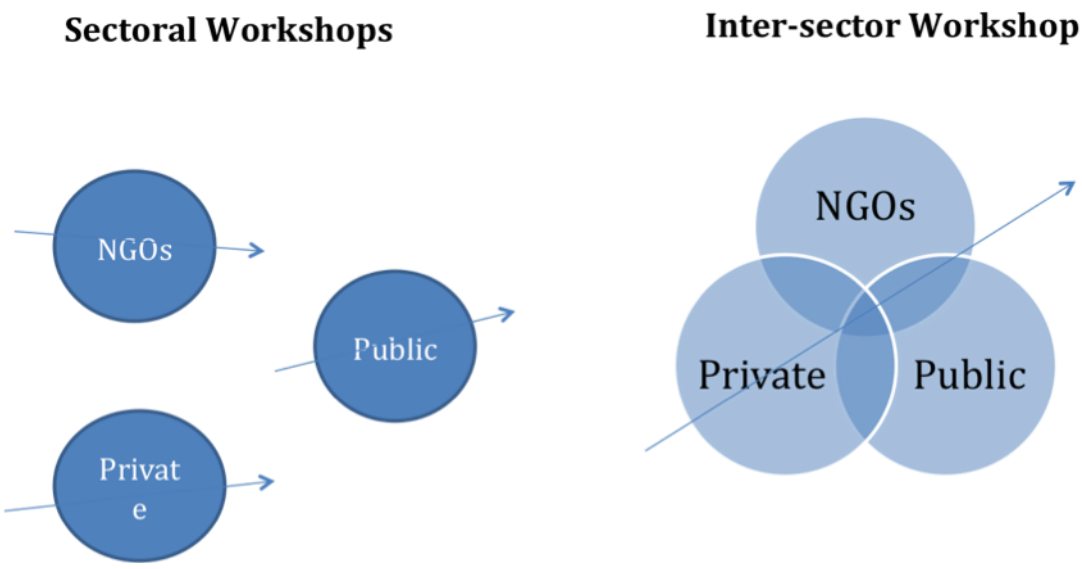

Figure 2- Structure for data collection and data analysis based on a sector and inter-sector approach.

As a result of this methodology design, for the two case studies presented in this research a total of 16 interviews were undertaken for the Mandú Alliance case study, with 24 interviewees overall. In terms of methods, five sector workshops were held with the four main parties in the process: CARE Brazil, EMBRAPA, Piauí Federal University and Floravida Institute; with an 'inter-sector workshop' with six participants from previous workshops. Appendix 5 presents the agenda of interviews and methods used for this case study. Additionally, seven semi-structured interviews were undertaken with key informants from the alliance staff, Mandú partners who

were not members of the alliance and other institutions that abandoned the collaborative process, in order to obtain an external perspective. Finally, three semi-structured interviews were held with different groups of participants, as a means of completing the picture of the 'process map' and validating some information. These were various communities and groups that benefit and take part in the alliance activities. The case study constructed from these narratives is presented in Chapter 4.

For the Quito case study, a total of 14 interviews were carried out with a total number of 19 interviewees. In relation to the types of method used during the interviews, two were participatory group inquiry (sector workshops). These were held with representatives from FONAG and FFLA teams. The second participatory workshop (inter-sector workshop) was held at the end of the process to validate the 'process map' (macro-structure of the collaborative process). Additionally, nine semi-structured interviews were held with the main parties involved in this case study. Finally, one semi-structured group interview was held with Corporation Randi Group, an agent that bridged the multi-stakeholder process main coordinators (FONAG and FFLA) with communities and other local groups located in remote parts of the Quito metropolitan area. This interview was crucial in order to represent the least heard agents in this process - local communities. A final individual interview using participatory tools was held with FFLA's main representatives to complete FONAG's (main facilitator of the Quito experience) narrative of the process. Appendix 6 presents the agenda of interviews and methods used in this case study, which is introduced in Chapter 6. Appendix 7 shows some images of the nature and conditions of fieldwork for both case studies.

In practice, these methods turned out to be more flexible than initially expected in responding to the diversity of contextual conditions for the four case studies. In reality, some sectors were sometimes represented by a group of people while others were just by a single individual. Consistency in the research approach and the role of the observer was granted throughout the four case studies as participatory tools were used both with groups and individuals in most of the interviews. Semi-structured interviews were used when there were time and physical constraints in the interview location to run a participatory discussion. This happened mainly with governmental agencies.

These methods also required the researcher to be reflective and flexible so as to adapt the research objective to the diverse conditions of the various cases studies. To guarantee the adequate adaptability of the methods of enquiry to the local conditions and to minimise the risks of these decisions, two additional elements were included in this methodology strategy. First, a 'neutral agent' was used in each case study to build up an initial picture of the process. This aimed to have a broad picture of the process, agents, conflicts and the like, as a starting point to adjust the methodology to the conditions of each case study. These agents were FONAG (Fund for the Preservation of Water Resources) for the Ecuador case study, which was responsible for conducting the collective process in the Quito experience; and CARE Brazil, NGO working in Parnaiba and youth issues for many years, and one of the main articulators of this inter-sector partnership.

The second element of this strategy was to invite a local person as research assistant. This had a double objective: first, to show a familiar face to the interviewees in order to build trust and obtain sensitive information that may otherwise be withheld; second, to identify the language, hidden conflicts, topics and other agent-specific information in preparation for each interview or workshop. Additionally, this person was crucial for coordinating the interviews' agenda and providing the logistics necessary for the interviews. Another objective was to build local capacity as a result of fieldwork. These people were offered this non-paid work under two conditions: 1) not having any existing conflicts with any of the parties under research, and 2) treating the information obtained confidentially until a copy of the interviews was made available. The research assistant attended most of the interviews and helped with the participatory tools, taking part in the decisions regarding the tools and approach in the interviews and the first analysis of the data collected, as noted above. As part of this goal of building some local capacity, conceptual discussions on partnerships and complex system were held responding to the (frequent) demands of any process participants. Using a participatory approach for data collection is also part of the strategy to build local capacity, as it provides a picture of their own process that they do not usually have due to its complexity and changing dynamic.

In practice, this methodology strategy turned out to be adequate for the purposes of this research, and accurate in relation to the quality of the data collected. The various forms of enquiry resulting from the combination of participatory and

semi-structured interviews presented the flexibility necessary to undertake data collection under a complex systems approach in heterogeneous context conditions. The diversity of interviewees (from politicians, corporation managers, facilitators of the process to community people) and the conditions of the interview locations (from offices in Quito's skyscraper, to a church or community halls) demanded high adaptability for interviewing. While this was not a problem in this work due to the researcher's former experience in the topic of inter-sector partnership and methods (AVINA 2005), it made the task of interviewing challenging and complicated. In this sense, the strategy of having a research assistant was crucial for being able to adapt to and to be prepared for each particular informant. However, sometimes more advanced skills in facilitating discussions and conflicts management were necessary when sensitive topics or attitudes were encountered. Despite the most 'conflicting' parties not being interviewed following the 'neutral agents' advice (FONAG and CARE Brazil), other conflicts - hidden or existing - can arise during the interviews, as in the case of Quito. Marking the difference between this research and the multi-stakeholder process and showing a sympathetic and helpful attitude, helped to re-focus the discussion most of the time.

Another difficulty encountered in this methodology strategy was in relation to the time necessary to prepare an interview considering the outcomes of the previous one. Interviews were scheduled over a period of weeks (1-3 weeks according to the case study). In cases such as Quito, where the number of variables and agents involved in the process is higher, data processing for the following meeting was quite demanding. Having more time for data processing would also have helped to better prepare the inter-sector workshops or discussions.

Following this vein, the tools used for participatory inquiry based on cards and walls turned to be quite limited when trying to capture complex dynamics. This limitation also constrained the task of discussing these dynamics with local agents, and representing and analysing the data. An ideal scenario would allow the representation of multiple interactions between events, agents and system conditions, and to be able to discuss the first stages of the analysis with local agents. The researcher searched for software to overcome these limitations; however, none of the tools found were simple enough to use during an interview without high risk of interference with the discussions. However, the maps obtained in this research, both

for the agents and process, helped to keep the discussions focused on the facts, to provide a simple picture accessible to all kind of participants and to validate a robust structure during fieldwork for further analysis.

3.3. Data Processing and Analysis

The analytical approach used in this research draws on Holland's (1998) perspective on studying complex adaptive behaviour. Holland claims that although there is not a comprehensive method of studying the emergent behaviour of complex systems, it can be looked at in terms of the mechanisms[28] and procedures. These mechanisms, so defined, "provide a precise way of describing the elements (agents), rules, and interactions that define complex systems" (Holland 1998: 6). Furthermore, this author argues that the way to create a general theory of complex adaptive systems is to make cross-disciplinary comparisons of CAS. This cross-examination aims to extract common regularities and to shape them into building blocks for general theory. Cross-comparison, however, according to this author, provides another advantage as the features that are subtle in one system can be salient and easy to observe in another.

Following this rationale, this research was structured as three stages to attend to the research questions, as discussed above. The first stage of this research presents the empirical evidence of complex processes of inter-sector partnerships in the form of two case studies. Each case study comprises a descriptive chapter and an analytical chapter; Chapters 4 and 5, for the 'Mandú Alliance' (Brazil) case study, and Chapters 6 and 7, for the 'Integrated Water Plan in Quito' (Ecuador) case study. These chapters are followed by the comparative analysis in Chapter 8. The case studies' descriptive chapters (4 and 6) result from processing, translating and editing the data collected in fieldwork.

Similarly to the structure used for data collection, the case studies' design and analysis have been shaped following the blueprint of a complex dynamical systems approach; that is, an organisation of events based on macro, meso and micro level of occurrence, to explore emergent behaviour and causality; and a chronological order, to explore the dynamical evolution of the process. These two levels of data

[28] Mechanisms for Holland (1998: 6) go beyond the overly mechanical idea and "come closer to physicist's notion of elementary particles as mechanisms for mediating interactions".

organisation are referred to as ‘process level’ (meso and macro) and ‘agent level’ (micro). The first parts of the descriptive chapters present the macro structure of the collaborative process or ‘process map’. The events and conditions that determined the creation and evolution dynamics of the multi-stakeholder collaborations common to all agents involved in the case study are presented here. This ‘process map’ is drawn from cross-analysis of the agents’ individual processes (‘agents’ maps’). The second parts of the descriptive chapters present the agents’ perspectives and journeys (processes) in engaging in and enduring inter-sector partnerships. These sections describe the institutional background, trigger elements and challenges that determined the main agents’[29] processes for collaborative work. The data presented in these sections stems from the group and individual interviews undertaken during fieldwork. For each agent, this information results from the data collected during the sector workshops or interviews, and from other agents’ interviews as a result of the strategy of cross-questioning to validate data. An example of this cross-questioning was that agents were interviewed regarding the participation of other agents in the collaborative process. This first stage shows how the design of case studies can be extended beyond its traditional ideas (Eisenhardt 1989; Yin 1994) by applying the blueprint of complexity science (Anderson *et al*. 2005).

The second stage of this research represents the data analysis by case study (Chapters 5 and 7). This analysis focuses on exploring the complex mechanisms and dynamics that explain the behaviour observed in each case study. Here, the concepts of complex dynamical systems are used as an analogy to advance a further understanding of the particular dynamics and properties of the complex social systems of study. This analysis follows the macro and micro level structure[30], and their interrelation. Many researchers (Kauffman 1993, 1995; Holland 1995; Levin 1999, 2005) have noticed the importance of looking at the interactions between micro and macro dynamics in a system. Levin (1999), for instance, suggests that processes of evolution at lower scales, including the evolution of tightly coupled species, produce emergent macroscopic patterns at higher levels of organisation that in turn feed back to influence lower spatial dynamics. For the sake of simplifying this analysis, the

[29] Agents may refer to individuals, groups or organizations.

[30] The structure in levels only works with the purpose of providing a structure for analysis. Complex systems do not present these levels in real life.

macro level considers the conditions and mechanisms occurring both during a process (meso level) (Kauffman 1993; Holland 1995; Sawyer 2005), and those that emerge from the process level to a higher level, such as new organisations, partnerships, collective behaviour, social capital, and the like. The analysis at the micro level examines the attributes[31] that explain agents' change of behaviour over the case studies and the dynamics that occurred at this level and which sustain the behaviour observed at a macro level. When possible, agents were grouped according to social sectors - public, private or non-for-profit – so as to note similarities and differences within and in-between sectors. However, this was not possible for all these case studies due to the diversity of legal figures and the institutional goals that organisations reflected: from public enterprises, to academic centres that play a role in community development, to private funding NGOs, and so on. A discussion on the applicability of a sector approach to analysis is included in the Conclusion. A causality analysis is carried out at both levels to understand the conditions and dynamics existing in the systems of study that explain the non-linear behaviour observed.

The third stage of this research strategy and methodology is a comparative analysis to explore the differences and similarities between the two case studies. This cross-examination seeks a double objective: (1) to draw common patterns of behaviour (regularities) and differences between the two case studies; and (2) to analyse the behaviour of the complex mechanisms underlying these common patterns and differences to both case studies. Following the same structure as former stages of research, the comparative analysis is divided into two parts: the mechanisms that explain the emergence of collective properties in the systems of study (macro level dynamics), and the mechanisms and sub-processes occurring at an agent level, or micro level. The search for similarities and differences across a first level of analysis based on the use of complexity theory as a metaphor is made for the purpose of advancing a new understanding and knowledge of inter-sector partnership processes and the behaviour of complex social systems.

Finally, the criterion to combine an inductive approach for data collection and a deductive one for the two stages of data analysis is represented and argued in this research strategy. An inductive approach is used to collect the empirical evidence and

[31] Holland (1998) refers to attributes as the internal structures that shape agent behaviour.

set the basis for investigating their complex dynamics using a deductive approach (Glaser and Strauss 2009; Oktay 2012). That is, no particular complex mechanisms are searched for during fieldwork and data processing; instead, they are deduced from the data analysis (Glaser 1965). In practice, the applicability of this analytical criteria and structure has turned out to be adequate for the research goals and questions as the rest of the chapters illustrate. The strategy to validate the accuracy of the research analysis is to assess the degree in which the analytical outcomes account for explaining the empirical data, as discussed in the Conclusion. The main limitations and challenges of this analytical methodology are noted below.

3.4. Risks and Limitations of the Methodology

This methodology design draws on a similar work previously undertaken by the researcher (AVINA 2005) using participatory methods for data collection and comparative analysis to draw generic principles among various empirical case studies. This previous experience and knowledge of the research process and methods has enabled this research to introduce into the current methodology design several risks encountered in previous work. These included, first, that the experiences enquired (case studies) had a genuine interest in the research topic in order to facilitate access to the necessary data. The mitigation of this risk is reflected in the low number of respondents that failed to attend the interviews which could have threatened the representation of the subject of study, the system These were: a representative of a community-based water council who did not attend due to a misunderstanding with the time scheduled for the meeting; and a representative of the Water Secretariat who cancelled the meeting for travelling reasons, but, however, suggested another participant of the process to replace her perspective and institutional view. The rest of the meetings scheduled were attended. Another strategy for dealing with attendance based on previous experience was to inform attendants in advance about the research goal and tentative methodologies; to propose the sharing of other experiences in the topic; and to have the flexibility to adjust the interviews to the interviewees' interests and demands. Other agents not included in the case studies were: (1) the two private companies from the Quito case study, a bottling and floral company, as they declined the invitation to be interviewed for this research. As for the FONAG representatives, they declined due to lack of interest in the collaborative process; (2) indigenous

people in the Quito case study; due to the recent conflicts and the risk of worsening the situation, FONAG's representatives discouraged access to these groups.

A second risk included in this methodology design was the logistical difficulties of accessing informants since agents were spread across the region. In cases such as Ecuador, trips could take up to 3 hours by car when accessing more remote respondents such as indigenous and other community groups. To include a research assistant and the planning in advance for these circumstances helped to manage this risk.

Another expected risk of this methodology design was the possible bias in using a 'neutral agent' (FONAG in the Quito case study and CARE Brazil in the Brazilian case study) on which to base the data collection strategy. As expected, these agents had a bias in the process according to their institutional agenda. This bias, however, turned out to be manageable in the two cases presented in this research (not that much in the case study of Pedro Leopoldo (Brazil). The strategy to overcome this was to contact (phone calls) other major agents prior to the interviews, and to validate the information provided by the 'neutral agent' during the interviews. Additionally, respondents were asked, when necessary, for other agents' perspectives of the process as a strategy for validating the data provided by each agent. This information, when available, is included under "External Perspectives" in the case study's descriptive chapters (4 and 6).

The main risk during fieldwork, even if foreseen, was the high dependency the research had on collecting the number of cases necessary for data analysis. As one of the two case studies collected turned out to be inadequate for the research goals, a second round of fieldwork was undertaken, as discussed above. No other unforeseen risks turned up from this research methodology.

This methodology, however, shows some limitations in attending to the research goals according to the empirical conditions. First, participatory discussions require a significant time and attention demand from the interviewees. Due to the small scale of the case of studies included in this research, most of the participatory discussions turned to be more manageable and less time demanding than expected. This was due to the fact that the various agents included usually one or a few people. Thus, the 'sector workshops' lasted between 2 and 4 hours. Semi-structured

interviews, however, showed more variability as they attended to different purposes, ranging from 1-3 hours. Semi-structured interviews turned out to be less appropriate for the narrative construction as the lack of collective discussions allowed a more institutionalised response. Guiding the interview to make respondents reflect following a chronological line and focusing on key events helped to break up the institutional discourses. For some agents, mainly governmental agencies, the high turnover of participants in the process of study hindered the building of a complete narrative of the agent perspective. In this vein, another constraint was how the institutional hierarchy, particularly for governmental agencies, would influence the group discussion.

An example of this is the Water Secretariat in the Quito case study, where the two interviewees preferred to have separate interviews to allow the person with more responsibility to provide 'the institutional narrative'. Sometimes, differences of opinion in relation to the institution's participation in the process were behind the existence of separate narratives from the same organisation. Another general limitation of this research methodology is that some interviewees had difficulties in reflecting on their own experiences. A chronological structure and some facilitation skills helped to create the narrative. As a result, most of interviewees welcomed the reflection and process maps created as a result of the participatory enquiry, as it reflected their own institutional journey and multi-stakeholder process from a different perspective. This strategy was also intended to build local capacity, as discussed above. The agents who responded more positively to participatory enquiry were the private and public agents. A final limitation was in relation to the inter-sector workshops. Agents' busy agendas frequently prevented them from having the availability to attend a second discussion, the inter-sector workshop. Internal conflicts of the collaborative process were also a common reason for interviewees not to attend the inter-sector workshops.

In terms of analytical criteria and structure, the main difficulties encountered in this research refer to the deductive approach of this work. To deduce the complex mechanisms at play behind the two case studies has been an enthralling and challenging task that has combined stages of analysis and literature review larger than initially expected. Additionally, the own complex nature of the object of study complicated the selection of 'the adequate' angle for analysis. After several trials and

mistakes, the current structure for analysis proved to be adequate and accurate for studying complex social dynamics.

Finally, cross-examination has been a crucial stage of analysis to provide patterns of behaviour that can be used to guide practicioners and inform policymakers regarding inter-sector collaborative processes. Furthermore, this research sheds light on further properties and features of how complex social systems behave and how dynamics such as those explored in this work influence this behaviour. This work suggests that this research methodology, 'qualitative dynamical modelling', could have profound implications for theory, practice and policymaking, as it offers a new approach to understanding and studying complex social processes, as discussed in this thesis' concluding chapter.

Conclusions

This chapter has argued that the use of complex dynamical systems' theory to investigate inter-sector partnerships (ISPs) requires a new research approach and methods for enquiry. Here, it was argued that the new research approach needs to go beyond the methods stemming from the disciplines that have traditionally studied inter-organisational collaborations, as they fail to address the complex, synergetic and dynamic nature of these processes. It was argued that this research approach also needs to go beyond the modelling tools commonly used in the field of complexity as 1) they shear away details around the object of study, which are fundamental for understanding complex social dynamics (as these are context and history specific) (Holland 1998; Wolfram 2002; Stacey 2007); and 2) because "mathematical models cannot deal with the full diversity of human behaviour" Stacey (2007:220).

Instead, a qualitative methodology that draws on complex dynamical systems' theory, combining a deductive and an inductive approach, is proposed to attend to the research goals and questions. This qualitative methodology is proposed to overcome the criticisms made of both qualitative (mathematical modelling) and other qualitative uses of complexity theory in other fields of knowledge, while attending to the requirements of this research topic. An inductive approach is used in a first stage to frame the behaviour observed in the field for each case study under the structure of a complex dynamical system (Chapter 4 and 6). A deductive approach is used in a

second stage to investigate the complex mechanisms and interactions that account for explaining the behaviour observed for each collaborative process or case study (Chapter 5 and 7). In this stage, a set of multidisciplinary concepts is used to complement the overarching role of complex dynamical systems' theory.. In a third stage, a deductive approach is also used to identify the common patterns and complex principles that operate across the two cases of study (Chapter 8). An inductive approach is finally proposed to transfer the common behaviour observed from comparative analysis to inform policy makers and to guide action-design in the field of inter-sector collaborations, as discussed in the concluding chapter of this thesis.

In relation to the research methods, the combination of participatory methods and semi-structured interviews, together with case studies, are presented as a set of tools that show the flexibility, accuracy and adequacy necessary for the research topic, strategy and approach. Here it is stated that these methods account particularly for the two kinds of elements necessary to approach ISPs from a complex dynamical perspective: 1) to bring a broad picture of the system of study by providing with the multiple perspectives, variables and dynamics, hidden or explicit; 2) to create the collective narratives necessary to investigate systemic properties such as emergent behaviour; and 3) to dig deep into the level of detail necessary for understanding the particularities of each case study. This methodology has shifted the role of the researcher from the traditional forefront position of describing the object of scientific enquiry to the role of facilitating the protagonist of the action to make this construction. This section also argued how the study of complex dynamics requires that the data collection, data processing (case study description) and analysis reflect the rationale of complex systems: time line format, multilevel structure and interactions' mapping. Here it was explained that for the purpose of analysis the data is structured into a macro level (emergent and process level (meso level)) and a micro level (agent level) to explain the emergent dynamics of collaborative work.

This chapter also presented the risk analysis of the methodology strategy and the measures undertaken to overcome them. Further assessment of the applicability of this methodology during fieldwork is made; thus, the challenges and limitations confronted are noted for future research. The main challenges noted were in relation to: the researcher's capacity to play the role of facilitator for the purpose of constructing collective narratives; to know the context conditions and current

dynamics of the locations of study and language spoken in those locations in order to reduce the distance between observer and object of study; to understand the different institutional backgrounds and languages in order to perceive the nuances of each narrative; and the researcher's flexibility in adapting to the diversity of conditions in order to obtain the required data. In relation to the limitations of this methodology: the scale of the system of study, the human nature of the agent of study and the constraints of the participatory tools used during fieldwork were the main ones noted. Various suggestions are included to overcome these methodological limitations.

Finally, this research has noted the various ethical issues around this methodology design. These refer mainly to bridging the gap between knowledge production and the return (payoffs) of this for respondents. To deal with this issue, this research has included various actions to build some local capacity. The first measure was to select experiences for case studies with a genuine interest in the research topic and to set up a relationship based on exchange or *quid pro quo*. This included taking notes of any challenges the case studies presented, providing feedback to them from my personal knowledge and from the other case studies. These issues were covered during various meetings and during the workshops. The ideas of complexity theory and its various mechanisms were the topics that raised the most interest. The second measure undertaken to provide a return or feedback to the case studied was to create the role of 'research assistant'. This was intended to build some local capacity by providing access to a local person for all the discussions of this work. The last measure planned in this respect was to share all the data collected from fieldwork and as a result of the analysis. A copy of the data collected during fieldwork was left during all the visits. The results of the analysis however, have not yet been provided. The time span in between the fieldwork and the completion of the analysis (with eight months of maternity leave after fieldwork) and use of a different language (academic English) for this thesis, have been the main barriers to accomplishing this goal.

This research approach is presented then as an alternative model for theorising and guiding human action based on a qualitative methodological strategy that this work has named 'qualitative dynamical modelling' (QDM). This dynamical pattern is presented in Chapter 8 as a sequence of stages and complex mechanisms that build up the capacity in the system to enable inter-sector collaborations and partnerships to

emerge and evolve. This work therefore sets the basis for the creation of a first qualitative dynamical model of ISPs. The latter however would require further research to calibrate this model based on the inputs from new case studies and its practical application. The concluding chapter of this thesis explores the applicability of this research methodology to other areas of knowledge that aim to advance the theory and practice of complex processes of social change, such the inter-disciplinary field of Sustainability studies.

The next chapter presents the first case study of this research, the construction process of the Mandú Alliance, in northeast Brazil.

Chapter 4

Case Study Description
"The Mandú Alliance"
Piauí- Brazil

Introduction

The Mandú Alliance is a multi-stakeholder partnership between Piauí Federal University, EMBRAPA[32], Flora Vida Institute[33] and CARE Brazil[34] - also called a coordination group - to promote development in areas of education, citizenship and income generation in some Piauí coastal communities (Brazil). Appendix 8 presents an organisational chart with the main agents involved in this case study.

Multi-stakeholder partnerships, also referred to as multi-stakeholder networks (Roloff 2008), adaptive governance (Dietz *et al.* 2003), and transition management (Loorbarch 2007), from various different perspectives, are increasingly used in the sustainability field as part of governance strategies or participatory platforms for more effective decision-making, conflict resolution and policy making. This case study reflects how inter-sector partnerships can represent a successful strategy to promote effective social programmes.

This chapter aims at presenting the first empirical case study of this research in order to investigate the dynamics of this collaboration process from a complex dynamical systems' perspective in the following chapter (Chapter 5). For this purpose, this chapter examines the main events that have enabled or hindered the collaboration process, their causes, and the journey and challenges that the institutions from the various sectors involved (public, private and non-for-profit) faced to engage

[32] EMBRAPA is the Brazilian Public Research Enterprise for Agricultural and Livestock.

[33] The Flora Vida Institute is the local branch of the chemical company Vege Flora Group.

[34] CARE Brazil is the regional branch of the International non-for-profit organisation CARE International.

in collaborative work. Ultimately, this chapter presents evidence of how these collaborative strategies increase communities' adaptability to change.

The first section of this chapter outlines the context to understanding the events described in this multi-stakeholder process. The second section presents the main events of the multi-stakeholder process that led to the creation of the Mandú Alliance and its subsequent development up until August 2009, the period of this data collection. The third section illustrates the adaptation journey that the Mandú Alliance main partners experienced over the time frame of this research.

The data presented was collected during fieldwork in 2009, covering the events occurring between 2003 and 2009. The methods used for data collection were a combination of participatory tools and semi-structured interviews. As a result, 24 representatives of the various institutions involved in this cases study were interviewed over 16 interviews. This included the Mandú Alliance's members, the organisations that declined to continue in the process, community beneficiaries of the Mandú Alliance's actions, and other partner organisations from the region. The types of interviews were: five participatory group interviews, seven semi-structured interviews and three semi-structured group interviews. Personal names have been omitted for confidentiality reasons.

Background Information

Piauí is one of 26 states located in Northeast Brazil, and its capital is Teresina. This capital is the only state capital in the Northeast to be located inland. The reason for this is the fact that Piauí was first colonised inland and slowly expanded towards the ocean, rather than the other way around as with the rest of the area (Mott 1985).

While Teresina has the highest population in the state with over 3,118,360 inhabitants in 2010 (IBGE 2010) it also centralises most of the government investments. However, Teresina is located 366 km away from the Piauí coast where the Mandú Alliance' activities are localised - see Figure 3 below.

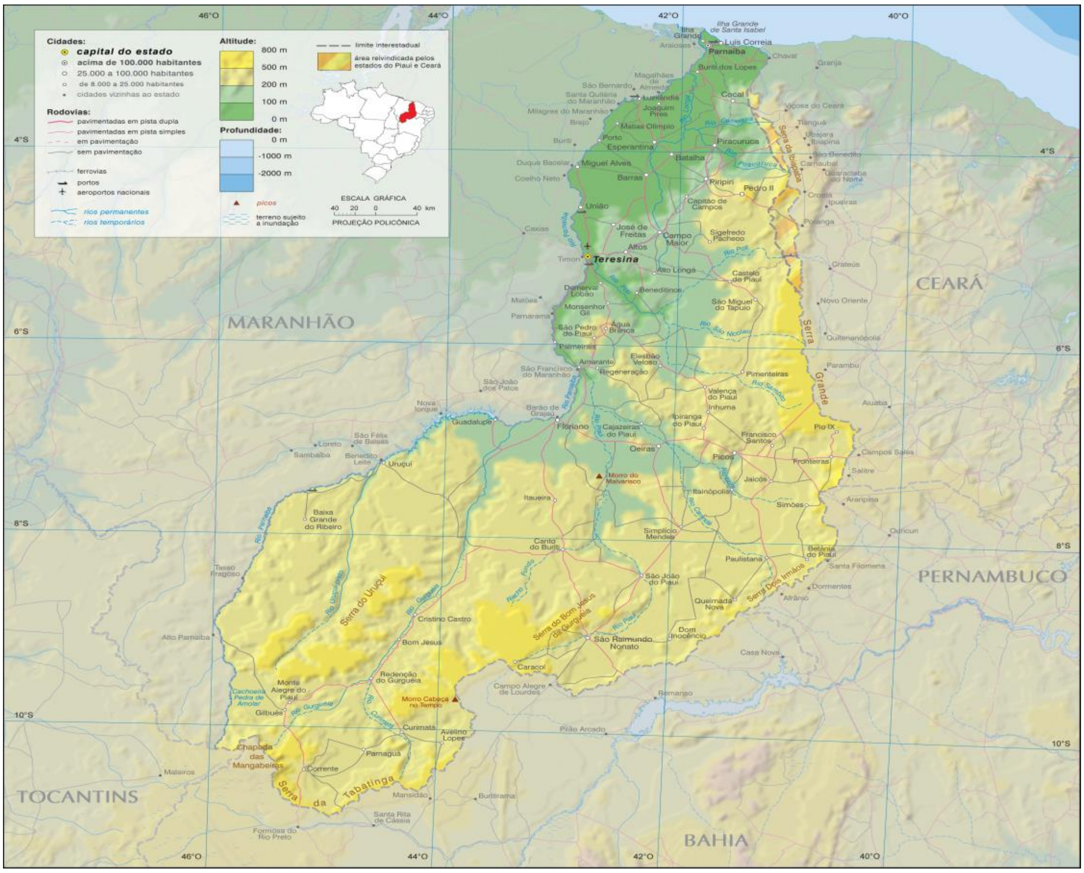

Figure 3- Physical Map of Piauí State (Brazil).

Piauí has 66km of coast - the shortest of any Brazilian state that borders the Atlantic Ocean (IBGE 2010). Despite this short distance, the coastal area is rich in natural resources with a high ecological value (Selbach and De Souza 1998), the reason why the region has an EMBRAPA research centre (Brazilian Public Enterprise for Agriculture and Livestock Research), which is one of the Mandú Alliance member organisations.

The Mandú Alliance works in the Parnaiba Delta region, the only delta in the Americas that opens up to the sea, and the second one in the world (Paiva 1999). The delta consists of 73 fluvial islands covering an area of 2700km² (IBGE 1996). Parnaiba is a port city and the main city in this region. In the 1940s, it was one of the richest cities in Brazil, due to its port activity (Da Silva 1993). The city had 140,839 inhabitants in 2007 (IBGE 2007). Today it has an important role in exports and agriculture, with approximately ten thousand hectares of irrigated land, also called the ‘Irrigation Quarter’. This large extension of irrigated land and the water quality in the region, attracts the main Brazilian organic farming producers, as for instance, for the *acerola* production for vitamin C (Lerzundi 1998). Despite the high ecological value

and diversity of the natural resources in this region, coastal communities around the delta are scattered (Cavalcanti and Camargo 2000). Its economy is based on agriculture, fishing and some tourism, due to the long distance from the main airport in Teresina (Lerzundi 1998). However, external tourism companies are increasingly lobbying local politicians and communities to open up the region to foreign investors.

The Northeast of Brazil is known however for its low level of HDI (Human Development Index) - Parnaiba HDI of 0,674 in 2002 -, as compared to the rest of Brazil with 0,794 in 2004[35]. Left-wing governments since President Henrique Cardoso (1995-2002), Lula da Silvia (2003-2011) to the current administration of Dilma Rousseff (2011-), have implemented actions to reduce this social inequality and problems of poverty such as the Fome Zero and Bolsa Familia Programme. These actions - also known as conditional cash transfer (CCT) programmes, mainstream social policy in Brazil - had targeted 30 million of Brazil's poorest people by 2003 with a target of 44 million by 2006 (Hall 2006). Conceptualized as 'social safety nets' as in the short term these programmes aim to 'catch' and 'protect' the poor from economic shocks; they also promote development through the creation of employment and income-earning opportunities (World Bank 2000). CCTs are considered in the literature as a pragmatic response for rapidly dealing with the suffering of some social sectors (Conway 2000). Furthermore, Hall argues that they also represent "a major ideological shift in thinking towards a more selective and means-tested approach for addressing mass poverty" (Hall 2006: 691). Finally, the literature discusses that this politically determined distribution of benefits by the State that CCT programmes represent, also means a shift from the notion of universal citizenship rights in favour of selective social rights (Able & Lewis 2002; Hall 2006).

These social inequality and poverty rates also attracted the interest of several international foundations that have settled in this region of Brazil such as the case of CARE International. This international non-for-profit organisation, in 2003, set up a branch in Parnaiba called CARE Brazil, which intends to promote a more sustainable socio-economic model for the region.

[35] http://desenvolvimentonordestino.wordpress.com/2007/09/04/idh-mundial-2004-referencia/- accessed in September 2012

In 2005, the Mandú Alliance was created to strengthen young people's entrepreneurship. In 2009, the Mandú Alliance worked in ten coastal communities: four in the Parnaiba region; three in Ilha Grande (on the coast); one in Luis Correia; and two in Cajueira de Praia (See Figure 1). At the time of data collection, the Mandú Alliance had attracted more than 2,000 young people with its actions[36].

4.1. The Multi-Stakeholder Process: Main Events and Causes

This section presents the main events common to the various organisations involved in the Mandú Alliance and that enabled or hindered the evolution of the multi-stakeholder process.

The information presented in this section stems from five group interviews (four group interviews with the organisation members of the Mandú Alliance and a multi-stakeholder group interview), seven individual interviews and three semi-structured group interviews, undertaken with different organisational representatives who were part of the collaborative work.

A comparative analysis was done across the group interviews to identify the similarities and differences among the different institutional journeys and their causalities and build a collective narrative. This analysis was undertaken during fieldwork by this researcher, together with a local research assistant, appointed from within the alliance and the support of the two main institutional representatives of the alliance. Its outcomes were presented in an inter-sector workshop for data completion and validation. Representatives of the four main alliance organisational members and other members of staff, a total of ten participants, attended this workshop (see Pictures, Appendix 1). The final outcomes of this inter-sector workshop are presented below.

4.1.1. A Call for Collective Action

In 2003, the Kellogg Foundation published a call for projects related to poverty alleviation and grassroots development for Northeast Brazil. This announcement drew the interest of several local organisations already involved in community development

[36] http://www.care.org.br/nossas-acoes/programas-territoriais/?page=piaui, accessed June, 25th 2012

in the Parnaiba region. To expand the scale of action was the institutions' main reason for attending to Kellogg's call.

The Kellogg Foundation is an International Foundation from the US that supports grassroots organisations, both financially and technically, aiming to improve children's and young people's situations. Promoting local community dialogue and networks in order to create a platform to identify challenges, establish priorities, and allocate resources for children to succeed, form the nucleus of Kellogg's main strategy components[37].

The announcement was spread from one organisation to another, until Kellogg's support requirements were met. Personal and institutional knowledge, common interest and respect were the main conditions behind these connections.

The initial proposal submitted to Kellogg reflected the institutional fragmentation of local action and the diversity of approaches to meet social needs. Hence, in 2004, Kellogg initiated plans to integrate these proposals into a common strategy for the region. As a result, the candidates were invited to attend a one-year training course taught by ABDL (Brazilian Association for Leadership Development), which aimed at strengthening their institutional capacity and creating a proposal of integration for the region. The training lasted until November 2004 with no guarantee of Kellogg's support to the integrated proposal.

The institutions that attended the training were: the conservative local NGO Susana Jacobs Childcare Post (PPSJ); the local tourism company Eco-Adventure; the regional branch of the International Foundation, CARE Brazil; the public research enterprise, EMBRAPA; and the Piauí Federal University, the major academic agent in the region. The work of these institutions and their trajectories in this process is presented in Part II of this chapter.

All of the interviewees agreed that: "many outcomes came out of the training". However, to set up the basis for the first inter-sector dialogue in the region was the first enabling outcome in the unfolding of this process.

4.1.2. First Inter-Sector Dialogue and Alignment

In 2004, Kellogg's one-year training programme provided the space for the first inter-sector discussions and interactions in the region, setting a common bottom-line for the

[37] http://www.wkkf.org/who-we-are/who-we-are.aspx, accessed in September 2012

various agents. Despite some history of partnerships in the region, no inter-sector debate or space had existed in the region until that time.

The training allowed the participants to have conceptual discussions on topics such as leadership, the concept of 'territory', different development approaches, and to share the different agents' perspectives, goals and interests. It also allowed the participants to examine the benefits of collective work and the limitations of working in isolation. The diversity of institutional interests and priorities, as well as the differences in language and time horizons were the main challenges of the first inter-sector debates.

The Brazilian Association for Leadership Development (ABDL) was responsible for the training. ABDL is a well-known Brazilian NGO whose mission is to strengthen social leadership for sustainable development[38]. Several aspects of the training were crucial for building a collective identity, as stated by numerous interviewees.

First, the length of the one-year training programme enabled participants to have sound discussions on key concepts and ideas, allowing them to share a vision of the region's needs and strategies for intervention. Professional facilitation of the debates was crucial in order to 'translate' the different institutional 'languages', avoid conflicts and reach collective outcomes.

Kellogg's requirement to design an integrated proposal as part of the training was another aspect that influenced inter-sector alignment, as it prompted the participants to reach agreement. Also, the interaction of the Kellogg Foundation with other local and regional agents and increasing the organisation's scope of action and capacity, were other motivations for the organisations to attend the training.

The greater interaction resulting from the training, however, caused some friction to arise. During the training, organisations were looking for potential partnerships with other training attendees. That was the case of CARE Brazil, EMBRAPA and CARE International who set up a partnership, together with the Local Residents Association, to undertake a community garden project. Some participants saw in this action a betrayal to the common effort being undertaken, and competition started to arise.

[38] http://www.abdl.org.br, accessed in September 2012).

4.1.3. Competition for Space

While the training participants were closer to building a common proposal, frictions between two participants: PPSJ (Susana Jacobs Childcare Post) and CARE Brazil, started to arise. According to the interviewees, a fight for a prominent position in the common proposal arose between these two agents.

Triggered by this conflict, the PPSJ abandoned the last stage of the common project design. Months later Eco-Adventure, another training participant, also left the process. A close relationship between Eco-Adventure's Director and the PPSJ President was the connection between these two exits from the collective proposal. However, once Kellogg financial support was agreed, Eco-Adventure asked to rejoin the group. The other participants on the basis of clear opportunism rejected the demand.

The training attendants, later Mandú Alliance members, used institutional conflicts such as the institutions' exit as an opportunity to strengthen their institutional governance. New rules were set up in relation to institutional interaction and communication. One of these rules was to keep the relationship always at a professional level, and never at a personal one. This has helped to avoid personalising the numerous conflicts and challenges that have stemmed from the collaborative process.

4.1.4. Community Engagement

Several training attendants such as CARE Brazil and the Piauí Federal University agreed on the need to integrate the community perspectives into the project proposal. For the other organisations, however, such as the Flora Vida Institute and EMBRAPA, participatory work or community consultation was a far cry from their institutional working methods.

Triggered by the Federal University, young population needs and priorities for action in the region were collected. ABDL (Brazilian Association for Leadership Development) provided the funds to engage the network of young community leaders called *'Teia de Jovens'* (Young Network). The existence of this network was crucial to obtaining the perspective of the youth population from the various communities.

This community consultation process was another crucial element in the unfolding of this multi-stakeholder process in different ways. First, it provided the

training attendants with a better understanding of the young population's situation and needs and the importance of local networks and leaders in achieving a greater impact. Secondly, the degree of community awareness and mobilisation achieved as a result of this consultation process was crucial not just for involving the communities, but it also weighed positively in Kellogg's decision to support this multi-stakeholder process. When Kellogg fieldworkers visited the region they were overwhelmed by the youths' motivation and leverage of the project actions.

In 2004, Kellogg Foundation announced its financial support, which led to the formalisation of the Mandú Alliance.

4.1.5. The Formalisation of the Mandú Alliance

The Mandú[39] Alliance was set up in 2005 to promote actions in the field of environmental education, income generation and social articulation in all Piauí coastal communities.

The final institutional group that made up the alliance - also called the coordination group - was: EMBRAPA (Brazilian Public Research Enterprise for Agricultural and Livestock), CARE Brazil (International Foundation for Sustainable Development), Flora Vida Institute (private non-for-profit branch) and Piauí Federal University.

At the time of its official creation, the alliance benefitted from a strong institutional identity and governance model built during the previous two years. An interviewee from the Piauí Federal University explained, "The outcomes achieved during these initial years were crucial for the later alliance development".

The personal relationships built during the innumerable hours of interaction during the one-year training, the institutional alignment achieved throughout the discussions, the concepts and approaches to community development shared, and the common knowledge and understanding of the context situation and challenges, were the main 'building blocks' of the strong alliance identity (Holland 1995).

Furthermore, the consultation process brought important changes for the alliance organisations and community perceptions. The visits of Mandú members to

[39] "Mandú" was the name of a local indigenous leader that fought against slavery in Brazil. The alliance coordination group chose this name to honour him.

the communities, in order to understand the different socio-economic and environmental needs and hazards, shifted their perception of community work. This change in perception happened differently according to the institutional experience the alliance members had with community work. On the other hand, communities also changed their perceptions of the alliance and its members as they got to know and understand better the role and work of the various organisations. The consolidation process of the Mandú identity, the governance model and perceptions was crucial for overcoming important challenges of collaborative work such as trust, mutual understanding and willingness to undertake collective work where set.

4.1.6. Project Layout - Shift to a 'System' Approach

The first major challenge of the Mandú Alliance was to communicate its project to the wider society. The project approved by Kellogg was an aggregation of different institutional actions under a common line of action: education and training. Mandú's staff however started to face the pitfalls of the project's fragmented structure as they began to execute it.

First, the lack of a collective rationale hindered the definition of priorities for execution. Secondly, the lack of clear definitions on specific aspects such as fund allocation, costs and liabilities prompted institutions to start claiming funds for their individual actions, without considering the others. External demands to be part of the alliance added more pressure to the problem of the project's structure.

In 2007, following Kellogg's Foundation advice, the alliance set out plans to reframe its strategy. After cross-examining the members' common interests with the context needs, the following topics came up: education, citizenship and income generation. These topics, referred to as 'systems' in the new strategy, became the alliance's priorities for action. According to the alliance interviewees, "this approach fitted more with the alliance focus on 'territory'". Young people from the communities, trained in project management, also participated in this strategic analysis.

This 'system' approach was crucial to allow the Mandú Alliance to increase its number of partners, and work more strategically by adding the capacities needed to reinforce each 'system'. This approach also enabled the alliance to influence more efficient public policy, as these were involved in this programmes, which was one of

Mandú's goals to increase its scale of impact. At the time of this data collection, the Mandú Alliance was the largest project for community development in the region.

4.1.7. Complementary Roles and Institutional Independence

To search for complementary roles between the partners while keeping their institutional independence, was another crucial aspect of the Mandú Alliance's evolution. In 2009, Mandú members played the following complementary roles:

The Federal University was in charge of training teachers to support the ideas of the alliance in community development, moderate discussions as part of the alliance strategy and to design a methodology for adult education. The university also contributed with its research skills, and provided contextual information to sustain strategic planning.

CARE Brazil was responsible for the alliance executive coordination, fundraising, accountability and financial management. Also, it contributed with its community work skills to promoting and teaching community leadership. The first Citizenship Education School in Parnaiba was one of the outcomes from this line of action.

The Flora Vida Institute looked after the environmental aspects of the alliance's projects. It also funded actions around sports, music, and art as tools for community engagement and education in values.

EMBRAPA was responsible for the technical assistance and coordination of the Income Generation System, one of the three Mandú systems. It was also in charge of executing the Oyster Production Project, which aimed to provide a source of income for coastal communities.

The reshuffle of the Mandú strategy reinforced its search for complementary roles and partnerships around the 'systems'. Having institutional independence between the alliance's role and the organisational functioning was crucial for the alliance's evolution and survival. Visiting other multi-stakeholder experiences in the region and country helped the Mandú members deal with some practical dilemmas of collaborative work.

The search for complementary roles also allowed the alliance to build a 'pool of tools and skills' provided by all the members. This diversity of institutional resources became the alliance's competitive advantage for its work as it provided a

broad understanding of the region through the agents' perspectives and community needs.

This stage, however, presented multiple challenges such as: dealing with multiple partners, integrating multiple actions, and giving continuity to the actions (over ten years) to make a difference in the conditions of the young population, agreed the interviewees. Additionally, the increased number of partnerships built by the alliance such as with the *Peixe Boi* and SEMAR (Piauí Environment and Hydrological Resources Secretariat), also required some institutional adjustments at an operational level to increase transparency and accountability.

The benefits from this pool of resources, according to the interviewees, were: "to learnt new concepts and tools from the different partners, which some had already integrated into their institutional strategies; and to provide continuity and larger scope of action to the alliance actions". For instance, the Flora Vida Institute used participatory tools to undertake community research in the area related to its business. This illustrates how Mandú was already influencing other local and regional agents, prompting professional mobility in the region.

4.1.8. Alliance Internal Functioning

The Mandú internal functioning was another fundamental aspect both for the evolution and impact of the alliance and its organisation members.

The concept of 'partnership' was the core idea that shaped Mandú's collective identity and functioning. From the Mandú members' interviews it can be concluded that this concept included a series of principles such as playing complementary roles, providing different skills, giving equal responsibility in the strategy execution, and equal liability of the budgetary management. Other shared values were honesty, critical sense, and respect for each other's views. This set of values was present at all levels of the alliance's functioning, as noted during fieldwork.

This partnership approach was also reflected in the alliance's governance model. As all members of the Mandú coordination group had equal rights and responsibilities both at a strategic and a financial level, decisions were taken collectively. "Good coordination and effectiveness is crucial to achieve scale and impact when working collaboratively" stated CARE Brazil interviewees.

The alliance's internal operational model was the clue for this coordination and effectiveness. Mandú members held weekly meetings to align the week's actions, monthly meetings to grant the member coordination in the various issues of the month, and strategic meetings every six months, to review and adjust strategic aspects of alliance work. Extra meetings were additionally held to assess unforeseen events or problems. Decision-making could be delegated to other Mandú members if the coordination group so decided.

Communication was another crucial aspect of the alliance's smooth functioning. "Communication is open and fluid, as people are available for discussions whenever necessary", stated the interviewee from the alliance. Once again, this communication culture results from the alliance's construction stage during Kellogg's training. The alliance's member stated that a communication scheme is not necessary if trust, collective governance and shared responsibility in decision-making exist.

Attitude was another key feature of alliance functioning. Dialogue always needed to be respectful, allowing everyone to express their own views. Constructive communication was sought at all times, allowing the use of people's ideas as building blocks for innovative ideas. Destructive attitudes were not allowed in the alliance. Also, professionalism was a crucial requirement for good communication. As noted above, responsibilities were never claimed at a personal level.

Finally, transparency was another important factor in the alliance's effectiveness. In 2009, a new accounting method was set up to improve the alliance's institutional transparency, both internally and externally. CARE Brazil's strength in this area contributed to this transition.

The construction of a collective identity and functioning wasn't exempt from many challenges. "Dealing with vested interests was a case in point" stated several interviewees during the inter-sector workshop. Searching for the action's best outcome was the best way to keep personal interests aside. This approach also helped in managing priorities and in saying "no" to the multiple external demands of collaboration.

A second major challenge for the alliance was the organisational dissimilarities of its members. To overcome this, differences and conflicts were used as a source of institutional strengthening. An instance of this is the PPSJ (Susana Jacobs Childcare Post) and Eco-Adventure exit, which was used by the alliance

members as an opportunity to discuss internally how to keep unity of interest and norms.

Over the years, the alliance leveraged an important number of local and regional partners from different sectors that joined forces to its strategy in the region. As the network of partners grew across the region, so spread the Mandú partnership culture and values.

4.1.9. Shift of Leadership: from Individual to Institutional

A search for more institutional leverage of the alliance's organisational members to its strategy was crucial in overcoming the Mandú dependence on the leaderships of its initial founders. According to all the interviewees, this was a turning point in the alliance's evolution.

The Mandú Alliance resulted from the leadership of local agents representing different institutions. This individual leadership was transformed into collective action, as a common approach for addressing the socio-economic problems of the region was built over the one-year training. However, increased institutional back up was necessary to sustain the alliance strategy over time.

This leadership transfer was taking place at the time of data collection. This was facing profound challenges as EMBRAPA, the Federal University and, to a lesser extent, the Flora Vida Institute were sceptical about devoting more institutional resources to the alliance. CARE Brazil was the most supportive, as it shared institutional objectives and strategy, and had an interest in replicating the lesson learnt from the alliance by other regions.

Pro-active actions were set up to leverage institutional interest. CARE Brazil coordinated visits from institutional representatives to local communities. This helped to shift the perceptions these institutions - EMBRAPA, Flora Vida Institute and the University - had on community work and the difference that the alliance was already doing in the region. The major shift came from the Flora Vida Institute, whose director from the São Paulo headquarters set up more partnerships in the Parnaiba region after learning about the benefits of multi-stakeholder partnerships. A second action was to improve the alliance communication within these institutions by producing reports on the alliance work and outcomes. CARE Brazil's Director followed these reports, when possible, with meetings with senior managers from the

institutions to present and discuss the alliance work and strategy. These actions were intended to bring the Mandú Alliance within its member organisations and to shift people's perspectives and behaviour.

As a result, other staff members from the Federal University, the Flora Vida Institute and to a lesser extent, the EMBRAPA, increased their support and participation in the Mandú strategy. A crucial aspect for consolidating this transition of leadership was "to leave room for the new participants to be part of and shape the alliance strategy", as pointed out various interviewees. At this point in the process, to set up a communication scheme that defined clear norms in the division line between the role in the alliance and the individual role of the organisation, as for instance in the use of the alliance logo, helped to erase potential conflicts of identity.

This leadership transition was a challenging process for most of the organisation members, and it took approximately five years, from 2004 to 2009, to reach a good level of leverage. Important challenges are still going on, however, according to the interviewees. Details of the challenges of this process by organisation are described in Part II of this chapter.

Other challenges the alliance were tackling at the time of data collection were: the creation of a council to support fund-raising and further partnerships; to set the foundation for replacing CARE Brazil's role as executive coordinator in the light of the cuts in philanthropy occurring at an international level; and to increase the alliance's visibility in the region whilst diminishing bureaucracy.

Summary of Part I

This section has presented the main events that influenced the evolution of the Mandú Alliance as a collective entity and that of its members at an organisational and individual level. Here it was demonstrated how having a collective goal, such as Kellogg's offer of support; how aligning the agents different perspective and interest through dialogue, shared concepts and values (identity); and how overcoming potential dampening forces stemming either from internal conflicts or external influences, were crucial elements for the construction of an inter-sector partnership.

Various strategies and processes were drawn upon to determine this outcome, such as: a clear division of roles, institutional independence from collective work; a strategy that fits all the parties' interests; a flexible communication and governance

model; a pool of common resources; and decreasing dependencies, both of leadership and of the financial resources in this case study.

As a result of this process, at the time of data collection in 2009, the Mandú Alliance was working in 10 coastal communities: four in the Parnaiba region; three in Ilha Grande; one in Luis Correia; and two in Cajueira da Praia. Some of the projects developed by the alliance at the time were: to support Cajueira film production, created by young people from the communities as a tool for portraying views on their reality; and the creation of cooperative of sweets by young women as a professional alternative and a tool to work other values and vision on their region (see pictures in Appendix I). Community people's education and training was however the alliance main programme (education 'system' or strategic goal). This programme aimed at reinforcing the other two 'systems', those of citizenship and income generation. An instance of these actions' outcomes was the first Citizenship Education School in Parnaiba, set up by the Mandú Alliance. An example of the Income Generation actions was an oyster production project coordinated by EMBRAPA.

Overall, 2,000 young people have directly and indirectly benefitted from the alliance's work, strengthening their entrepreneurship and participation in the actions that shaped their communities[40].

The spread of the alliance's work in the region started to have a multiplying effect at the same time that it increasingly attracted other organisations to what was referred to the 'Mandú culture'. The main motivation of these agents was to improve their capacity and reach of work in the region.

Finally, this section has noted how the main events that shaped the construction process of the Mandú Alliance also provoked changes at an organisational and individual level. The following section presents the changes and challenges that the various social agents faced to engage into the Mandú Alliance.

[40] http://www.care.org.br/nossas-acoes/programas-territoriais/?page=piaui, accessed June, 25th 2012).

4.2. Perspectives and Challenges of Collaborative Work at an Organisational and Individual Level

The literature notes that organisations display different approaches for and means of dealing with social dynamics particularly between those meeting public, private or not-for-profit goals (Loorback 2007). Although organisations have been defined for decades as consisting of structures and processes (Parsons 1960), they tend to be somewhat vague about how and which process events are affected by external forces (McKelvey 2000).

This section presents the transformation process that the organisational members of the Mandú Alliance experienced over its construction process. The first section outlines some background information about the institution. The second section describes the journey to collaboration by examining what motivated them to engage in a multi-stakeholder process, what role they played in the collective tasks and the changes they experienced through the process, and the main challenges.

The information presented in this section was collected during fieldwork through personal and group interviews. It represents the interviewees' personal opinions.

4.2.1. CARE Brazil

Institutional Background:

CARE Brazil is the regional branch of the International Foundation CARE International. CARE International (CI) is a confederation of twelve autonomous non-governmental organisations working in 84 countries, supporting 1,051 poverty-fighting projects, reaching more than 122 million people in 2011[41].

CARE Brazil is a non-for-profit organisation (NGO) registered in Brazil, whose members of staff and council are from the hosting country. CARE Brazil's Council has a CARE International representative within it. CARE Brazil was set up in 2001 to combat the structural causes of poverty in the lowest HDI (Human Development Index) areas of Brazil such as the north-east of the country, which is the

[41] http://www.care.org.br/nossas-acoes/programas-territoriais/?page=piaui- Paged accessed on June 2012

subject of this case study. Experience exchange and partnership building are the main institutional strategic components for promoting local and sustainable development[42].

Training and education are CARE Brazil's two main areas of work. Another strategic component is the strengthening and integrating of young people's views and needs into local development actions and the preserving of their rights.

Collaborative Journey:

Trigger Point for Collaborative Work: CARE Brazil's trigger point for engaging in the Mandú Alliance was proving to the Kellogg Foundation the potential of Parnaiba's young people for shaping their realities, as well as the search for a strategic partnership with the Kellogg Foundation to support the region's needs.

Institutional Role in the Alliance: CARE Brazil's main role in this multi-stakeholder process was to act as a catalyst or facilitator agent in local development processes. An example of CARE's catalytic role was the creation of 'Teia de Jovens' ('youth network') in 2004, together with other training participants such as the Federal University and Susana Jacobs Childcare Post (PPSJ). This initiative aimed at identifying young people's views on the current needs and priorities for action in their communities. Another example is CARE's catalytic role in leveraging greater institutional support for the alliance strategy.

Other skills brought by CARE Brazil to the multi-stakeholder process were: a good understanding of local dynamics; the creation of collective agendas; fund raising and executing actions.

All these skills somehow contributed to this multi-stakeholder process. However, the executive coordination and fund-raising were CARE Brazil's main responsibilities within the alliance. CARE Brazil's executive role was never used by the institution or perceived by other partners, as a privileged position in the alliance decision-making.

Institutional Change and Main Challenges: The affinity between CARE Brazil's strategic goals and the Mandú mission was an enabling condition for CARE's

[42] http://www.care.org.br/nossas-acoes/programas-territoriais/?page=piaui- Paged accessed on June 2012

catalytic role in the alliance construction process and its consolidation. This strategic alignment also enabled CARE International's back up to engage in this multi-stakeholder process. Moreover, the close connection between CARE's Parnaiba office to the headquarters in São Paulo brought mutual benefits. While the headquarters supported the Parnaiba office in setting up some important partnerships with the European Union and Tinker Foundation, the work of the alliance inspired CARE's projects both nationally and internationally. An example of this is that CARE UK copied the use of community radio as a means of keeping up with young people's views and needs.

The main challenge that CARE Brazil faced at the beginning of the process was dealing with the other agents' perceptions of change and the priorities of the region. The other parties saw CARE as a Cooperation Agency, as it relied on international support. As participants learnt of CARE's efforts to leverage local partnerships and funds for its strategy this perception shifted.

4.2.2. EMBRAPA

Institutional Background:

EMBRAPA is the Brazilian Public Research Enterprise for Agriculture and Livestock. Its mission is to provide feasible solutions for sustainable Brazilian agribusiness development through knowledge and technology generation and transfer[43].

In 1993, EMBRAPA opened a research unit of 1,615 ha for the study and development of the Parnaiba region, also called the Parnaiba Research Unit (UEP). UEP's main research fields are: the culture of cattle milk, fruit growing, aquiculture and natural resources. It also plays a role in the production of young plants for further repopulation and analysis of water quality for irrigation purposes. The UEP belongs to EMBRAPA Meio-Norte office, and has 72 members of staff, 11 of which are researchers and 61 are research assistants[44].

[43] http://www.embrapa.br/english- Paged accessed on June 2012

[44] http://www.cpamn.embrapa.br/aunidade/aunidadeparnaiba.php- accessed on June 2012

Collaborative Journey:

Trigger Point for Collaborative Work: The trigger point for EMBRAPA to engage with the alliance was a shared interest in researching and promoting sustainable income opportunities for local communities.

Institutional Role in the alliance: EMBRAPA's main role in Mandú was as coordinator of the Income Generation System, one of Mandú's three strategic areas or systems. As part of its responsibilities, they were in charge of the Oyster Production project execution and technical assistance.

However, EMBRAPA was represented for most of the multi-stakeholder process by a few researchers of the Parnaiba Research Unit; it never consulted with the Research National Centre or EMBRAPA's main office. EMBRAPA's focus on research and not on development was the main cause for the lack of institutional leverage for the alliance at the first stage of the process.

Institutional Change and Main Challenges: Institutional change was EMBRAPA's main challenge along the process as its research role was seen in conflict with community development work. Perceptions were different for researchers working on the front line, where the applicability of the research outcomes was a clear concern.

The organisation's size, conservative culture and bureaucratic functioning were the main resistance forces in driving institutional change and leverage to the alliance. At the beginning of the process, the researchers representing EMBRAPA in the alliance felt very isolated and were seen as 'aliens' by other staff of the Parnaiba Research Unit. At the time of data collection, things were slowly changing, as other members of EMBRAPA become aware of the alliance's outcomes and impact on the region.

EMBRAPA's main challenge was dealing with people from the communities and learning how to integrate different demands and views. EMBRAPA, as well as the Federal University had difficulties in buying in participatory methods such 'Action-Research', a method used by Mandú Alliance to identify people's needs. They considered this method extremely subjective, which for them blurred the applicability of its results.

The most recent challenge EMBRAPA has faced was shifting the community perception of development work. A tradition of paternalist policies and aid agencies in the region has made people dependent on external agents for developing any action. To rebuild local people's self-esteem and autonomy for action was EMBRAPA's main challenge in providing sustainability to the income generation projects.

4.2.3. Piauí Federal University (UFPI)

Institutional Background:

The Piauí University (UFPI) is a federal institution for high education created in 1968 (Law nº 5.528, of 12/11/1968). Although the University is located in the city of Teresina, Piauí's State capital, it has campuses in various cities of the state. Piauí Federal University supports this institution through State funds[45].

Collaborative Journey

Trigger Point for Collaborative Work: The engagement of the Piauí Federal University (UFPI) in the Mandú Alliance was through the leadership of one of its professors. This person was the first to respond to Kellogg's announcement and to call other institutions to participate.

Institutional Role in the Alliance: The university is responsible for the education system, one of Mandú's three strategic areas or systems. This involves leading the discussions for setting up education actions and methodologies of work to support the work of the other two areas. The university also provided its research skills and contextual information to sustain the alliance's strategic planning.

Institutional Change and Main Challenges: Shifting the university's traditional function in society to play a role in community development was UFPI's principal challenge. To share the alliance's first outcome was once again the trigger point to change the conservative culture of academics and perception of development work. The UFPI representative in the alliance reflected this situation when saying, 'they

[45] http://www.ufpi.br/page.php?id=1 - Page accessed on June 2012

needed to see it to believe it". Engaging in a multi-stakeholder dialogue was another challenge for the UFPI. In this respect, visiting the communities and getting to know other alliance representatives helped again to shift people's attitudes.

The UFPI representative and professor stated that "looking for allies ideologically closer to the ideas you pursue is a crucial strategy when searching to make a transformation". Influencing a small group and then expanding to a larger group was this professor's strategy for institutional change.

Learning to think on a different timescale and to know other institutional languages were other two major challenges faced by the UFPI. "During the first inter-sector dialogues, it was clear that every agent spoke a different language, but many times we were saying the same thing with different words", noted the respondent. "We learnt that community development is a long-term process that requires planning actions beyond 10 years, and this was beyond the university timescale of work", added the interviewee.

At the time of data collection, UFPI support for the alliance had shifted. It had more staff members involved in the alliance and had introduced some institutional changes for attending to its responsibilities in Mandú. An example of these changes was the academic support to students involved in alliance actions, to help them to cope with both academic and community work. The openness to new ideas of UFPI's younger generation was noted as the main enabling condition for many of the institutional changes introduced.

In terms of outstanding challenges at the time of data collection, the financial sustainability of the education system was one of UFPI's concerns. Improving UFPI's scale of work to provide a better service to community needs, both in terms of better targeting community priorities and giving continuity to its actions, were other recent challenges that would require further institutional support for the alliance.

4.2.4. Flora Vida Institute

Institutional Background:

Created in 2002 by the Centroflora Group, Floravida Institute is a non-for-profit organisation, whose goal is to contribute to the communities' socio-environmental development through actions in education. The institute headquarters are located in

city of Botucatu, centre-west of the São Paulo State, and is also present in the Parnaiba city[46].

The Centroflora Group owns Vegeflora, manufacturer of drug inputs for the pharma-chemical industry located in the city of Parnaíba, Piauí State. Vegeflora produces pilocarpine salts, active components used mainly in drug formulas prescribed in the treatment of patients with glaucoma. These salts are extracted from the leaves of the Pilocarpus microphyllus Stapf (jaborandi) plant. All raw materials processed in Vegeflora originate from sustainable farming[47].

Collaborative Journey:

Trigger Point for Collaborative Work: The Flora Vida Institute was invited by CARE Brazil to join the Kellogg training scheme. The personal and institutional affinity that the institute held with other regional agencies was behind this invitation.

The motivation for the institute in responding to Kellogg's offer was the opportunity this represented to increase its reach of action and learn to work with young people. "The Institute is very aware that working with communities is one of our weaknesses so we search for partnerships all the time", acknowledged the Flora Vida representative. Hence partnerships and environmental issues were already strategic components both for the institute and the company.

Institutional Role in the Alliance: Flora Vida's role was to supervise the environmental issues of the alliance's actions and to coordinate projects around sports, music and art aiming at promoting community engagement and citizen education. Examples of these actions were the Street Football project; the film production company 'Cajueira Films'; and the Young Fund (Fundo Jovem), which supports youth entrepreneurship in these coastal communities.

[46] http://www.floravida.org.br/instituto/- Paged accessed on June 2012

[47] http://www.centroflora.com.br/index.php/pt/empresas-do-grupo/vegeflora.html- Page accessed on June 2012

The engagement of Flora Vida Institute in the alliance at the beginning of this multi-stakeholder process was very much constrained to allow the Parnaiba office staff to participate in the alliance activities, similarly to EMBRAPA.

Institutional Change and Main Challenges: The main benefits the institute gained from being part of the alliance were: better understanding the context where the company operated for years; dealing with inter-personal and inter-institutional issues; and learning key concepts and approaches to community work. This is reflected in the statement of the institute's representatives when they say that "to be part of Mandú enabled us to realise how far we were from understanding social development and how the geographical distance from us in the field to the headquarters in São Paolo, thousands of miles away from Parnaiba, was becoming a barrier to keeping up with all the changes occurring at the Parnaiba office".

The institute also reviewed some of its operational methods when learning more effective ones from the other Mandú members. For instance, the institute copied CARE Brazil's financial system, which led to a better financial performance; it introduced a new evaluation method and improved some communication tools such as reporting.

All these changes that initially occurred in the institute's Parnaiba office weren't perceived from the company's headquarters in Sao Paulo. Two years later from the beginning of the multi-stakeholder discussions, the first outcomes of the alliance were one again the turning point for overcoming this geographical barrier. Furthermore, this was the gateway for the recognition of institute staff at a local level, which led to better professional opportunities such as access to training and learning trips. This recognition reflects a better two-way connectivity and dialogue.

Finally, the visits of the Flora Vida President to the Mandú project in 2008 set another hallmark in the institutional engagement process. This visit reinforced its participation in the alliance and enabled new partnerships outside Mandú to be created, such as the Alive Chemistry Project (Farmacia Viva). A better understanding of the regional context, the other agents and Mandú's work, was once again the enabling condition for this institutional transformation.

At the time of data collection, the strategy of the Flora Vida Institute was more aligned with the company strategy, providing both organisations with a larger reach of action and impact. Knowledge was also flowing more efficiently between the two

institutions, reinforcing to a greater extent the perspective of the headquarters on the benefit of partnerships and community work. This institution alignment also strengthened Mandú's work through the better perception that the community gained of the alliance and its partners. A sign of this capacity building was the fact that the company did not cut the Flora Vida budget when going through financial constraints.

4.2.5. Young People from the Communities

Background Information:

Young people involved in the Mandú actions went through significant transformations too. This changed according to the age ranges of the participants, despite the fact that most of the project participants were between 13 and 19 years old. In terms of figures: 60% of the youngsters that participated in any Mandú project carried on in any action, 20% left after a while yet carrying away the Mandú values; and 20% rejected any invitation to participate. The engagement of 60% people translates to 2,000 beneficiaries of the alliance's Mandú actions.

The most popular projects of the Mandú Alliance, many in partnership with other local agents, were: The Sweets Cooperative ('Cooperativa de Doces') in Labino (Ilha Grande); and the 'Cajueira Films', an entertainment company hosted the community of Cajueira da Praia.

Young People's Perspectives of the Process:

Mandú's actions offered them a better understanding of their reality, the chance to have a say on their own needs and more professional opportunities. For some of them, it was a means to divert their energy from dead-end roads such as drug-taking. "Now we feel capable of changing our lives", stated an interviewee who was 15 when he first joined Mandú; now he is 23. This personal and professional development provided by the alliance also reached their families, both their children and parents.

The community consultation made by Alliance members while still part of the training was the starting point for young people's engagement in Mandú work. This process steered young people to set up actions in their communities to improve their future; enabled them to be part of the feasibility assessment for these potential actions; and as the funds were available, the project was running and their skills were

improving, they found jobs in the projects such as Visual Art Trainer, Leadership Trainer, Film Manager, etc.

One of Mandú's most successful projects was '*Cajuina Filmes*', an entertainment company set up in 2008 by a group of young people to combat the offer of retailing companies that portrayed situations and values very different from those in the communities. The company aims to explore youngsters' needs and provide them with relevant content and entertainment through films, theatre, dance, etc. Recently a film festival has been created as a result of this success. Here conferences and debates are held by and for young people. "Actions like this festival have enabled young people from the communities to gain confidence and to stop migrating to other regions of the country", acknowledged one of the company founders.

Learning how to work in partnership was another benefit for young people. Before the Mandú Alliance existed young people from the communities had to manage by themselves the different institutional demands that varied in terms of timescales, priorities of investment, reporting, etc. Instead, Mandú offered them a unified window where all the actions from their members were integrated and the procedures were aligned. "At the beginning it was difficult to understand what the Mandú Alliance was and if it would work out", said one of the interviewees. However, Mandú became a role model for them on how to work collaboratively.

Mandú's Perspective on Community Engagement:

The lack of credibility of local people in development projects was one of Mandú's main challenges in engaging people from these communities. HDI (Human Development Index) levels in this part of the country have historically attracted funds that have been mismanaged by governments and fraudulent NGOs making communities lose credibility in these organisations. "At the beginning of the process some people from the communities thought that behind the alliance there were politicians trying to take advantage of them", stated one of the interviewees.

Mobilise young people to work was another major challenge. Many youngsters were inactive, and hence in a comfortable position. Having to spend a whole afternoon learning in a training programme from Mandú was a challenge for many of them. However, lack of opportunities in this area triggered many youngsters to embrace Mandú' actions very enthusiastically and to grow with them.

Project trainers were locals from within the region so young people thought they had nothing to learn from them. This resistance is a sign of the low self-esteem that local people held and that Mandú has attempted to change. “Now young people do appreciate and even get more inspired when they see one of them achieving something important, as they mirror themselves on that person”, said an interviewee from the community. Theatre lessons run by the NGO *Peixe Boi* is an example of an action designed to improve self-esteem. During these classes young people can talk about their reality, project themselves into the future and act out role models.

Ensuring that people felt part of the group was another challenge when working with youngsters. To build a sense of belonging was a crucial component of all Mandú’s training aiming to promote young entrepreneurship. To work among themselves allowing dialogue between different parties and finding a common ground was a principal challenge for them when designing Mandú’s actions.

Community debates on general issues were also part of the Mandú strategy, aiming at increasing the capacity of young people to discuss political issues. “Nowadays, youngsters see themselves as community leaders presenting their proposals to local authorities and engaging in political debates with them”, appointed an interviewee from the community.

The main challenge of young people at the time of data collection was how to sustain community projects over time beyond Mandú support. “The human capital created by the Mandú is our main solution to this challenge as we can influence community spaces beyond the alliance’s actions”, agreed several interviewees from the community.

Conclusions

This case study has presented the main events and agents’ perspectives that determined the Mandú Alliance construction process.

The Mandú Alliance experience is an example of how a new dynamic can be constructed in a region and it can influence the local dynamics. It also reflects how this new dynamic can spread out from a local to a regional level increasing its scale of reach. This new dynamic, however, represents a shift of paradigm from the traditional paternalist (fragmented and top-down) approach to social development to the strengths of self-organised collective work, despite the resistance that this process

faced in a first stage of construction. Mandú represents a new strategy based on a bottom-up approach to problem solving, and an integration of different institutional perspectives, capacities and actions around three focal points: education, citizenship and income generation, which are strategic for the population group focus of its work. This strategy was managed to tackle the structural problems around young people in the region - low self-esteem, lack of opportunities and high levels of migration - by breaking through the fragmentation of institutional actions, perspectives and time horizons in relation to social change.

The Mandú Alliance also proved to produce outcomes that were beyond the individual organisation's reach of work, at the same time as providing capacity building, innovative actions and network opportunities to institutional partners. For these reasons, the alliance became a model for local and regional organisations searching to increase their scope of action and strengthen their institutional capacity. Indirectly, the professional mobility produced as a result of the alliance also contributed to the 'Mandú culture' spreading across the region. As employees moved from one institution to another, they spread Mandú's values and approaches to sustainability to the host institutions. An example of this is SEMAR (Piauí Environment and Hydrologic Resources Secretariat) participation in the alliance's work, which was due to the fact a former Mandú employee had joined the governmental agency.

The Mandú Alliance also became an alternative mechanism for influencing policy making. The integration of governmental agencies around Mandú's three 'systems' or strategic areas contributed to the shift of public servants' perspectives on (1) the social challenges and needs in the region, and (2) their view on other agents' perspectives and roles. At the same time, similarly to the alliance's members, policy-makers needed to adapt their operational functioning to meet the Mandú requirements for collaborative work. As a result they started to introduce within the public policy sphere elements of long-term planning, collective goals, multi-stakeholder interactions, common language, and adaptability to the diversity of context-conditions.

Furthermore, the capacity of local and regional agents to respond and adapt to unforeseen internal and external changes has also been reinforced as a result of the creation and work of the Mandú Alliance in the region. According to all the respondents, this can be observed through the stronger network structure between

organisations, communities and people in the region; the strengthening of personal and institutional capacities; and the common vision and values in relation to the sustainability for the region that were created as a result of the alliance. In other words, the Mandú Alliance has helped to reinforce the resilience[48] capacity of the communities involved with this project.

This research work argues that all the elements that influence the creation of the Mandú Alliance and its development reflect the dynamics of complex systems. For example, the reinforcement of the network structure in the region, greater connectivity between agents, the internal motivation of agents to join the alliance, the catalysing role of external agents, the specialisation process that organisation and individual agents experienced to attend the collective work demands, the mutual influence and agreement that agents exerted each other, the emergence of the alliance from the agents' interaction, the construction process of a common identity and behaviour, and how the Mandú culture is spreading in the region.

The following chapter uses a complex dynamical systems theory approach to analyse why the dynamics that determined this experience evolved in such a way and what complex mechanisms, context conditions and processes shaped this process. Would the ideas of complexity theory be capable of explaining the construction process of this inter-sector partnership? The following chapter provides the answer to this question.

[48] Resilience in this context is understood as Folke *et al.* (2005: 443) definition as "the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still remain essentially the same function, structure, identity, and feedback".

Chapter 5

Case Study Analysis
'The Mandú Alliance'
Piauí- Brazil

Introduction

This chapter analyses the complex dynamics behind the inter-sector process that led to the creation of the Mandú Alliance in the Parnaiba region (Piauí State, North Brazil). This chapter analyses the events that occurred between 2003 and 2009.

This is the first of two analytical chapters that explore complex dynamical behaviour in two different contexts and multi-stakeholder processes in the context of this research. The ultimate goal of analyses of these two case studies is to produce a comparative analysis (Chapter 8) that identifies common patterns of functioning behind inter-sector partnership processes. For this, an analysis of the mechanisms, processes and conditions that enabled each case study is made in the analysis of each case study, and similarities and differences are sought in the comparative analysis.

The Mandú Alliance, as described in the former chapter, is a multi-stakeholder partnership created in 2005 between the Piauí Federal University, EMBRAPA[49], Flora Vida Institute[50] and CARE Brazil[51] to improve the conditions for young people in several coastal communities of the Piauí State (Brazil). These coastal communities had not benefited from the recent economic boom in the region in terms of changing their socio-economic situation. Moreover, the north-east part of Brazil, where Piauí is located, has been for many decades one of Brazil's poorest areas (IBGE 2007). The lack of effective regional and national public policies combined with a poorly diversified, local-based economy and the distance in accessing this area, have contributed to poor socio-economic indicators.

[49] EMBRAPA is the Brazilian Public Research Enterprise for Agriculture and Livestock

[50] The Flora Vida Institute is the local branch of the chemical company, Vege Flora Group.

[51] CARE Brazil is the regional branch of the International non-for-profit organisation, CARE International.

This situation attracted the interest of international development organisations such as CARE Brazil, and other local actors, such as EMBRAPA, Federal University and the Flora Vida Institute, to try to reverse the vulnerability of these coastal communities. Aiming to produce a synergetic impact, these institutions work under the umbrella of the Mandú Alliance, strengthening the capacity of young people from these communities to build a more sustainable socio-economic model. For this, the alliance works in the fields of education, citizenship and income generation.

By the time of this data collection in 2009, the Mandú Alliance was already working in ten coastal communities and more than 2,000 young people had benefited from its actions[52]. Full details of the events, conditions and outcomes that were involved this case study are presented in Chapter 4.

This research argues that the events and dynamics observed in this experience reflect the nature of the complex behaviour of social systems. To explore this hypothesis this chapter applies a complex dynamical systems' theory approach and other concepts stemming from the field of complexity theory, presented in Chapter 2. This aims to answer the main research questions: 1) what is the complex dynamic behind the inter-sector collaboration process of each case study? A subsidiary question in relation to this is: how do the various agents' institutional backgrounds[53] influence their journeys to collaborative work?; and 2) What are the main principles that contribute to the construction of inter-sector partnerships under a complexity theory approach?

To answer these research questions the first part of this chapter explores the dynamics that influence this collaborative process at a macro level. This involves investigating *what* are the complex mechanisms at play, *why* they emerge and *how* they function and interplay to produce the observed outcomes. The second part of this chapter examines the transformation of agents' behaviour over the process that explains the dynamics discussed at a micro-level. This section discusses how agents' attributes, the organisations' structure and dynamic, and the agent location in the system define the different adaptation journeys organisations experienced to engage

[52] http://www.care.org.br/nossas-acoes/programas-territoriais/?page=piaui, accessed June, 25th 2012

[53] By `background´ this work means the different vision of reality, institutional culture, language, etc that organisations coming from different social sectors present.

into collaborative work and their payoff distribution. The third section of this chapter briefly examines how inter-sector collaborations contributed to build resilience in the system of study.

5.1. The Dynamics of the Multi-Stakeholder Process at a Macro Level

Chapter 4 presented the main events and conditions that led the Mandú Alliance to its creation and further development. Details of the events that enabled or hindered the multi-stakeholder process at a macro - or collective - level and a micro - or agent - were described there.

This section examines how the Mandú Alliance and other dynamics observed in the process emerged from the interaction of the multiple dimensions and levels of the system; and according to the parameter values present in these dimensions (Kauffman 1993; Mitleton-Kelly 2003b). This reflects the fact that the behaviour of the system stems from the interplay of its structure and dynamics, and according to the attributes of its components (Kauffman 1993, 1995; Holland 1995, 1998)

However, fundamental questions around the functioning of this process need to be explored to better understand the dynamics of inter-sector collaborations, such as: What forces and conditions enabled the creation of the Mandú Alliance? Considering the challenges and changes organisations examined to be part of the alliance, what drove them to engage in this process? What did the creation of the alliance represent for the beneficiaries and the Parnaiba region? How do we explain the expansion process of the Mandú culture in the region?

The following sections look for answers to these questions and others that arose during this analysis, through an examination of the system dynamics at a macro level.

5.1.1. Featuring the Nature of the System

The starting point for this analysis is to feature the conditions and dynamics that the system of study showed at the beginning of the multi-stakeholder process to later analyse how they enabled the emergence of the Mandú Alliance. By system of study this analysis refers to the multiple agents, structural conditions and dynamics that, in the context of the coastal communities where the Mandú Alliance works, interacted

shifting the system dynamics. In 2009, the alliance was working in ten coastal communities: four in the Parnaiba region; three in Ilha Grande; one in Luis Correia; and two communities in Cajueira da Praia.

In terms of size, the system of study can be considered as a small social system, according to Brazil cities' average size and the scale of the country, as Parnaiba city had 140,839 inhabitants in 2007 (IBGE 2007). At the beginning of this process of study, in 2003, the system network structure showed quite a low connectivity between types of agents (public, private and civil organisations), with few links to regional and national nodes (cities and other agents) (Watts 2003; Albert and Barabási 2002). Some of these links however showed strong bonds revealing the inter-dependence between agents, as for example between the coastal communities and CARE Brazil, and among several national corporations (agricultural activity) and other commercial hubs.

This connectivity and inter-dependence reflects the various dynamics present in the system at the beginning of the process: (1) the expansion of new economic activities such as agro-business and tourism, that together with the traditional commercial activity of the Parnaiba port, were changing the region's socio-economic conditions; (2) the dependence of this new economy on natural resources as large extensions of land being transformed for irrigation and tourism investors lobbying to build up the currently preserved Piauí coast; and (3) the unequal distribution of this economic expansion with coastal communities having the worst share.

Coastal communities, as a result of these changes occurring over the last few decades and the lack of effective policies, are increasingly vulnerable. This vulnerability has resulted from their increased economy dependence on the new economic activities, increased risk of reconversion of their lands, and the intense consumption rate of their natural resources. The interaction of these multiple dimensions accounts for the increased vulnerability of these coastal communities. This scenario is what Mitleton-Kelly (2003b) refers to as the 'problem space'.

As this problem space is built over time, it leaves parallel gaps in the system that offer other agents the opportunity to occupy a new niche, which can eventually improve their fitness capacity, and hence create a new dynamic in the system, as shown by this case study. What are the conditions and mechanisms that enabled this new dynamic to emerge? The following section provides answers to this question.

5.1.2. Niche Opportunity

An analysis of the process of creation of the Mandú Alliance shows that the same conditions that led the coastal communities of study to a situation of high vulnerability also opened up the opportunity for agents to occupy the niche left by the failures of the former dynamic. Holland (1995) refers to this process of creation of new spaces in the system as 'niche opportunity'.

Watts (2003) refers to 'niche opportunity' when network conditions are set to allow an external agent to fill a gap left in the system. Kauffman (1993) brings this term from biology to refer to the gaps or niches that a system constantly creates as a result of its ever-changing nature or evolution. Niches offer new opportunities for local or distant agents to improve their fitness[54], and can be a source of innovation.

The trigger point (Kauffman 1995) that led agents to occupy the niche created in the system, in relation to the vulnerability of coastal communities, was Kellogg's[55] announcement of support. This announcement offered agents from different sectors the opportunity to participate in the one-year training. It also included an invitation for participants to present an inter-sector collaborative project by the end of the training, which would improve the region's young population conditions.

The first process that therefore led to the emergence of the Mandú Alliance is the 'niche opportunity' for agents, such as the Kellogg Foundation, to create a new dynamic in the system (Kauffman 1993, 1995; Watts 2003).

The second process that can be drawn from this case study is the match formation between the niche created in the system and the new agent internal configuration (attributes and attitudes) (Holland 1995; Kauffman 1993). Scholars report on how external resources and actors can play an important role in catalysing new processes when interacting with local people or resources (McCay 2002).

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[54] The fitness of a species represents its degree of adaptation with respect to the external environment (Bartolozzi 2006).

[55] The Kellogg Foundation is an international not-for-profit organisation that has two strategic goals: (1) to improve children's and young people's conditions and (2) to promote local community dialogue and networks as a means of tackling children's needs (http://www.wkkf.org/who-we-are/who-we-are.aspx, accessed in September 2012). To achieve these goals, the institution provides technical and financial resources to improve some aspects of this population group.

The entrance of an agent such as the Kellogg Foundation shows that the balance between receptive forces and resistance forces is positive. This reveals the presence of a complex mechanism at play in the configuration of people's perception: path-dependence. The history of national and international agencies providing services (food, income opportunities, and education) to this part of the country, mainly through conditional cash transfer (CCT) programmes as mentioned above, has created the dependence of these agents on external sources. This perception and these attitudes towards the presence of external agents is what have counterbalanced the forces that enabled Kellogg to enter the system. This situation also illustrates that the system structure and dynamic are governed by agents' perceptions and attitudes, as further discussed in the Part II of this chapter.

However, other enabling conditions present in the system also determined the emergence of this multi-stakeholder process - the system social capital (Diezt and Ostrom 2007; Ostrom and Ahn 2003). The literature refers to social capital in terms of the level of trust, leadership, learning, meaning, knowledge and experience that a system exhibits (Berkes and Folke 1998; Carpenter *et al.* 2001; Diezt and Ostrom 2007). After Kellogg's announcement, a small group of agents organised themselves to boost the most capable organisations in the region to join the training. This leadership, but also the trust already present between these agents was crucial for them to respond to the Kellogg offer (Folke 2005). Furthermore, this group of local leaders showed specific attributes that distinguished them from other local agents. The first one is at the level of perception (Waltner *et al.* 2003), as they were able to perceive Kellogg's announcement and collaborative work as an opportunity for them and for the region. A second attribute was their previous knowledge and experience in collaborative work stemming from former partnerships.

The final enabling condition of the system at the time of Kellogg's announcement was the capacity that young people from these communities already exhibited. These coastal communities, the target of the Mandú Alliance work, had already collaborated with international agencies and other local agents. Therefore, Kellogg's announcement was well received by local communities, as the capacity to interact with this type of agents also existed in the system.

This section has illustrated how the social capital and capacities existed in the system at various levels; the path-dependence installed at the level of agents' perception and the match process between the new agents and the conditions of the

system were the main aspects that enabled the entrance of the Kellogg offer and the creation of the Mandú Alliance. Furthermore, the enhancing effect that the Kellogg offer had on the local agents, such as their interest to join forces to tackle a common local problem and to seek new strategies for improving the sustainability of the region shows that positive feedback was another mechanism shaping the dynamics at this stage of the process. These enabling conditions and interconnections are represented in the collective process of inter-sector collaboration construction presented in the Appendix 3.

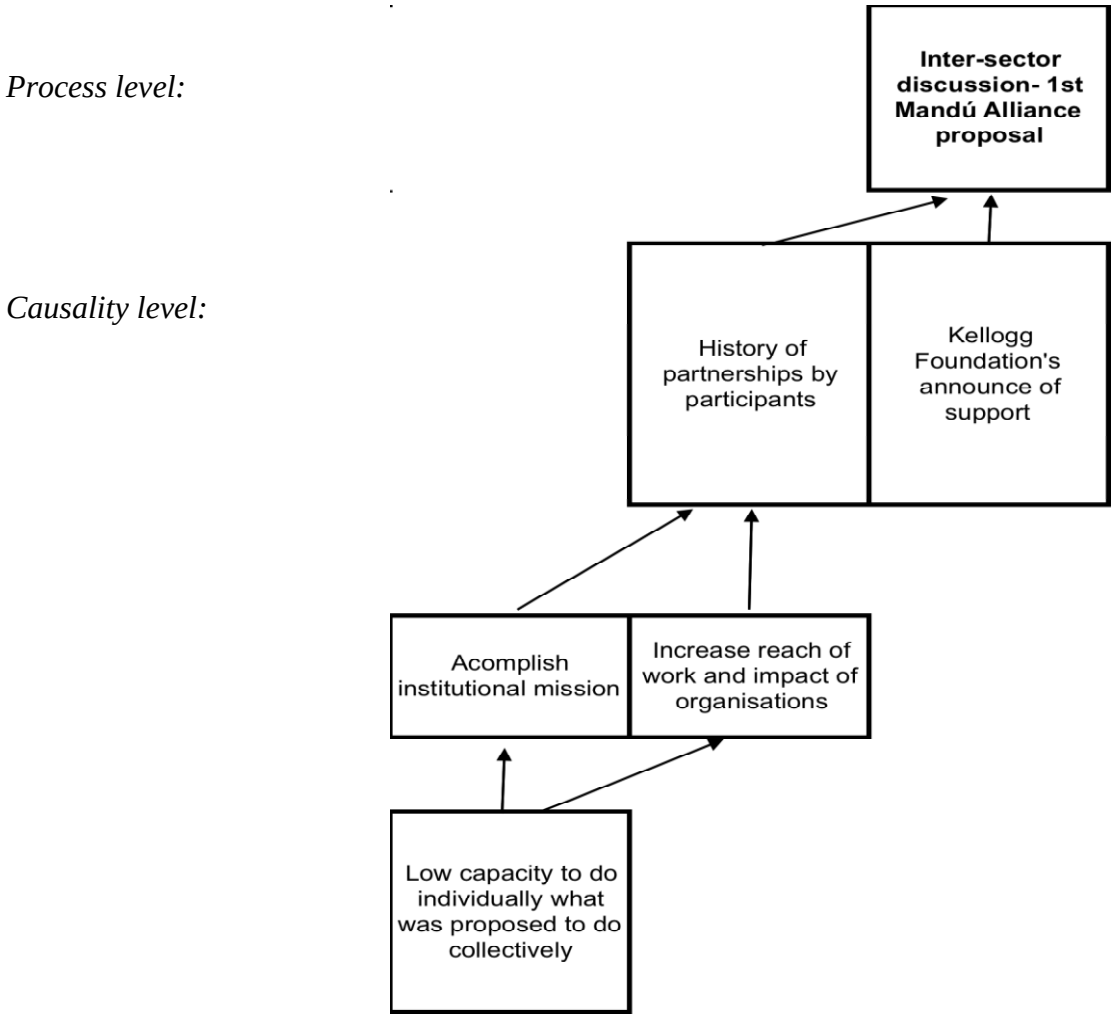

Figure 4- Main conditions that enabled the first inter-sector discussions that ultimately led to the creation of the Mandú Alliance taken from Appendix 3.

Therefore, the enabling conditions and mechanisms at play represented the building blocks for a higher-level order to arise (Holland 1995). The question to be explored next is: what mechanisms led to the creation of Mandú Alliance?

5.1.3. Self-Organisation Process

The first mechanism that determined the creation of the Mandú Alliance was the agents' capacity to self-organise to produce such an outcome. This section examines how this self-organisation process shows features that are common to complex adaptive systems in general, however, other requirements crucial for self-organisation to arise are revealed.

Whereas there is not a unified definition of self-organisation, there is a consensus that the term refers to a broad range of pattern-formation processes both in physical and biological systems (Camazine *et al.* 2003). A basic feature of self-organised systems is that pattern formation occurs through interactions internal to the system, without external direction, manipulation, or control (Kauffman 1995; Camazine *et al.* 2003; Levin 2005). The nature of this mechanism is known hence to be spontaneous or autocatalytic (Kauffman1993).

However, Kauffman (1995) explains that for these internal interactions to 'catch fire' (using Kauffman's terms) a critical diversity of agents must be reached in the system. This is, as "a threshold diversity is crossed, a web of catalyzed reactions crystallizes in a phase transition; the catalysed reaction sub-graph goes from having many disconnected tiny components to having a giant component and some smaller, isolated components" (p. 64).

This analysis shows how the features that allow self-organisation to arise in other complex adaptive systems also are present in this case study. First, the training provided the collective space for agents to interact spontaneously according to their own interest in this process, hence without external control or direction. This bottom-up nature of this process is what enables self-organisation to 'catch fire', using Kauffman terms.

Agents' diversity seems to be, however, a second main condition allowing these interactions to take place. The training involved participants from different social sectors: EMBRAPA (public enterprise), the Federal University (academy), the Flora Vida Institute (private enterprise), CARE Brazil (international organisation but comprise of local staff), and the NGOs Susana Jacobs Childcare Post (PPSJ) and the tourism company (Eco-Adventure). A sign that a diversity threshold was crossed is that at a first stage of the training, agents were disconnected or poorly connected and as the training evolved, they started to form small clusters to undertake collaborative

work. By the last stage of the training, agents had formed a big cluster that ultimately became the Mandú Alliance. This process of increased connectivity is in line with Kauffman's (1993) ideas of phase transition occurring previously to pattern formation.

However, is the access to a collective space a sufficient requirement for interactions to spontaneously arise provided critical diversity exists?

An additional element drawn from this case study for the emergence of self-organisation is how the diversity of interests between the participants was also crucial for spontaneous interactions to arise. As explored above, organisations showed different interests and motivations to engage in an inter-sector dialogue. Nevertheless, the existence of overlapping interests turned out to be another enabling condition for interactions to arise spontaneously (Folke 2005; Kauffman 1993, Waltner *et al.* 2003). Axelrod's (1997) investigations about the complexity of cooperation follow this rationale. Axelrod states that, "the opportunity for interaction and convergence is proportional to the number of features that two neighbours [agents] share" (1997: 171).

A second crucial element for self-organisation to emerge drawn from this case study is agents' internal properties (Kauffman 1995; Holland 1998). Agents who endured the multi-stakeholder process were shown to have the ability to improve their internal attributes and collective capacity, and to adapt in response to internal and external changes in the training. An example of this is observed in the agents' ability to create partnerships to develop actions of common interest in parallel to the training. That was the case of CARE Brazil, EMBRAPA and CARE International who set up a partnership, together with the Local Residents Association, to undertake a Community Garden Project.

An example of the ability that some participants showed in response to an internal challenge was at the moment when two of the organisations left the training. The exit of the NGO-PPSJ (Susana Jacobs Childcare Post) and the company Eco-Adventure could have meant a blow to the multi-stakeholder process as they left half way of the final project design. Yet this meant an opportunity for agents to reinforce their collective values, identity and norms of functioning, which was crucial to tune the self-organised process to an expected outcome.

The ability showed by these agents seem to indicate that agents' internal attributes and capacity, and the diversity of interest that each kind of agent presents

were also crucial conditions for the emergence of self-organisation (Kauffman 1995; Stoker 1998; Levin 2005).

However, what is the nature of the agents' interactions that enabled them to create a collective outcome as a result of their self-organisation? In other words, were the above conditions and self-organisation the only forces behind the creation of the Mandú Alliance?

5.1.4. Co-Evolutionary Dynamics

Another complex mechanism that determined the creation of Mandú Alliance was co-evolution.

For many years sociologists have observed the interaction of formal and informal systems in organisations, although they did not use the term of 'co-evolution' (Scott 1987; Lazaric 2000; McKelvey 2002). Ehrlich and Raven first coined the idea of 'mutual influence' in 1964. However, McKelvey (2002: 3) was the one who proposed the use of co-evolution in the context of organisational studies, in terms of "mutual influence" since evolutionary processes are reactive and not predictive or causal, according to him.

The study of complex systems dynamics places co-evolution at the heart of self-organisation processes (Kauffman 1995; Camazine *et al.* 2003). Furthermore, Kauffman (1995: 216) states that "co-evolution extends beyond mutualism and symbiosis and appears to be a powerful aspect of biological evolution".

This analysis argues that Kellogg's one-year training provided the conditions for agents to have a mutual influence, or to co-evolve, giving rise to the creation of a collective identity, the Mandú Alliance. Various conditions, however, define the nature of co-evolution and the influence it has on the system's dynamics, according to this case study. A starting point for examining these aspects is to look at both the internal and external forces that triggered the mutual influence between agents and the consequent changes in their behaviour.

Agents' exchange of information shows how internal forces influence co-evolutionary dynamics. These internal forces are their interest, motivation, knowledge and own internal capacities. External forces in this case study are the new concepts and ideas about territory, leadership and sustainable development brought for discussion during the training. This is also reflected in the respondents' statements on

how these two kinds of inputs or sources of information enabled them to evolve individually and collectively.

The impact that these two forces have on promoting mutual influence seems to point to the same direction to the responsive nature of co-evolutionary dynamics noted by McKelvey (2002) and Camazine *et al.* (2003).

A second insight from this analysis is the increase in the agents' capacity both at an individual and collective level that co-evolutionary dynamics reflect in this case study. This is observed in how agents, as a result of the interactions occurring over the training, had a greater understanding of the system dynamics and the position and roles of all agents in the system. This new knowledge and perspective on the system functioning started to change agents' individual behaviour both in their attributes (capabilities) and attitudes (visions, ideas, values), improving their fitness position or capacity to engage into collective work (Kauffman 1993; Holland 1995; McKelvey 2002). This insight then sheds light on the influence that co-evolutionary dynamics have on the system. This is in line with Kauffman's idea that in the "co-evolutionary system both the fitness and the fitness landscape of each species is a function of the others species" (Kauffman 1995: 222).

Additionally, the system increased capacity points towards another quality of co-evolutionary dynamics - a transition process (Kauffman, 1993). In this case study a transition process is reflected in how agents' individual behaviour was transformed into a collective behaviour and identity as a result of co-evolutionary dynamics. This is observed in how the training drew closer agents' perspectives, beliefs, knowledge and perspectives to social change, and more specifically to support young people. This is again in line with Kauffman's (1993, 1995) idea that co-evolution is a transition behind pattern creation.

In relation to the nature of co-evolution, this case study shows how this mechanism seems to follow a dynamic of self-reinforcement. That is, the more agents know about each other, the more trust is built, so the more information they exchange and the more they interact. This self-reinforcement process seems to follow Kauffman's rationale when he states that co-evolution plays a fundamental role in self-organisation as it provides an internal force for spontaneous interaction (Kauffman 1993; Camazine *et al.* 2003). For this he refers to this intimate enhancing interplay between these two mechanisms as a 'coupled dance' (1993, 1995).

In this vein, it is important to note how in this case study the lack of significant dampening mechanism from outside the training was a condition that enabled the amplifying nature of self-organisation and co-evolutionary dynamics (Camazine 2003). According to McKelvey (2002: 2), "if co-evolution […] is dampened out too soon then it cannot have the nonlinear, positive feedback effect that Complexity Science sees as the basis for new order creation". Finally, in terms of the conditions that enabled co-evolution to arise, this case study shows how the training provided additional conditions to the ones present in the system that were crucial for both self-organisation and co-evolution to occur.

First, the training provided a structured space for agents to have dialogue, have a mutual understanding and reach agreement. This space was structured first by the presence of professional facilitators who guided agents' interactions and managed potential conflicts. From a complex dynamic perspective, this means that the facilitators tuned the co-evolution and self-organisation processes by dampening potential conflicts and amplifying consensus building. A second aspect of the training as a structured space was to have a common goal to which to drive or tune the co-evolutionary and self-organisation processes. These conditions appear to be crucial in managing a key property of complex adaptive systems noted by Holland (1995, 1998): the capacity to tune the system. As illustrated by this case study, the presence of a structured space enabled the tuning of the system towards the desired goal of creating a collective action to improve the youngsters' conditions in these communities.

A second feature of the training that enabled co-evolution to arise was its duration. McKelvey (2002) notes how co-evolutionary responses are adaptive and frequently time-delayed. From this case study it can be drawn that the duration of the training allowed participants not just to interact but also to respond to the influence that the co-evolving and self-organising process had on them. As a result of these conditions - structured space with a common goal, a tuning agent (facilitator) and a minimum duration - by the end of the training collective norms, values and approach to change of the future Mandú Alliance were created. This seems to be in line with Arthur's (1997) and Kauffman's (1995) ideas that co-evolution is at the root of the production of novel macro structures. The collective process of inter-sector collaboration created during fieldwork (Appendix 3) reflects the interrelations between these elements and outcomes.

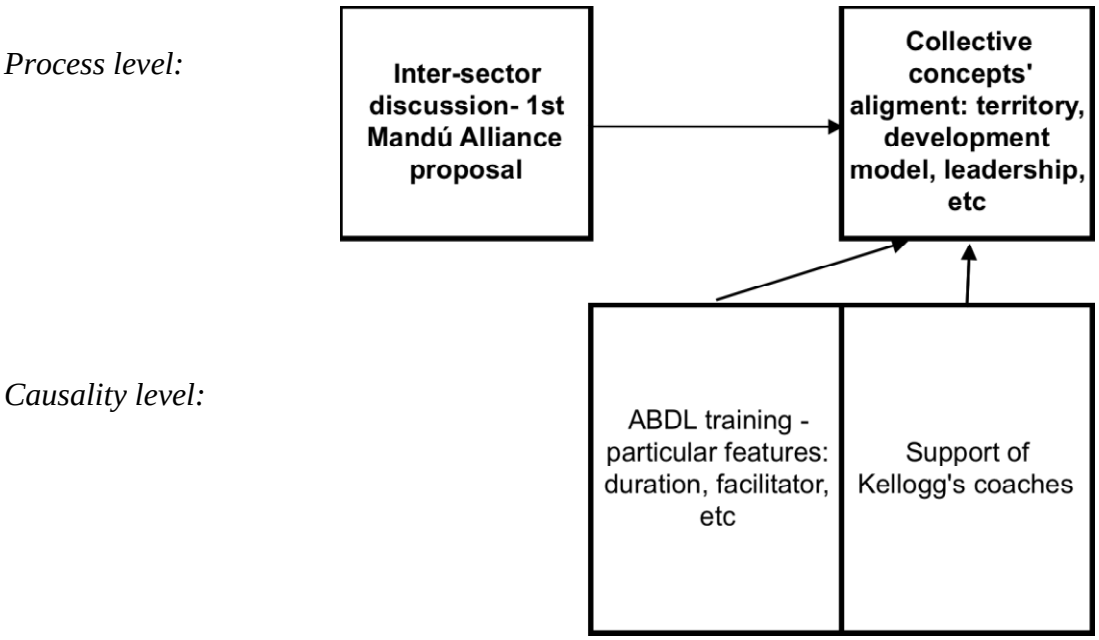

Figure 5- Main conditions that allowed co-evolution and self-organisation to take place in the system's dynamics, enabling the creation of a collective vision, definitions and identity (Appendix 3).

This leads to the next point of analysis: how was a new structure in the system created?

5.1.5. The Emergence of the Mandú Alliance

From a complex dynamical perspective, the creation of the Mandú Alliance represents the emergence of a new order in the structure of the system. This section examines the general definition of emergence and uses Goldstein's (1999) properties of emergence to investigate the construction process of the Mandú Alliance.

Emergence is known as the raising of novel and coherent structures, patterns, and properties from the interaction of the system component parts (Holland 1998). Since this phenomenon is neither reducible to, nor predictable from the properties of individual system components, emergence is described as a property of the system (Halley and Winkler 2008; Goldstein 1999; Holland 1998; Camazine 2003).

Goldstein (1999) states however that an emergent phenomenon appears differently in different types of system; despite this, they share certain interrelated and

common properties that identify them as emergent. First, emergent patterns present features that are not previously observed in the complex system under observation hence they show radical novelty. This novelty is the source of the claim that emergence is neither predictable nor deducible from the lower or micro-level components. Secondly, emergent patterns show coherence or correlation as they appear as integrated wholes that tend to maintain some sense of identity over time. Thirdly, since coherence represents a correlation that spans separate components, the locus of emergence phenomena occurs at a macro level in contrast to the micro level locus of their components. Fourthly, emergence is a dynamical construct and is associated with the arising of new attractors[56] in dynamical systems. Finally, Goldstein (1999: 50) states that "emergent phenomena are recognisable and different to some degree from previous emergent phenomena".

This analysis argues that Goldstein (1999)'s properties of emergence provide a conceptual framework to investigate the processes and conditions that led to the emergence of the Mandú Alliance. First, the alliance presents goals and norms (governance model) that go beyond the organisations' individual roles, beliefs and working procedures, as described in detail in Chapter 5. Although the alliance's features are coherent and correlate with the agents' individual and common ones, it reflects a new identity that was not in the system before (Mead, 2007). Furthermore, according to Goldstein's (1999) third and fourth properties, the alliance's construction reflects a dynamic process that spans from the lower level components (individual agents and organisations) to create a macro-level entity (alliance). The emergence of a new identity and governance model is illustrated in the participatory collective map of the process included in Appendix 3.

[56] An attractor is "a set towards which a variable, moving according to the dictates of a dynamical system, evolves over time" (Bak *et al.* 1988: 38)

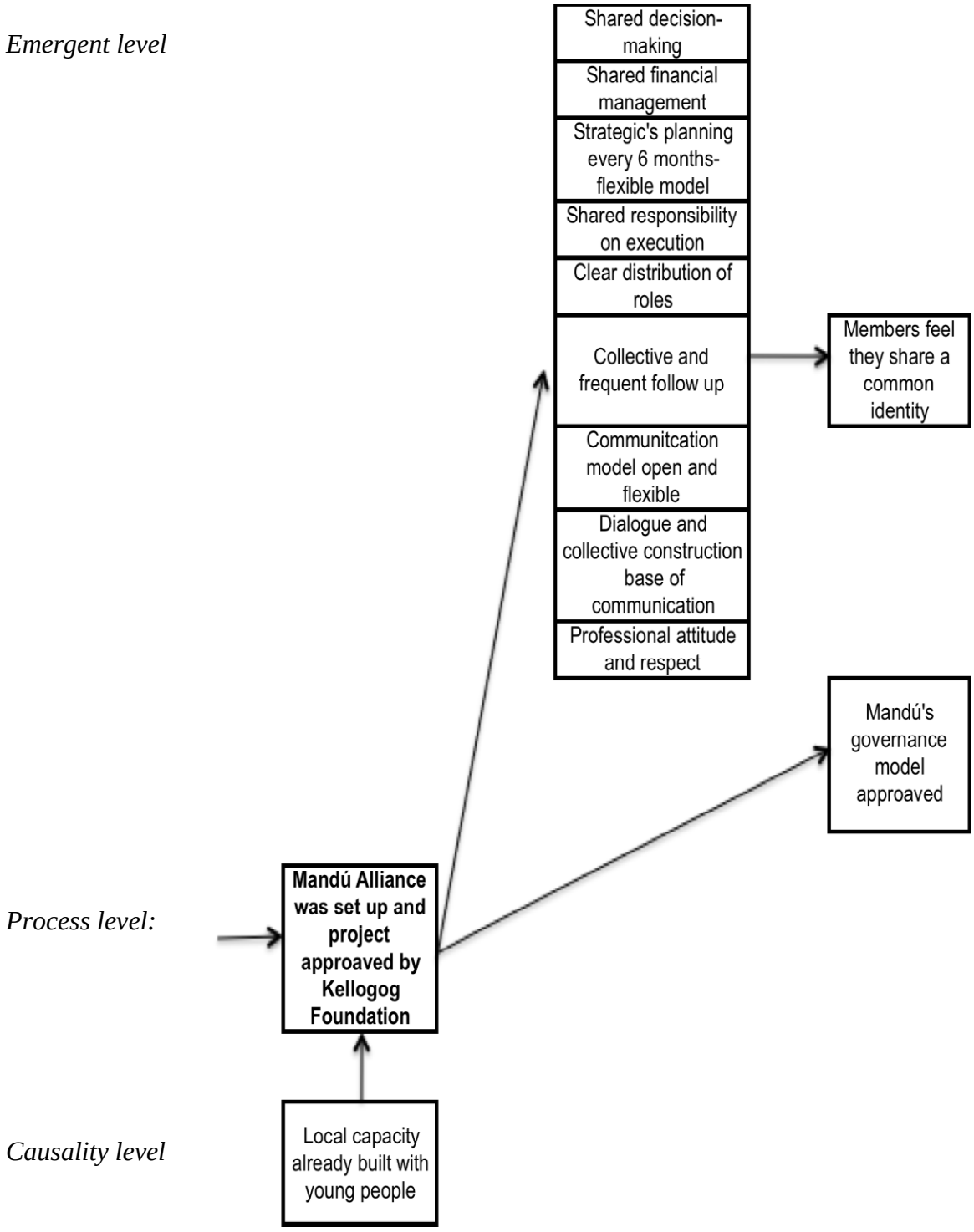

Figure 6- Main conditions that enabled the emergence of Mandú Alliance's new identity and governance model taken from Appendix 3.

This seems to indicate that the Mandú Alliance's formation is the result of a collective phenomenon. Finally, all this suggests that the emergence of the Mandú Alliance was a dynamical construct, which has given rise to a new attractor in the region. The arising of this attractor is observed in the number of organisations that are copying the alliance's concepts and values, spreading what interviewees called "the Mandú culture" in the region (Walker *et al.* 2004). These insights are in line with Kauffman's idea of phase transition and the creation of a new pattern, discussed above (Kauffman 1993). The new pattern or attractor created in this experience is both the Mandú Alliance and the partnerships culture that is spreading into the system.

Additionally to Goldstein's properties, this case study seems to indicate that the aggregative capacity of the members of the created alliance was crucial for its emergence (Holland 1995; Kauffman 1993; Goldstein 1999, Bak 1996; Brunk 2002). According to Holland (1995: 11), the property of *aggregation* enters into the study of emergence in CAS (complex adaptive systems) in the sense that "complex large-scale behaviour emerges from the aggregate interactions of less complex agents".

This case study seems to indicate how two aggregative processes were fundamental for the emergence of the Mandú Alliance, the first one being the financial resources required by the alliance to start functioning. The second one is the Alliance members' capacity, both individual and collective, to create a collaborative work. For both kinds of variables (human and financial) this case shows how a threshold value was crossed when the Mandú Alliance was officially created in 2005. This is that, at the moment of its creation, the alliance already exhibited a collective identity and the financial resources to achieve its collective goal - to improve youngsters' conditions in several coastal communities of Piauí.

This analysis suggests first that the system of study exhibits the same properties observed by Goldstein (1999) in other types of complex adaptive systems. Secondly, that the creation of the Mandú Alliance is a dynamic process that stems from the interaction of lower level components. Therefore, this analysis argues that the aggregative nature is an indicator of the occurrence of emergence (Halley and Winkler 2008; Goldstein 1999; Holland 1998; Camazine 2003).

5.1.6. The Mandú Alliance as a Poised State

This analysis has explored so far the various mechanisms that have enabled the construction of collective behaviour, a crucial process for collaboration to arise as illustrated in this case study. A fundamental question however, remains to be explored to fully understand the dynamics of inter-sector collaborations: why do organisations from different sectors decide to engage into a collaborative strategy that has significant costs instead of adopting another strategy?

The analysis argues that Kauffman's idea of 'poised state' offers a conceptual framework to explore this question (1993). Kauffman's hypothesis is that selection attains the systems, which are poised both internally and collectively as it optimises the capacity to evolve thanks to an attractor of the selective dynamics, a generalised 'poised state' (1993). A poised state, as explained in Chapter 2, is a steady state attractor that Kauffman also refers to as Nash Equilibrium, borrowing an analogue from Game Theory. Nash Equilibrium is a local combination of actions or strategies whereby each agent is happier locally as long as other agents do not deviate from their own fixed strategy. For this that Kauffman (1995: 218) states that Nash Equilibrium is a strategy that accounts for explaining "how independent, selfish agents might coordinate their behaviour without a master choreographer" under a cooperation strategy.

What is important to note in this analysis is that complex theorists have proved that as ecosystems climb towards a poised state - ESS equilibrium[57] - an agent's average fitness increases (Kaufmann 1995). A poised state is, however, just one of two evolutionary options of a system, according to Kauffman (1993). The first is when the partners in a coupled system keep dancing in an intertwined process; or secondly, when the coupled system attains a steady state (poised state) at which the local optimum of each partner is consistent with the local optimum of all the other partners. This means that in between the range of possible equilibrium, agents have chosen so far to remain in this state.

[57] Neumman struggled to formulate a version of Game Theory for evolutionary biology by generalizing the idea of Nash Equilibrium so it reformulated the term into evolutionary stable strategy (ESS). According to Kauffman (1995), this concept seems to be more appropriate for the study of complex social systems as it accounts with the interaction between the agents and their context.

This analysis proposes that the Mandú Alliance represents a poised state in the system dynamics as a set of agents have reached a steady state at which all agents are at a local optimum, using Kauffman's terms. This reflects the concept of evolutionary stable strategy (ESS) as the payoff[58] the alliance members get might not be the best for a particular agent but each player is better off not changing his strategy as long as the other player strategy remains unchanged (Kauffman 1995).

Furthermore, the state at which the alliance is poised also seems to represent a new attractor in the system of the selective dynamics (Kauffman 1993; Walker *et al.* 2004). This is observed in how the Mandú Alliance attracts the interest of other organisations in the Parnaiba region, which gives the alliance the possibility to influence them. Examples of organisations are SEMAR (Piauí Environment and Hydrologic Resources Secretariat) and *Peixe Boi* (NGO that works on environmental issues in the region) who joined the Mandú Alliance to learn the partnership culture and have a higher impact on the region.

These examples seem to be in line with Kauffman's (1995) idea of a 'poised state' as an attractor of the selective dynamics. In this vein Goldstein (1999) states that the emergence of a new structure in dynamical systems is associated with the arising of new attractors.

This section has illustrated therefore that the Mandú Alliance represents a poised state where agents have spontaneously decides to remain here as (1) their average fitness capacity is higher, as long as the other agents decide to remain in this state; and (2) they are more likely to evolve due to the attractor dynamic they play in the system. This analysis sheds new light in the motivations for agents to engage in collaborative dynamics, the payoffs they get and how to manage them.

5.1.7. The Mandú Alliance as a New Attractor

A final property that stems from the former idea of poised state and its attractor role in the system is self-organised criticality behaviour.

[58] Interviewees stated that the main pay-offs they obtained from being part of the alliance were: to gain a reach of impact that goes beyond their individual capacity; to strengthen their capacities by learning from other agents; to bring collaborative work to other institutional spheres; and to gain visibility and credibility by working with the Mandú Alliance.

Bak *et al.* (1988) argues and demonstrates numerically that dynamical systems with extended spatial degrees of freedom[59] in two or three dimensions naturally evolve into self-organised critical states[60]. Bak *et al.*'s main argument to sustain his findings is that systems seek a critical state in order to show robustness to small changes (Bak *et al.* 1988; Fronczak 2008). Furthermore, Bak *et al.* describe the self-organised critical state as an attractor of the dynamics (Bak *et al.* 1988). Bak *et al.*'s description of 'self-organised critical state' refers to the same phenomenon that Kauffman's defines as 'poised state', discussed above. Both authors equally refer to this critical state as a state where the system increases its internal capacity. This capacity is referred by Bak *et al.* as 'robustness' and by Kauffman as 'fitness'.

To investigate the presence of self-organised criticality in the system of study is relevant for this analysis for two reasons: (1) it could enable us to explain the shifts in the system capacity (robustness or fitness) as a result of exhibiting a poised state, as explained in Section 5.3. of this chapter; and (2) it could enable us to explain the dynamics behind the role of the Mandú Alliance as a new attractor in the region.

In relation to the creation of new attractors, scholars agree that activity in this self-organised critical state takes place in terms of bursts or avalanches that makes a perturbation to travel across the system latitude (Bak *et al.* 1988; Fronczak 2008; Paczuski 1995). This case study suggests however another property of attractor, which is that the dynamic of expansion is directly related to the dynamic of attraction. This is observed in how the alliance at the same time draws on and creates highly valued human capital that travels in the region helping to spread the Mandú culture. This was the case of a former Mandú employee who was hired by the Piauí Environment and Hydrologic Resources Secretariat, a very influential agent at a regional level. In the opposite direction is the case of a former employee of Peixe Boi who joined the alliance team and with it the interests of this NGO to join the alliance work. This expansion and attraction dynamic of the alliance is reflected in the collective map of this processes of inter-sector collaboration presented in Appendix 3.

[59] In physical systems the 'degrees of freedom' refers to the dimensions of a phase space. For social systems, these dimensions would be the political, economic, social and the like that form the system structure.

[60] Bak *et al.* defines critical state as the state of the system where "it is barely stable with respect to further perturbations" (1988: 365). Kauffman refers to this critical state as poised state.

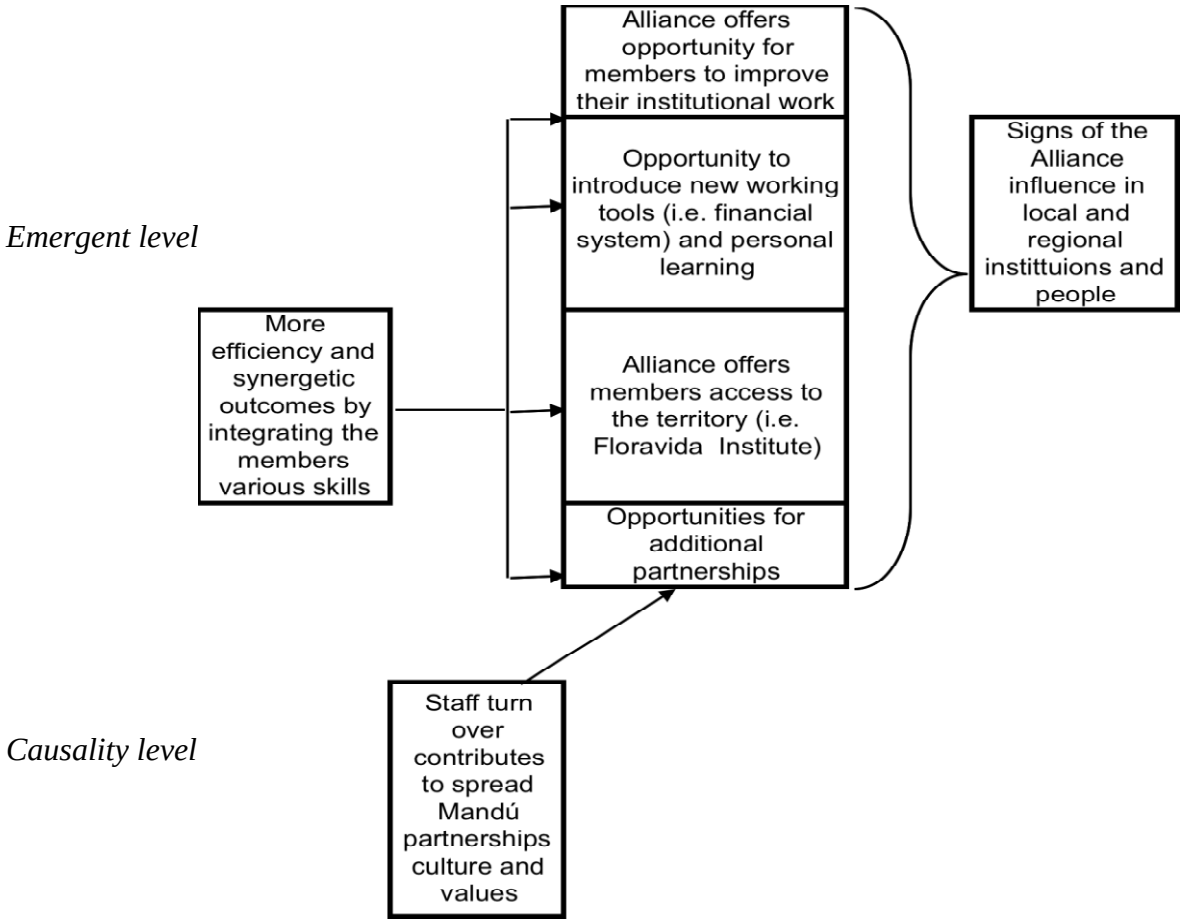

Figure 7- Main conditions that define the attractor dynamic of the Mandú Alliance taken from Appendix 3.

Summary Part I -

This section has examined the conditions and mechanisms that at a macro level influenced the creation of the Mandú Alliance and the spreading of the partnership culture in the Parnaiba region.

A main insight from this section is how the Mandú Alliance seems to represent a poised state in the agents' evolution path where they increase their capacity in relation to other agents in the system. The capacity and competitiveness they acquire by collaborating points to be the initial motivation for agents to engage in collaborations. However, the influence that a collaborative process can exercise in the system dynamics (attractor) seems to be also part of the motivation for agents to remain in the collaborative agreement.

The conditions necessary to reach such a poised state of collaboration discussed in this section are: first, the system has to show the enabling conditions for

a new dynamic to be created, as opposed to the dynamics present in the system; and secondly, mechanisms such as self-organisation, co-evolution and emergence have to arise and interplay for a new order such as the Mandú Alliance to be created.

This section illustrated how the mechanism that accounts for the expansion of collaboration across the system might be self-organised criticality and complex cascades (Bak *et al.* 1988, Bak 1996; Brunk 2000, 2002)

5.2. Micro Level Dynamics

This analysis has explored so far the mechanisms and conditions that led to the emergence and development of the Mandú Alliance at a macro level. From this section it was seen how the dynamics observed at a macro level were influenced by the agents' attributes (capabilities or skills) and attitudes (perspectives, interests and the like) present at a micro or system component's level.

Part II of Chapter 5 presents a detailed description of the transformation process that the Mandú partners experienced over the alliance construction process and development. Here, background information about the institution is outlined as well as the changes, motivations, roles and challenges that each exhibited to adapt to work collaboratively.

This section aims at exploring the adaptation processes occurring at a micro level that enabled agents to shape the processes at a macro level. This involves examining (1) the agent's attributes and attitudes, (2) the organisation structure and dynamic, (3) the agents' location in the system network structure and (4) the distribution of payoffs stemming from the multi-stakeholder collaboration dynamic. Similarities and differences between agents according to their different institutional backgrounds (public, private and not-for-profit) are also discussed.

The second part of this section examines how the changes occurring at a micro level have influenced the behaviour observed at a macro level and have contributed to the increase in the system resilience[61] capacity.

[61] Resilience in this context is understood as Folke *et al.* (2003) definition as the capacity of a system to absorb disturbance and reorganise while undergoing change so as to still remain essentially the same.

5.2.1. Institutional Adaptation at a Micro Level

Changes in the Agents' Internal Configuration:

This section examines how the agents' behaviour shifted over the multi-stakeholder process as a response to the changes occurring at a macro level. For this purpose this analysis draws on Holland's (1998) idea that agents present an internal structure that shapes their behaviour, which he refers to it as attributes[62]. This research, however, uses a broader understanding of this idea to account for the behaviour observed in this experience and to describe the agents' internal structures in terms of attributes and attitudes. Attribute in this research refers then to the capabilities agents present in their internal structure, the attitude referring to the ability agents' display to introduce change. Furthermore, this section also draws on Kauffman's formula for catalytic reactions as a conceptual framework to investigate how the changes occurred at an agent level influence the changes observed at a macro level.

Kauffman refers to the changes occurred in the agents' capability over time as specialisation process (1993). Kauffman's investigation of catalytic reactions showed that a specialisation process is needed for the autocatalytic entity to increase its efficiency to achieve a change of regime (1993). Furthermore, he states that the search for further *efficiency* in catalytic processes is a function of the level of 'specificity' achieved by the catalyst agent and the 'velocity' of the catalysis.

In relation to the specificity necessary for efficient catalytic processes, this case study points to the changes occurring in various domains of learning as drivers that contributed to the increase in the agents' capacity to perform the specific tasks involved in collaborative work. For instance, during the training period, agents learnt various concepts aimed at improving their capacity to work collectively, such as leadership, territory and different development strategies. However, indirectly, the training also enabled agents to learn different institutional languages, perspectives, kinds of knowledge (academic, technical knowledge, and local knowledge), and indeed, how to develop collaborative strategies. According to the interviewees, these changes occurring in various levels of learning account for the changes observed in

[62] Holland (1998) refers to attributes as the internal structures that shape the agent behaviour. Holland explains that agents must select these internal structures from the torrent of inputs they receive from the context. These changes in the internal structure, or attributes, are the ones that must enable the agent to anticipate the consequences that follow when that pattern is again encountered.

(1) the function that agents have in the system; (2) their understanding of the system dynamics; and (3) their capacity to interact with other agents in the system, to mention the main ones.

Secondly, in relation to 'velocity' necessary for efficient catalytic processes, the exit of two of the participants from the training - NGO Susana Jacobs Childcare Post (PPSJ) and the local tourism company Eco-Adventure - illustrate this point. As discussed in Chapter 4, the exit of these organisations was due to their disagreement to the changes recently incorporated as part of the first collective norms. Once one of the organisations understood the consequences of its exit they claimed to return to the alliance without any success. This example shows the lack of capacity that these organisations have to introduce the changes necessary to undertake collaborative work (specialisation process) at the required pace or 'velocity', using Kauffman's terms.

This analysis seems to indicate that Kauffman's formulation for catalytic reactions in chemical system can be used as an analogy for exploring the dynamics of emergence from social agents' interactions. The relevance of this is that interactions are the basic mechanism for a system to evolve into greater levels of complexity (Kauffman 1993; Holland 1995, 1998). Therefore, from this case study it can be drawn that the underlying conditions for interactions to occur seems to be: (1) the agents' capacity to specialise in the tasks and domains necessary to engage in collaborations; and (2) the velocity with which agents specialise.

This analysis is also in line with Kauffman's idea that selection is involved in the process of agents' specialisation as it trims away those agents less capable for the task (1993).

In terms of the agents' capacity to introduce changes (attitude), another insight from this experience is the different adaptive mechanisms agents' used to respond to the changes occurred at a macro level. A first mechanism seems to be adaptation[63]. An example of adaptation would be how the alliance's organisation members adapted to Kellogg's requirements of focusing on supporting young groups. A second

[63] Adaptation, in biological terms is the process whereby an organism fits itself to its environment (Holland 1995).

mechanism seems to be evolution[64]. An example of evolution would be the change that the corporate values of Flora Vida Institute had over this process. A third mechanism of response to external change seems to be co-evolution[65]. An example of this would be the fact that all the Mandú member organisations adopted a common financial system to manage their multiple institutional functions.

From these examples can be drawn how agents were capable of using different strategies to adapt to or specialise in response to the changes in their environment. As illustrated, these responses can be short-term or long-term, and can produce superficial or more profound changes in the agents' internal configuration (attributes and attitudes).

Organisation Structure and Dynamic:

Another element of analysis in this case study is how the institutional background, referred to in terms of structure and dynamic, influenced the agent's specialisation process and hence its capacity to engage in collaborative work. An example of this is CARE Brazil. This institution presented a strong connectivity and exchange of resources with its regional headquarters. One of the causes of this was its horizontal model of governability, which enabled information to flow across different levels of the organisation. According to Folke (2005), this network structure is what shapes organisations' capacity to learn and adapt to changes. This kind of structure enhances change to flow across the organisational levels, therefore shaping the flexibility of the organisation to change, as further explored in the resilience section (5.3.) of this chapter.

The absence of some of these conditions in other organisations such as the Federal University or the EMBRAPA also follows Folke's rationale. These organisations' structures and dynamics showed a low interaction between organisational units or branches, with centralised power and a hierarchical management model. According to the interviewees, these institutional characteristics seem to be the conditions that determined the organisations' conservative culture and

[64] Evolution in this context is understood as the historical process that leads to the formation and change of biological systems (Johnson and Lam 2010)

[65] Co-evolution refers to the mutual influence between agents that turns into changes in the agents' internal configuration (Kauffman 1995; Camazine *et al.* 2003)

frozen behaviour, using Kauffman's terms. The long presence of such behaviour acted as a resistance force for these organisations to specialise and to adapt to the emerging collaborative work. In terms of complex dynamics, this suggests the possible influence of two mechanisms: historicity and path-dependence, as past events and models of functioning influenced agents' effort to introduce changes in their organisations (Kauffman 1993; Mainzer 2007; Arthur 1990).

Another element of analysis is how the capacity to introduce changes in organisations seems to rely considerably on the agent. An example of this is the Flora Vida Institute. The institute's young and qualified staff showed a capacity to learn quickly (velocity) the range of new ideas (specificity) stemming from the process. According to the interviewees, the internal configuration (attributes and attitudes) of these agents was the condition that enabled them to have a specialisation process such as this. This configuration, together with the institutional structure and dynamic of the company, seem to be forces that increased the capacity of these agents to influence their surrounding environment. This is reflected in how the behaviour of agents within the institute, particularly in the São Paulo headquarters, changed as they incorporated some of the learning stemming from the multi-stakeholder process.

This insight on how institutional change relies on the agents' capacity also applies in the opposite formulation. Those agents that showed less capacity to learn and adapt to external changes seem to be less able to influence changes in their organisations. Examples of these agents are EMBRAPA and The Federal University, whose representatives were the most reluctant to adopt the new ideas stemming from the process of study so they were unable to influence their institutions. The important role that individual agents play as a source of institutional change is also reflected in CARE Brazil's decision to leverage decision-makers from the alliance's organisational members to back up more their representatives' work.

An intermediate situation of how the institutional background influences agents' specialisation process and their capacity to influence change is the Flora Vida Institute. As discussed above, this organisation showed a significant specialisation process as a result of this process. The man enabling conditions for this seem to be (1) the company strategic interest in collaborative strategies (level of dynamic), and (2) an institutional structure that enabled it to capitalise on new opportunities (semi-network structure, profile of human resources and management model). Therefore, as the Parnaiba staff (local office) managed to influence the decision-making sphere in

São Paulo (headquarters), the learning stemming from the multi-stakeholder process percolated across the organisation's structure.

This analysis suggests therefore that the capacity agents have to specialise is coupled with (1) the configuration of the organisation both in terms of structure and dynamic, and (2) the ability the agent has to influence change. It is on these lines that various interviewees pointed to age range as a main variable in the agent's ability to introduce change as younger people show more flexibility than higher age ranges to review their internal configuration (attributes and attitudes) and hence introduce changes in their contexts. Furthermore, in terms of the organisation configuration, this analysis also proposes that a minimum degree of connectivity between units and levels of management (network structure) is required for change to percolate across the organisation (Folke, 2005; Kauffman, 1993; Albert and Barabási, 2002).

Agent Location in the System Network Structure - Distribution of Payoffs:

Another observation that can be drawn from this case study is that the agents' specialisation processes necessary to engage in the particular collaborative tasks also varied according to their social role. Furthermore, it shows how the payoffs from this specialisation process seem to vary according to their institutional goal and their location in the system network structure.

As discussed above, the main motivations for agents to engage with and remain in the Mandú Alliance were: to gain a reach of impact that goes beyond their individual capacity; to strengthen their capacities by learning from other agents; to bring collaborative work to other institutional spheres; and to gain visibility and credibility by working with the alliance, according to the interviewees.

An analysis of these motivations suggests that they vary according to the agents' institutional goals or social role of this institution (social sector). An example of this is how the Federal University and the EMBRAPA had institutional goals and strategies quite different from the Mandú Alliance, particularly in relation to their population target (young people) and its participatory strategy with communities. An intermediate situation is the case of the Flora Vida Institute, whose institutional mission is also distant from the goal of the Mandú Alliance. However its business strategy already included some degree of partnership with communities. At the other

extreme is CARE Brazil, which displays a complete alignment between the organisation's role in the system and the collaborative task of the alliance.

This seems to indicate how the proximity between the agent's role in the system and the specific goal and strategy of the collaboration influences the specialisation process that single agents and organisations require to work collaboratively. Therefore, those agents more distant from the collaborative task and collaborative strategy would need to exert greater effort to achieve the level of requirement necessary to work collaboratively. In a different way, those agents closer to these conditions would be better off in terms of the institutional cost[66] (specialisation process) necessary to engage in collaborative work (Kauffman 1993).

A different formula applies to the payoffs agents get from the collaboration work, which seems to respond to (1) their role and (2) their location in the system. In this regard, this case study shows how there are multiple ways in which this payoff can be measured: in relation to the institutional mission, the institutional strategy, the specific agent conditions, its location in the system, and the like. To illustrate this point it can be observed how the Flora Vida Institute gains a great competitive advantage by joining the Mandú Alliance, as this reinforced its capacity to interact with more agents in that territory. An opposite response but with the same outcome is reflected by CARE Brazil. Thanks to the increased impact of the alliance in those coastal communities, CARE Brazil is decreasing its presence in the region as a strategy to promote sustainability. These examples show how the payoffs produced in this experience unveil the network of connections between multiple levels of the system and the variables that involve collaboration dynamics, hence their complexity.

Therefore, this analysis argues that payoffs cannot be used as a measure of the degree of engagement or the success of collaborations. Instead, this case study shows how the capacity gained by the agent to work collaboratively as a result of its specialisation process, the distance between the role of the agent and the collaborative task and strategy, and the features of network structure present in the organisations and system, are more accurate indicators for measuring the evolution of collaborative dynamics.

[66] This cost in this case study refer to the time, human resources, financial resources and other intangible goods such as learning and the like, that are necessary when greater interactions and co-evolution occurs (Kauffman, 1993).

Overall, this section has examined the processes and mechanisms occurring at a micro level, which supported the dynamics observed at a macro level. It has been argued that agents' adaptation at a micro level is a function of the agents' internal configuration (attributes and attitudes), the organisation structure and dynamic, and the location of the agent in the system. Ultimately, this suggests that multi-stakeholder partnerships improve the agents' capacity and position in the system. However, does the increase capacity of agents at a micro level increase the capacity of the system at a macro level? The last section of this chapter examines this point.

5.3. Resilience Building by Inter-Sector Collaborations

The former sections discussed how a multi-stakeholder process shifts the system network structure and dynamic while increasing the agents (participants of the process) capacity to work collaboratively. This capacity is in line with Kauffman's (1993, 1995) use of the term 'fitness' under the Darwinian sense of evolution and the role of natural selection. That is, the fitter agents are, the more they are privileged by natural selection hence by evolution, as also seems to indicate this case study.

This section examines how the greater individual and collective capacity created as a result of this multi-stakeholder process also seems to contribute to improving the system's resilience capacity. Resilience in this context is understood as the capacity of an ecosystem to tolerate disturbance without collapsing into a qualitatively different state that is controlled by a different set of processes (Folke 2005).

Literature on adaptive governance (Dietz *et al.* 2003) and adaptive co-management (Olssom *et al.* 2004) explore how multi-stakeholder interactions or polycentric institutional arrangements contribute to improving the system capacity to respond to changes (Folke 2005). However, this literature does not enter into a detailed description of the elements, which govern the construction of this capacity.

This case study has explored the mechanisms, conditions and processes that enable multi-stakeholder collaborations to increase the system capacity at three levels: individual level, organisational level and collective level.

At an individual level, it was observed how to improve the agent perception on its location in the system and to confront this with other agents' locations, helped to improve its capacity to react and to adapt to changes in relation to other

competitors (Kauffman 1993, 1995). Additionally, this case study showed how agents' better understanding of the system overall dynamic and the elements that define their adaptation capacity increased its space of possible responses (space of possibilities) for further evolutionary steps (Mitleton-Kelly 2003a).

At an organisational level, the specialisation process to engage in multi-stakeholder processes has provided organisations with the skills to manage both their individual organisational functions and their collective or collaborative tasks. This provides the organisation with the capacity to address higher levels of complexity, such as the Mandú Alliance; therefore, to respond and adapt to more complex situations (Kauffman 1993). Kauffman (1993) notes that, as the system gets closer to the complex regime, it is more able to respond to complex situations, to innovate and to have flexibility in terms of structure and dynamics, and to respond to changes. He also refers to the intermediate state where the system shows a combination of frozen and melted components as the edge of chaos.

Finally, at a system level, this case study shows how the shifts in the system structure resulting from the transformations occurred at an agent level, allowing improvement in the flow of resources across the system. Resources such as knowledge, technology, human and finance were transferred to improve the situation of youngsters from coastal communities by the inter-sector process, the professional mobility and the expansion of the partnership culture in the region. According to the interviewees, this higher flow of resources and resulting dynamics has increased the capacity of the system to respond more efficiently to internal and external changes.

This section has illustrated, therefore, how inter-sector collaborations contribute to the improvement of the resilience of the system by reinforcing its capacity at different levels: individual (agent), organisational and collective.

According to this research, the relevance of this finding is that the more resilient a system is, the greater its capacity to select its evolution path. The means for this greater selection capacity are: (1) privileging fitter agents while trimming away those who do not show the minimum conditions to undertake collective work; and (2) by being able to respond to more complex changes with more complex responses. In this case study, the main conditions that seem to influence the construction of resilience are: (1) its increased connectivity and network structure, and (2) the pattern under which these resources flow, which is its governance model.

Conclusions

This chapter has produced empirical research on i) what the complex dynamics are of inter-sector collaborations; ii) how agents adapt to work collaboratively, and iii) how inter-sector collaborations increase the resilience of the system or its capacity to adapt to change. This structure of analysis was intended to bring answers to the two main research questions: (1) What is the complex dynamic behind the inter-sector partnerships of the cases of study?, the subsidiary question: How do the agents' institutional background influences their journey to collaborative work? And (2) What are the generic principles that contribute to the construction of inter-sector partnerships under a complexity theory approach?

In relation to the first research question, this case study has explored the main mechanisms and specific conditions that influenced the complex dynamics behind the Mandú Alliance construction and evolution. The first part of the analysis discussed the mechanisms and processes that accounted for the creation of the conditions for inter-sector collaborations to emerge. The main processes discussed here were 'gap formation' for opening up a new niche of possibilities; 'match formation' for enabling new agents such as the Kellogg Foundation and the alliance members to enter the new niche in the system; external agents as triggering points or 'bridge agents' (Watts 2003) for the resources needed to occupy a new niche; the mechanism of path-dependence and the social capital existing in the system as the enabling and enhancing conditions for the emergence of inter-sector collaborations in the system.

In relation to the mechanisms that account for the creation of an inter-sector collaboration project, this section discussed the presence of self-organisation, co-evolutionary dynamics and emergence. Here it is argued how critical diversity and collective spaces seem to be fundamental requirements yet not sufficient conditions for co-evolution and self-organisation to occur spontaneously in this particular process of study. This experience revealed that a minimum time-scale and the way the collective space is structured where interactions take place, seem to be fundamental conditions for these mechanisms to arise, interplay and to provide the 'building blocks' (Holland 1998) for further development of the inter-sector collaboration process.

When analysing the construction process of a novel inter-sector institution such as the Mandú Alliance, this case study illustrates how emergence behaves as a

phase transition or *dynamical construct* from individual to collective behaviour. Here it was discussed how to reach an inter-sector collaboration and more specifically to create a new institutional structure, a critical point or threshold parameter (Camazine *et al.* 2003) was crossed for this new order to emerge. This analysis argued that this state of collaboration represents a poised state (Kauffman 1993, 1995) in the system dynamics, where the agents' average fitness is higher, as long as the other agents decide to remain in this state. Furthermore, agents at this poised state or collaborative agreement are likely to remain in this position, due to the attractor effect the new collaborative dynamic plays in the system. This partnership state will probably last until the benefits of being poised in this state outweigh to the losses.

Moreover, the nature of emergence as a *transition phase* seems to have uncovered another crucial mechanism behind the complex dynamics of this inter-sector partnership, its self-organised criticality behaviour (Bak *et al.* 1988; Bak 1996; Kauffman 1993; Holland 1995, 1998) and the occurance of complex cascades. This mechanism that has passed unnoticed until recently by many social scientists (Brunk 2000), enables an investigaion of the percolation dynamics of the Mandú Alliance working across the system of study. Furthermore, this case study suggested how the main properties that regulate the emergence of complex cascades in the system are the aggregative nature of the system components. Inter-connectivity between the system components seems to be the main feature in regulating the dynamics of percolation of complexity cascades (Bak 1996; Brunk 2000).

To address the second research question, in relation to the different perspectives and challenges that agents from public, private and civil organisations face to engage in collaboration processes, the second section of this analysis examined the changes occurring at a micro level that explains the dynamics observed at a macro level.

At the level of the system's component parts, this case study suggests that agents from different sectors are driven by the same forces to engage into inter-sector partnerships: to improve their fitness capacity, to increase their reach of work and to look for innovative solutions to complex problems (Kauffman, 1995). Nevertheless, this case study shows how the payoff distribution from collaborative work seems to be a function of the specialisation process that agents go through in the process of collaboration, and their location in the system network structure, which is at the same time influenced by their social role. These three variables explained how agents from

different sectors showed a dissimilar journey (specialisation process) in engaging and enduring collaborative work and facing different challenges. The main attributes that agents show in engaging and enduring collaborative work drawn from this experience are: (1) their internal configuration (capacity and capabilities) of the organisation measured both in terms of structure and dynamic of the organisation (organisation level), and the attributes and attitudes displayed by the agent (individual level); and (2) the ability the agent has to influence change.

Overall, the interplay of these mechanisms occurring both at a macro and micro level together with the context conditions noted throughout the analysis, account for the complex dynamic behind the creation and evolution of the Mandú Alliance. During the analysis it was noted that multi-stakeholder processes contributed to the increase in the robustness (Kauffman, 1993) capacity of the system in responding to change. To reinforce this point, this chapter has gone deeper in analysing the influence that the Mandú Alliance had to reinforce the resilience capacity of the system. This illustrated that this inter-sector partnership has increased the capacity of the system at different levels - agent, organisational and collective, which has subsequently increased the connectivity, and network structure of the system shifting the pattern under which resources flow. These conditions, it was argued, were the main elements behind the greater capacity of the system to adapt to and respond to changes.

The following chapter presents the second and last case study of this research. This case study presents the inter-sector process that took place in Quito (Ecuador) intended to build an integrated water management plan between 2004 and 2010, the time of the data collection. This second case study represents another set of context conditions, the size of the system, purpose of the partnership, and hence an overall unfolding of events and outcomes different from the ones observed and discussed in this case study. In that sense, the same research questions are explored and the mechanisms and dynamics that govern this second experience are surprisingly similar to the ones explored in this chapter. What are the elements, then, that defines the similar behaviour yet different outcome of the collaborative process? The following two chapters present and analyse the Quito experience and explore this question.

Chapter 6

Case Study Description
"An Integrated Water Management Plan"
Quito- Ecuador

Introduction

This case study presents the inter-sector effort to set up an Integrated Water Management Plan for the Quito Metropolitan Area between 2004 and 2010. The outlook of a major water crisis in the Quito metropolitan region triggered the creation of the multi-stakeholder process presented here. In the 1980s, Quito had already faced a significant water crisis caused by the increasing demand of its growing population. This led to a shortage in the region's water supply and a subsequent decrease in the water quality. Despite the political efforts of this and subsequent governments, water management is still a strategic problem for Ecuador. The inefficiency and lack of representativeness of water users in the political and administrative structure of water management is highlighted in this case study as one of the main causes of this situation. The dissimilar and partial perspectives that the various water users enjoy, is another pitfall for effective water management in this region. In the light of the complexity of this situation, a group of local leaders promoted a multi-stakeholder process to bring all water parties together and create a new water management model.

This chapter aims at presenting the events and main causes that influenced this multi-stakeholder process, which involved more than 15 organisations that represented the interest of more than 2.5 million inhabitants. The following chapter (7) explores this process from a complex dynamical systems theory approach in order to shed light on the main research questions. This multi-stakeholder process is presented in two parts according to the analytical structure of this research and research questions. The first section outlines the main events and causes that most influenced the multi-stakeholder process, both at a collective level and at an organisational and individual level. These main events are drawn from a comparative analysis of the elements that most influenced the participation process of the main

organisations in this collective effort. The outcome of this comparative analysis was presented for validation at the end of the fieldwork visit to a small group of participants representing various perspectives on the process. The second section presents the perspectives, main challenges and enabling conditions for engaging in the process, of the main 10 participants. These participants are organised according to the sector they represent: public, private and non-for-profit organisations. The dynamics of water issues at the different levels of the administrative structure are also presented here.

The methods used to collect the data presented in this chapter were semi-structured individual interviews and participatory group interviews, undertaken with the main organisations involved in this process. This includes the Fund for the Preservation of Water Resources (FONAG), government agencies at a national level (SENAGUA- Water Secretariat; Secretariat for the Environment; MIDUVI- Ministry of Urban Development and Habitation), the public enterprise for water provision in the urban area of Quito (EMAAP-Q); local level structures of water management (Municipalities, Water Councils; Drinking Water Councils); intermediate organisations (FFLA, Randi Group), and the academy (Salesian University). Appendix 9 presents a chart with the main organisations that took part in this case study according to their institutional background. Overall, this involved 14 interviews with 19 interviewees, of which three were group interviews (two using participatory tools and one using semi-structured interviews), and ten individual interviews (nine using the format of semi-structured interviews and one using participatory tools).

Various email communications and phone calls were made with the main coordinator of this multi-stakeholder process (FONAG) to complete the aftermath of this process and validate some information. Personal names have been omitted for confidentiality reasons.

Background Information

Quito, Ecuador's capital has a population of 2.5 million inhabitants. The city is located at an altitude of around 3,500 meters, in the middle of the Andes, whose highest summit reaches more than 5,000m above sea level. Ecuador is administratively split into six hydrographical regions. The largest, in the north-west of the country, is the Esmeralda Region, where the Guayllabamba Basin is located

(Jaramillo 2008). The Guayllabamba Basin is one of Ecuador's most densely populated areas. The region faces the major national problem of water distribution and water pollution, either directly or due to shortage problems.

The water resources that supply the region's population come from: superficial water that flows from the upper basin of the Guayllabamba River; transfers from the Amazon Sub-Basins; and groundwater, particularly from Quito aquifers (see Figure 8 for the hydrologic administration of the Quito region). The western basins of the country provide the Guayllabamba Basin with the greatest percentage of water for human consumption. Here, the most relevant economic activities are stockbreeding, agriculture, fish farming and finally, eco-tourism. The main economic activities developed in the upper part of the Guayllabamba Basin are agriculture, stockbreeding, agro-industry, industry, tourism and the generation of hydro-electricity.

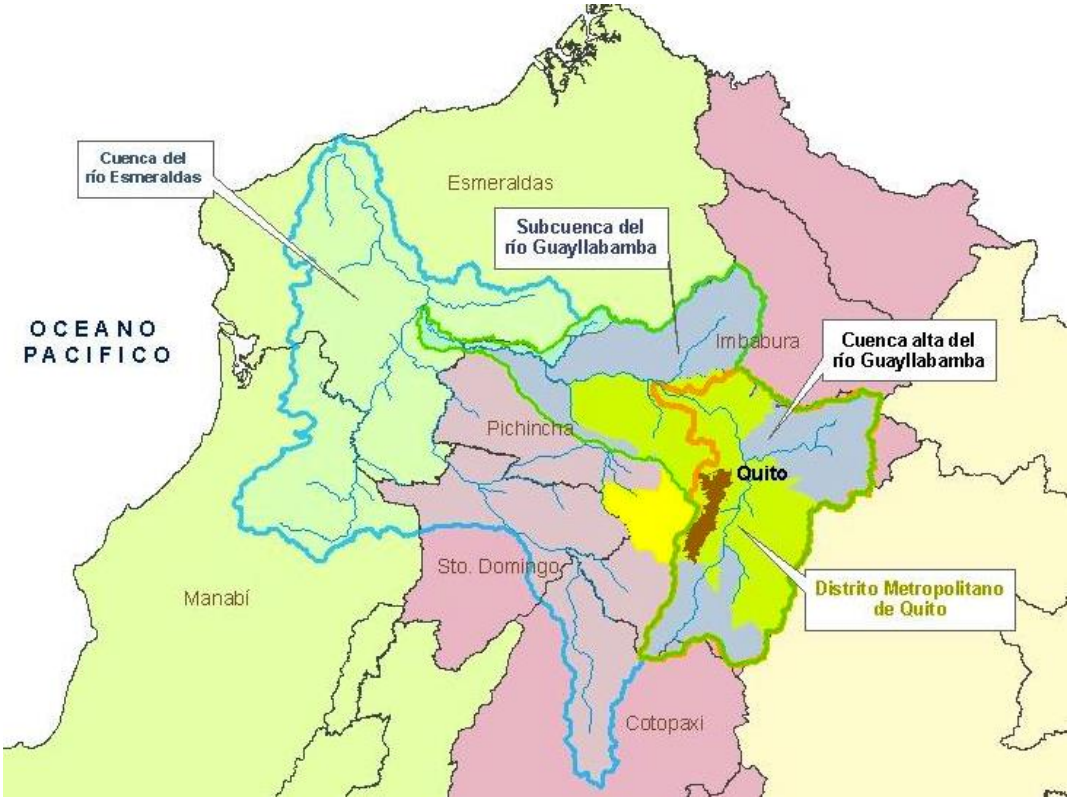

Figure 8- Hydrologic Administration of the FONAG's area of work (Source: http://www.fonag.org.ec/inicio/).

This region has an increasing demand for access to good quality water in sufficient quantity. This happens despite the decreasing availability of the water resources due to pollution, changes in land use, deforestation and growing

urbanisation. The expansion of urbanisation puts a lot of pressure on rural areas around cities and in the buffer areas of natural reserves such as the Cayambe Ecological Reserves –Coke, Antisana and Illinizas - and the Cotopaxi National Park (Burneo 2005).

Ecuador's hydrological policy, similarly to other Andean Countries such as Bolivia and Peru, attends to the World Bank and Inter-American Development Bank recommendations as part of their State structural adjustment programmes. These recommendations include the decentralisation of State functions, greater private participation in the provision of public services, and particularly, the creation of water markets. These recommendations have been however widely criticised for their market-oriented approach and questioned their capacity to provide an efficient distribution of water rights (Arrojo 2005; Ortiz 2011; Quintero 2010).

Countries like Ecuador which consists of a large population of indigenous people, have particularly confronted this neoliberal and commoditisation approach to water resources (Ortiz 2011). For these people water is perceived as a living being, partly divine and a source of life. Water has been traditionally seen by indigenous societies as an un-fragmented good whose management is based on reciprocity and complementarities, not to be exchange against any other currency (Quintero 2010)

Since 2000, a 'water world vision' based on the water commoditisation and privatization is being promoted as part of the global process to secure food production, industry and water consumption at a large scale. Andean countries consider this vision a threat to their world vision of water and are promoting a participatory process to create the 'Andean water vision'. This Andean vision aims to produce a global and modern vision on water management, able to tackle the current challenges while preserving the traditions and water uses of these societies (Quintero 2010). (More information on the indigenous movement in Ecuador is presented in Appendix 10).

In parallel to this process, President Rafael Correa (2007-) has introduced institutional reforms over the past years to overcome the obsolete legal framework and administrative structure of water management. Rafael Correa's government however is characterised by a renewed relationship between the indigenous movement and government. According to Simbaña (2007), a former leader of the indigenous movement, the step-back in Neoliberalism of the current government and

a new period for the indigenous movement, indicates that the country is facing a historical process of transition.

This case study reflects the challenges that a traditionally centralized government model such as the one in Ecuador faces to introduce the reforms necessary to attend to both international and national forces, while safeguarding efficiency and justice in the provision of water resources.

6.1. The Multi-Stakeholder Process: main events and causes

6.1.1. The Outlook of a Major Water Crisis

The prospect of a major water crisis in the Quito metropolitan region was what triggered the creation and evolution of the multi-stakeholder process presented here.

In the 1980s, Quito had already faced a significant water crisis caused by the increasing demands of its growing population. This led to a shortage in the region's water supply and a subsequent decrease in the water quality. In the light of these events, in 1992 the government undertook major reservoir construction and transfers of water from the Western region to the metropolitan area, to respond to the growth in water demand. To the ordinary public this intervention gave the impression that political measures had been taken to alleviate the problem. To the experts in the field, it showed the narrow vision of the government, which sustained a water management model based just on the drinking water demand and leaving aside other water users.

The increasing challenges around water issues that the country has faced over the last few decades were the focus of research and intervention of an international expert. He believed that a broader vision of water management based on a sustainable management model was necessary to sustain Quito's socio-economic growth. He thought that the different uses of water and conditions of the water sources had to be considered in the management plan of the water resources. More importantly, this expert believed that the different agents related to water are co-responsible for its management, so they also needed to take part in decision-making both at a policy and execution level.

6.1.2. The Support of the Nature Conservancy

The trajectory and leadership of this expert attracted the attention of The Nature Conservancy (TNC) to Quito's water management challenges. The Nature Conservancy is a major conservation institution from the United States, which supports the preservation and sustainable management of natural resources around the world.

Since 1996, TNC has supported this expert and other local agents to leverage the main agents in water issues to define a new model of water management for the region. In particular they first tried to engage the Public Enterprise for Water Supply in Quito (EMAAP-Q). EMAAP-Q is a public enterprise that supplies water in the Quito Metropolitan Area and is the major agent in the interface between government and consumers.

6.1.3. Creation of the FONAG

In 2000, after various years of negotiations, the Fund for the Preservation of Water Resources - FONAG - was officially set up as a joint venture between The Nature Conservancy (TNC) and the Public Enterprise for Water Supply in Quito (EMAAP-Q).

FONAG's mission is to integrate the main water actors (public agencies, enterprises, consumers and community-based organisations, including indigenous groups) in the creation of a new water management plan. To achieve this purpose, FONAG's role is to promote dialogue among the parties, guarantee proper decision-making, research and use of technology.

The FONAG is a private trust fund that has been regulated through the Stock Market for a period of 80 years. In 2000, FONAG founders established an investment capital of US$21,000, of which $20,000 was donated by EMAAP-Q and $1,000 by TNC. FONAG uses the equity of its capital investment to undertake its work[67].

In 2004, the fund had already reached $7 million and by 2011 the investment capital was $9 million. Until January 2011, FONAG had been operating using just the equity generated from its investment capital, based on the annual productivity rate

[67] http://www.fonag.org.ec/portal/lang-en/el-fondo/acerca-del-fonag.html accessed on January 2012

defined by the stock market. FONAG's director, however, was working to change the rules to allow the Fund to use up to 30% of its investment capital in its core programmes[68].

However, the successful growth of the fund ($9 million in 2011) was becoming a hindrance to the institutional goals, as it was attracting partners interested in accessing these funds. Also, having such a large amount of money in the bank put FONAG's work at risk, as Ecuador's banking sector is not very trustworthy.

Additionally, FONAG's legal identity (Trust) enabled it to receive financial resources from other sources apart from its members. An example of this is the GTZ (Deutsche Gesellschaft fur Technische Zusammenarbeit - German Bilateral Cooperation Agency), which supported FONAG's work in 2004. This external income helped FONAG to cover overhead expenses as the investment capital can only be allocated to core activities. Diversifying the income sources granted FONAG more political independence[69].

In May 2001 and March 2003 the Electric Power Company of Quito (EEQ) and the Cervecería Andina S.A., respectively, became members of FONAG. Later on, in January 2005 and April 2007, the Swiss Development Cooperation (COSUDE) and Thessaly Springs Company also became members.

Another element that made possible the creation of FONAG was the political endorsement of the Mayor of Quito, a pro-environmental politician who saw in the creation of the FONAG a political opportunity. The mayor was entering his second mandate as Rafael Correa, Ecuador's President, was likely to be re-elected. This situation provided a fruitful and stable political context for the multi-stakeholder process. As a result of this political climate and interest in FONAG, in 2008 it was assigned by the Quito Metropolitan Council (213 Ordinance) the task of officially building an Integrated Water Management Plan for the Quito Metropolitan District (QMD), giving FONAG legal backup to undertake this mission. One of the causes of the creation of this Ordinance was the good relationship between the international expert and the Mayor of Quito from a jointly event undertaken in 2004.

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[68] To find out more on FONAG's accountability, please access: http://www.fonag.org.ec/portal/lang-en/el-fondo/rendicion-de-cuentas.html (Website accessed on January 2012

[69] To find out more on the FONAG's legal dimension, please visit http://www.fonag.org.ec/portal/lang-en/el-fondo/acerca-del-fonag.html (Website accessed on January 2012

6.1.4. Training on Integrated Basin Management

In 2004, FONAG was selected to undertake four years of training (2004-2008) in Integrated Basin Management, supported technically and financially by the GTZ. This training was part of the GTZ's Action Programme for Latin America, which trained more than 1,000 people.

This training was extremely relevant for the multi-stakeholder process, as it gathered for the first time local and regional agents from different sectors related to water management in Quito. They were representatives of different government agencies from the different levels of the administration, public and private enterprises, researchers and technicians, and community-based organisations. The training enabled the participants to exchange and align ideas and concepts around water issues and to know the role of other participants and their interactions. This broadened the participants' vision on the functioning of water issues in the region and contributed to the building of personal and institutional relationships.

For FONAG, the training meant an opportunity to strengthen its capacity to accomplish its mission. GTZ (German Cooperation Agency) funds enabled FONAG to move from two to four members of staff and to run some communication activities, which ultimately allowed the fund to define its strategic niche.

At the beginning of the training, however, FONAG faced criticism from different agents due to the lack of information participants had of the recently created fund. This was due to the fact that from its set up in 2000 until 2004, FONAG was awaiting the investment capital to start functioning. Therefore, FONAG was very much unknown to most agents in water management. These criticisms awoke FONAG to the need of improving its institutional image and transparency, for which it designed a Communication Scheme. This scheme helped to improve FONAG transparency as it created a website to publish its finance sheet and actions, ran 'open doors' to enable visits to the organisation office and produced communication materials. Internally, the scheme also included an annual report to the board.

The communication scheme also aimed at broadcasting structured information on water resources and management in the region. FONAG was aware that the information in the Quito area on water management was scattered among the different agents and hence lacking in consistency. Also, there was a lack of scientific production and of experts on water issues in both the Ecuadorian and the Latin

American context. This information vacuum led FONAG to set up an Information System on Water Resources to compile accurate and complete data on water, which could support decision-making and water management in the Guayllabamba Basin[70]. Given the relevance of having consistent information to support coordinated actions, FONAG decided to make this role a strategic priority. This strategy also brought benefits beyond the process, providing internship opportunities for students and improving Ecuador's recognition in an international context.

Finally, the training also enabled FONAG to exchange ideas and values with other agents in the region and the country, hence strengthening its network. This network yielded to the creation of other funds for the preservation of water resources, similar to FONAG, in five other locations within Ecuador and in two other countries in Latin America (in two cities of Colombia: Cali and Bogota, and in Lima, Peru).

6.1.5. Strategic Alliance

The training also provided FONAG with an opportunity to assess how to accomplish its mission and promote a multi-stakeholder process aimed at creating an integrated plan on water management. In this regard, FONAG perceived the need for outstanding negotiation skills to lead the multi-stakeholder process and of holding a neutral position in the process to avoid resistance forces. With these two goals in mind, in 2006 FONAG set up a strategic alliance with FFLA (Foundation for the Future of Latin America), so this organisation could provide its negotiation skills and neutral image to the process.

FFLA is a well-known international institution, whose work is to lead multi-party negotiations on a range of socio-environmental issues. FFLA had no previous working experience in the water domain, but this was part of its strategic goals. Thus, this alliance also meant an opportunity for FFLA's institutional strengthening. According to the FONAG and FFLA respondents, the building blocks behind this strategic alliance were: mutual professional recognition and respect; good personal interactions; clear complementary roles and opportunity for learning.

According to the interviewees, the FFLA's facilitation role was crucial to engage some agents that otherwise would not have become involved due to FONAG's lack of transparency.

[70] For more information on this Information System, see www.infoagua-guayllabamba.ec

6.1.6. Legal Reforms

The training again provided FONAG with the opportunity to identify and react to resistance forces to the creation of a new water management model. To counteract difficulties in leading the multi-stakeholder process, FONAG envisaged the need to have a legal back up to undertake its mission.

In 2007, FONAG, with the support of BID (Inter-American Development Bank), the Tinker Foundation and FFLA (Foundation for the Future of Latin America) promoted a Council Regulation to create an Integrated Water Management Plan (IWMP) for the Quito area. As a result, in 2008, the Quito Metropolitan Council passed the 213 Ordinance, which appointed FONAG legally responsible for the creation of the plan. Furthermore, this ordinance stated that all agents involved in water management had to be part of the plan and that all the information sources on water need to be integrated.

In parallel to this council regulation, in 2008 the congress approved a new Constitution for Ecuador. The Constitution was also highly influenced by FONAG and its partners, who managed to introduce strategic concepts to support the new model of management envisaged such as 'Water Basin Councils', 'integrated water management', water as a 'limited natural resource', 'co-responsibility' for water resources, water as a 'strategic resource' for the Country and in the Latin American context, access to drinking water as a 'universal right', and the like.

The new *Magna Carta* also had some institutional reforms such as the formalisation of Water Basin Councils as the administrative unit for water management, as main water campaigners were demanding; and the creation of a single authority for water issues, the Water Secretariat (SENAGUA). The underlying conditions that enabled these legal reforms were (1) the political climate and water as a political priority at the continent level made FONAG's offer politically attractive; (2) the connection between FONAG's Director (former international expert) and the political sphere; (3) the quality of the recommendations that, due to former corruption scandals involving NGOs, reinforced the need to deliver sound arguments for the legal reforms, and which in turn counted on the support of other institutional partners; and (4) the strategy for the negotiations which included several personal meetings that enabled a detailed explanation and assessment of the payoff of these reforms.

Finally, the 213 Ordinance brought a new financial formulation for FONAG, which decreed that it would be allocated 2% of EMAAP-Q billing revenue. This 2% represented FONAG 90% income. Furthermore, this new financial formulation prompted EMAAP-Q's resistance to the multi-stakeholder process. The new association of FONAG to the public enterprise received strong criticisms of conflict of interest, mainly from agents opposing the monopolistic behaviour of EMAAP-Q. This conflict of image was overcome once the multi-stakeholder process enabled dialogue among the sections.

The process of achieving these legal reforms took almost one and a half years. Before this, little effort was made to tackle the multi-stakeholder dialogue.

6.1.7. The Design of the Multi-Stakeholder Process

At this point, the main elements for kick-starting the process were set: the strategic partnership between FONAG (Fund for the Preservation of Water Resources) and FFLA (Foundation for the Future of Latin America) and the legal back-up to undertake the multi-stakeholder discussion of a new water plan.

Hence, by the end of 2007, FONAG and FFLA started to design the strategy to conduct the process. This involved two main actions, first a map of the agents involved in any dimension of water management in the Quito region; and secondly, a diagnosis of their potential conflicts. The latter also considered a background analysis of legal, cultural, and other dimensions driving the functioning of water domain.

The diagnosis showed how people's perception of water was very local; "the mainstream idea was that water just comes from the tap", stated the FFLA respondent. About the composition of the water cycle in this region, people knew only about irrigation ditches and some local rivers, failing to understand the sources of water and other uses that this resource sustained such its ecological role.

These actions set up the bottom line for designing the strategy to conduct a collective process. The first element of this strategy was to define a governance model that mirrored the existing administrative structure on water issues split into levels: the local level, where operational issues were implemented; the regional or planning level; and the national level or the political level where government agencies accountable for water issues were represented. The lower levels would have a

representation at the upper levels. Decision-making was present at all levels. A key principal of this strategy was to have the flexibility to adapt during the discussions.

6.1.8. Multi-Stakeholder Workshops

A second element of this strategy was to define the actions necessary to achieve the ultimate goal of creating an integrated water management plan. For this, in 2008, a series of multi-stakeholder workshops involving agents from the multiple water dimensions started to take place. Six of these workshops were held at a basin level (regional level) and several others at a Sub-basin level (local level), following the governance structure defined.

These multi-stakeholder workshops aimed at building a common vision for the Guayllabamba Basin. They also enabled agents to get to know each other personally and to recognise each other's roles. Closer relationships and trust were key elements arising from these events. The first workshop aimed at identifying agents' common interests and relationships, and to enlarge the agents' understanding of the Guayllabamba Water Basin and its systemic functioning. As a result agents moved from the idea of 'my water' to perceiving that they all shared the same water.

Participation in the workshops varied according to the different levels. For example, representatives from the government at a national level took little part, with a high turnover from one workshop to another. According to FFLA, at this first workshop the government and the public enterprise for water supply in Quito (EMAAP-Q) were the two actors to hold most tightly to their own interests.

To compensate for the absence of key agents in the workshops, FFLA held one-to-one meetings with them to leverage their involvement in the process. Twenty-five meetings were held in parallel to the workshops with agents ranging from the national government to the local communities. These meetings turned out to be crucial for engaging critical agents. As a result, community representatives and government agencies mainly increased in number and became more proactive.

In 2009, the upcoming revision of the law on water issues started to overshadow the discussion and the uncertainty about the future hindered the process from evolving. In response to this, a consultant was hired to work on a one-to-one basis with the different agents to design an action plan for creating a new water management strategy under the new situation. The consultant undertook several field

visits and Internet-based debates to collect the agents' views and proposals for an action plan in a common document. This plan was presented in a multi-stakeholder workshop in late 2009 for the agents to validate. However, the plan was blocked due to the uncertainty about the content of the water law. Agents claimed that they focussed the next multi-stakeholder workshops on reviewing the new water law draft in order to present suggestions, instead of discussing the water management plan.

According to FFLA, one of the reasons for the agents stepping back from the action plan was the lack of representation of all agents' views as, for instance, the demands of some micro-basins. To overcome this situation and to keep the multi-stakeholder process alive, from the end of 2009 and almost all 2010, FFLA continued holding one-to-one meetings with key agents in parallel to the workshops.

6.1.9. The Revision of the New Water Law

In February 2010, a few months after this case study data was collected, the proposal for the new Water Law was published without considering the agents' suggestions. This provoked an uprising by indigenous communities, who occupied Quito in protest against this legal reform (to find out more on the history of the indigenous movement in Ecuador see Appendix 10).

The scale of the mobilisations required the intervention of the police and resulted in the shooting of an indigenous protester. The instigator of this shooting was never revealed. What is certain is that this event caused a crisis at a political level that led to the discussions on the water law reaching a deadlock. The political crisis meant an important blow to the recently constituted Water Secretariat - SENAGUA, making evident its lack of leadership both in the water law discussions and in the ministries leverage to back up this legal reform. Due to this mismanagement the President of the Republic assigned a new secretary to SENAGUA.

FONAG's role in this multi-stakeholder process also suffered a turning point as the new SENAGUA had a more proactive attitude. This subsequently led the president to revoke the 213 Municipal Ordinance to remove FONAG from its official role in the creating a new water management plan.

Various communications (emails and phone calls, June 2010 and February 2011) with FONAG's director after fieldwork revealed that FONAG signed a technical agreement with SENAGUA to jointly check 1,700 water concessions

involving the community. This collaboration aimed to reinforce SENAGUA's knowledge of auditing water concessions (the main problem for water management) in order to update the recently created database for water assignations, and to strengthen SENAGUA's role in the water scenario. Secondly, SENAGUA's new Secretary agreed to a FONAG proposal to create a National Hydrological Scheme, where the latter would design the document layout with the support of national and international experts. Finally, SENAGUA agreed to take over the leadership to create the Guayllabamba Water Council in order to create an example that could be replicated in other water basins.

From the agents' perspective, publication of the new water law meant a profound blow. This turned agents' former feelings of empowerment and self-organisation into disappointment and disbelief in the government and in the power of multi-stakeholders like these.

6.2. Perspectives, Challenges and Dynamics at a Micro Level

The former section noted that as the multi-stakeholder discussions were evolving, agents were experiencing a transformation at a lower level to be part of the collective process. In order to understand and analyse these transformations and how they related to the events that took place at a process level (listed above), further knowledge of the changes happening at a micro level is needed.

Literature in the field of complexity theory points to the need to look at the dynamics at a micro level in order to understand and explain the dynamics at a collective or macro level (Holland 1995; Kauffman 1993, 1995; Sawyer 2005). Holland (1995) suggests that if we are to understand the interactions of large number of agents, we must first be able to describe the capabilities of individual agents.

This section introduces the institutional and personal journeys experienced by the main agents involved in the process of creating an Integrated Water Management Plan for the Quito Metropolitan Region between 2004 and 2010. The selection of these institutions was agreed with FONAG (Fund for the Preservation of Water Resources) and FFLA (Foundation for the Future of Latin America), main facilitators of this process of study, based on the degree of participation, influence, representativeness and accessibility that participants had to this study.

The section is structured according to the agents' social role: public, private, and third sector organisations. This layout aims at exploring the second research question on what the different perspectives and challenges are that agents face in engaging in collaborative work according to their social sector, as shown in Figure 2 (Chapter 3). For each agent or social sector, the main challenges and enabling conditions stemming from this process are presented. When possible, the external perception of the agents' participation in the process is also included so that multiple perspectives on the agent experience are provided.

The methods used to collect this data were semi-structured individual and group interviews. However, access was denied to the floral and bottling companies, and indigenous representatives.

6.2.1. Community-Based Agents and Local Level Dynamics

This section presents the main agents acting at a local level: the Corporation Randi Group (Non-Governmental Organisation) and the Salesian University.

The main goal of the multi-stakeholder process at a local level is to set up and strengthen debating spaces, which are representative of the water users' diversity. This is part of FONAG's strategy to reshuffle the governance model in order to sustain a future Integrated Water Management Plan.

In the Guayllabamba Basin there are 11 Sub-Basins, of which only three were already active before this process started. Sub-Basins have existed traditionally in the region as spaces for community debate at a local level, as is the case with the 'Mingas'[71], despite the fact that they are not recognised by law. Until the recent revision of the water law, the only recognised multi-stakeholder space related to water management was the Council Basin, which operates at a basin level (regional level). The new version of the law, however, considered the basin councils as a consulting board not able to make decisions, contrary to what was expected by this multi-stakeholder process.

Agents' representation in these spaces varied between Sub-basins, with the Drinking Water Irrigation Councils the most represented and the Agrarian Sector the

[71] Mingas are community groups responsible for the creation and maintenance of the irrigation systems before the Water Councils existed. Water Councils are the governmental bodies that operate at a local level assigning water volumes.

least represented. People in rural areas are very busy with their cattle and crops routine and do not have much spare time and flexibility to attend these debating spaces.

An existing conflict at a local level is the misallocation of water volumes as the State allocates volumes of water larger than the real water available. The root of this problem is the lack of accuracy of public data (Hydrologic Model)[72] in relation to the volumes allocated to each specific use. The new partnership between SENAGUA and FONAG is tackling this problem. People's perception of water is another element that influences the dynamics at a local level. As noted above local level agents' vision of water is very localised and fragmented.

Nevertheless, after two years of work and under these conditions the multi-stakeholder process managed to set up three more spaces for debate and decision-making at a local level: CODECAME, La Chimba and El Pisque Sub-Basins. These spaces were aligned and would speak in unity at a basin level. However, their participation at a basin level was only due to the law's requirement, not because people engaged with the basin concept. This was due to the weak functioning of the Basin Council, but "once the basin level debate works, the Sub-basin level will too" agreed the Randi Group respondents.

Corporation Randi Group

The Randi Group is a Non-Governmental Organisation (NGO) that promotes sustainable development at a community level. Under that goal, they undertake development projects where participation and gender are core elements. Eighty percent of their financial resources come from consultancy work and 20% from other sources.

The engagement of the Randi Group in the process came in 2008 when Randi Group was hired by FFLA (Foundation for the Future of Latin America) for a two-year period to reinforce the debate of grassroots communities. Randi's task was to strengthen the water users' organisational structure at a sub-basin level in order to

[72] The default of the Hydrologic Model came up in the multi-stakeholders discussions as a potential risk for the Integrated Water Management Plan, hindering agents' confidence in this Plan.

ultimately reinforce their participation at a basin level (regional level). Hence, the Randi Group role in the process was as a consultant and not as water user.

At the time of this data collection, the Randi Group had already set up three spaces for debate and decision-making at a local level: and a fourth was under way. The Randi Group has already been working for seven years to set up these community debating spaces in other sub-basin regions.

Main Challenges: A major challenge for the Randi Group in promoting this multi-stakeholder process at a local level was to get the Sub-basins represented at a regional level (Basin Council) without having to set up a debate space in the eleven Sub-Basins of the Guayllabamba region, as this would mean long-term work. This was mainly due to the national government's lack of connection with the local level, as their only relationship was to assign the water concession to water councils[73].

Handling the relationship with the government was another main challenge of this process. The municipality was not always invited to the sub-basin debates as local agents did not legitimise this. However, a good relationship with the local governments was proven to reinforce these debate spaces. Nevertheless, the relationship with local governments evolved during the process, becoming increasingly engaged. To include the most excluded actors from the rural areas to these spaces was another challenge.

Enabling Elements: The informal nature of these spaces for debate was an element that enabled the process to evolve at a local level. The lack of a legal identity of these spaces allowed discussions to be held on different issues, as there was no pressure to achieve an institutional mission. Some of these spaces emerged as a reaction to inadequate water policies, as the communities monitored government actions.

External Perception: From the government perspective this community empowerment was a threat, particularly because the government both at a regional and local level

[73] Water Councils are community-based governmental agencies responsible for requesting the allocation of water volumes to the Government at a national level and for managing the resource at a local level.

was quite fragmented and having frequent internal conflicts, which also made communication with local agents more difficult.

Salesian University

The Salesian University has been engaged in development projects for more than twenty-five years in the Cayambe region. The Cayambe village belongs to the La Chimba Sub-Basin. Most of these actions have aimed at improving the water technology for irrigation and pasture, as Cayambe is a cattle region.

La Chimba Sub-Basin groups up to 3,200 users, including cattle raisers, indigenous communities, peasants, local councils, Water councilss, NGOs, floral companies and some national government agencies. This region has an underlying conflict between two villages that share a common irrigation ditch.

Peasants took over the ditch and imposed their own rules as they thought that the municipality had prioritised the flower companies over other users in the water share-out. This is why there had been no opposition from the private sector, since water supply had been granted to them.

The university support the Randi Group in leveraging local agents in the region. An example of this is that both organisations sent invitations to the first multi-stakeholder workshop of the La Chimba Sub-Basin, jointly with the Peasant House. This call was well received thanks to the Salesian University's reputation and the broad integration of the Peasant House in the region. The indigenous people were the only ones opposing the invitation, as they were in conflict with NGOs (for more information on the indigenous movement in Ecuador see Appendix 10).

Main Challenges: To integrate indigenous needs and views in the process discussions and outcomes was a major challenge in this Sub-basin. Indigenous communities do not support the creation of an Integrated Water Management Plan insofar as it is based on the concepts of 'Water Basin' and 'Basin Council' which they do not share. They claim that the division of the territory according to 'Water Basins' splits their communities into different units, which would mean them having to respond to different basin councils and live under different paces and rules. Indigenous groups proposed the idea of 'cultural basins' as a better compromise between water management and cultural integrity.

A political distance is present in this region because of this, as local governments have a neoliberal vision so did not understand or recognise the indigenous vision. In La Chimba Sub-Basin, the community relationship with the government was very poor, although not as bad as in other sub-basins, according to the interviewees.

Another major challenge in this sub-basin was the agents' irregular attendance at the diverse workshops. Starting every workshop with a summary of the previous one helped to overcome the difficulty with maintaining a flow in the discussion process.

Enabling Elements: An example of the efforts that this process of study did to integrate these indigenous groups was to call this multi-stakeholder discussion a 'space for dialogue' instead of 'Sub-Basin Council', as it was referred to in most of the other regions.

A final aspect that influenced the process evolution in this region was the positive influence of the lessons learnt by other processes they visited, funded by The Nature Conservancy.

The first two years of the process raised people's awareness of water management. In this period, suggestions for the water law and constitution reforms were made. While these were mostly considered including the idea of a 'Cultural Basin' being a crucial element of local empowerment, the final version of the water law excluded them, which provoked the communities' uprising.

Due to the emerging conflict with the indigenous and grassroots communities in this region, no interview was carried out with them. However, the Salesian University Director, who has been personally and institutionally engaged with indigenous people for more than a decade, represented their view on the process.

6.2.2. Public Sector and Dynamics at the National and Regional Level

At the time of data collection, the public agencies accountable for water management in the Quito region at a national and regional level were: the Water Secretariat (SENAGUA), the Environment Secretariat, the Land Planning Secretariat, the Public Enterprise for Water Management in Quito (EMAAP-Q), and the Ministry of Urban

Development and Habitation (MIDUVI). As they all had accountability for water issues, they were all invited to be part of this multi-stakeholder process.

The participation of the different ministries and public entities in the multi-stakeholder process changed over time. This was mainly due to the uncertainty caused by the approaching revision of the water law.

The revision of the water law did not have a formal public consultation process. However several groups passed their views to the government through meetings, websites, etc.; however, these were never considered in the final draft of the Water Law. An example of this lack of representativeness in this law revision is the absence of the National Secretariat for Water issues (SENAGUA). According to FONAG, when the President Rafael Correa reviewed the version of the Law that was published he was very disappointed that his team had not considered the users' recommendations.

The new Water Law was particularly weak on water governance. It mentioned the Basin (regional level), but left aside the Sub-basin level (local level). As mentioned before, this was a blow to the local agents' empowerment and engagement in this process of study.

The public perception of the government in Quito is one of distrust and disbelief. People's opinion of politicians is that 'they never keep their promise'. This general perception stems from the series of corrupt governments that Ecuador has had for many years. At the time of this survey, the government of Rafael Correa enjoyed greater popularity than those of former presidents and it was highly likely that he would be re-elected in the general election, as finally happened after this data collection. Correa's political team is more pro-environmental than those of many former presidents. However, several interviewees declared that the current government had quite a centralised decision-making approach, which would be an obstacle to the implementation of an integrated water management plan. For this reason, many agents sought to reinforce their lobbying of the government.

Water Secretariat – SENAGUA

The Water Secretariat - SENAGUA[74] - is the public body in charge of water issues for the country. Since Rafael Correa's first administration, SENAGUA has been the single authority for water matters, signalling the political relevance of water issues for the government's agenda.

However, the various ministries previously in charge of water issues did not give up their jurisdiction after SENAGUA was created. Hence, SENAGUA never got the real power of a single authority, damaging its institutional credibility. Since then, SENAGUA has become more of a lobbying entity, holding up internal interests instead of fulfilling its institutional role in water management.

SENAGUA's lack of leadership and coordination with the other authorities is reflected in the incoherence of public policies on water issues, as was the case of the water law revision. However, as described in the previous section, the conflicts generated by the revision of the new water law meant a reshuffling of SENAGUA.

SENAGUA's new Secretary has a clearer vision of the next steps needed for overcoming the situation in the country, according to FONAG's Director. In March 2011, the new SENAGUA team met with the different ministries' representatives in charge of water matters to restore the role of SENAGUA and to claim their participation in the creation of a National Hydrological Scheme. Also SENAGUA, with the support of FONAG, is looking to re-open the dialogue with the indigenous representatives. The new SENAGUA team has previous experience of this and has a good communication with the indigenous movement.

Secretariat for the Environment

The Secretariat for the Environment participated in most of the multi-stakeholder workshops and events of this process. This participation was however marked by a high turnover of the institution's representatives, which was a common reaction from many public agencies participating in the process. This meant a continual changing of views and attitudes by the different representatives, which hindered discussions and agreements. According to the interviewee, personal engagement was a key element

[74] The former SENAGUA team was invited to an interview about their own experience of this multi-stakeholder process however they cancelled in the last minute.

for the institution to endorse the process and to go through the internal institutional changes needed to maintain the common goals.

Main Challenges: A major difficulty in engaging the secretariat in the process was to gain support from the rest of the organisation for the suggestions and demands coming from the workshop. To overcome this, after each workshop, the content and agreements of the discussions were shared with the rest of the Secretariat team. Nevertheless, the Secretariat offered resistance to introducing changes at the pace needed to keep up with the workshops' demands.

The different kind of knowledge present in the workshops was an aspect that influenced discussions in the process, pointed out the Secretariat respondent. The amount of technical information made people from communities struggle to keep up with the discussions. This meant that most of the time, some agents approved documents without a full understanding of their content. The interviewee suggested that a separate space for technical discussion might be a solution to prevent the workshops becoming too technical.

Main Benefits: The interviewee assessed her participation in this multi-stakeholder process as a very positive and interesting experience, both at an institutional and a personal level.

According to the first representative of the Secretariat for the Environment in the process, the main benefits of the process were: to link "conservation to conversation"; to get to know other agents' work and to improve the coordination of actions from outside this process through networking. For example, the Secretariat for the Environment and the EMAAP-Q increased their coordination in order to undertake some environmental actions. They also acquired a closer institutional relationship with several other agents.

Public Enterprise for Water Supply in Quito- EMAAP-Q

EMAAP-Q is the public water supplier for the Quito Metropolitan Area. It hosts the Environmental Sanitary Unit (PSA) responsible for implementing a water and sanitation programme. This programme aims at improving flood prevention and maintaining the sewage grid, control of water leaks and basin conservation.

In 2006, FONAG's Director asked the Environmental Sanitary Unit to assume the technical and executive follow-up of the future Integrated Water Management Plan. To build up this management plan, they had the technical and financial support of the UICN (International Union for Conservation of Nature) and the BID (Inter-American Development Bank). This technical proposal, however, was never approved by above agencies. According to interviewees, the main reason for this was that the calculations coming from the hydrological model were wrong, as the baseline information was inaccurate.

They also considered that the main water consumers, such as the farmers with rights to water use, were missing from the process discussions. According to this view these points were key to the success of the process.

Main Challenges: To obtain institutional back up for the opinions expressed during the workshops was EMAAP-Q representatives' main challenge at an organisational level. Fear of a conflict of interest between the process and the company prevented them from increasing their engagement in the process. This situation became particularly difficult when the new directorate team brought in by the new elections finally decided to take a distance from the process.

The revision of the water law also laid uncertainty on how the public enterprise role would be considered in the new legal framework. Due to EMAAP-Q's lack of authority over the services supplied, they were lobbying for SENAGUA (Water Secretariat) to create a specific unit that would be in charge of water and sewage.

Main Benefits: To improve their institutional image was one of the benefits that EMAAP-Q took from this process, according to the interviewee. Thanks to the process, they moved from an image of conflict to finally being considered as another agent within the water domain who was interested and willing to reach agreements.

In 2009, EMAAP-Q set up the Corporate Social Responsibility Department to integrate the social component into its business performance. Until that moment, the company's strategic goals were limited to supply and billing and their communication channel with consumers was through the bills sent by post.

The process also enabled a better understanding of the company's efforts to improve water pollution in the Quito region, which until then had not been appreciated.

External Perception: EMAAP-Q's attitude at the beginning of process was seen basically as complying with the legal framework on water issues. Local agents criticised this attitude as it meant a lack of awareness of people's real needs. EMAAP-Q, however, did not perceive these conflicts as theirs, since they were acting in accordance with the law.

However, EMAAP-Q is another instance of a public agency that has changed its behaviour during the process. They were regular participants in the process with two to three representatives, and over the process they became better organised at an institutional level. This institutional change was due to two main factors: (1) they wanted to strengthen their position in the process; and (2) they wanted to be well informed and connected in order to undertake their mission. This change in their participation shaped their attitude. At the beginning of this process, EMMAP-Q was quite inflexible in relation to what the priorities were in water issues for Quito. This attitude improved as they became progressively aware of the other agents' needs and hence turned to dialogue and cooperation. "The non-political, non-confrontational, open dialogue nature of the workshops was crucial for this kind of institutional change and personal engagement in the process", stated FFLA respondents.

Another external perception of EMAAP-Q's role in the process is in relation to its power in water issues. Several interviewees pointed to the power relations as a main challenge for this process. According to the diagnosis of relationships undertaken by FFLA before launching the process, EMAAP-Q had more power than the municipal government. This general perception from the agents about EMAAP-Q's power position was clearly present during the process. As stated by FFLA: "although EMAAP-Q was just another water user, it had more political power than the other public bodies, as it was financially more powerful". Nevertheless, the approval of Municipal Ordinance 213 appointing FONAG (Fund for the Preservation of Water Resources) responsible for creating an integrated water management plan, changed EMAAP-Q's attitude and the balance of power.

Ministry of Urban Development and Habitation- MIDUVI

The Ministry of Urban Development and Habitation (MIDUVI) is responsible for the Water Councils.

Water Councils are community-based governmental agencies responsible for requesting the allocation of water volumes to the government at a national level and for managing the resource at a local level. The national government provides the infrastructure for the water supply and the water councils are accountable for its administration and maintenance, billing and sewage treatment. The taxes collected by the water councils are reinvested to improve this infrastructure. According to the government administrative hierarchy, water councils depend on the regional directorate for drinking water and sanitary treatment. This regional directorate is responsible for approving the creation of new water councils and for defining the water rates. At a higher level, the Regional Directorate for Drinking Water and Water Treatment depends on the Ministry of Urban Development and Habitation (MIDUVI).

The creation of EMAAP-Q (Quito Public Enterprise for Water Supply) generated a conflict with the water councils, as the public enterprise did not respect the Councils' autonomy and role. As the water councils became better organised and more united, they managed to change the Law, and prevent EMAAP-Q from usurping the Councils' jurisdiction.

Water councils are accountable for the water supply in rural areas, while the public enterprise EMAAP-Q is responsible for water supply in the Quito metropolitan area.

External Perception: The external perception of MIDUVI's participation at the beginning of the process was of a low profile. Water councils were supposed to be removed in the upcoming new water law so they felt threatened by the new regulation and had a confrontational attitude.

However, after taking part in several events, MIDUVI understood that the process was not a matter of 'who wins', but of cooperation for a common goal. This fact triggered them to move into a position of dialogue. This change in attitude even became extreme, according to the FFLA's facilitator, as they opened their institutional strategy for group discussion.

The El Pisque Water Council

Set up in 1999, the El Pisque Water Council works to provide efficient water management and adequate infrastructure to 59 users, which represent 6,500 people. Ten percent (10%) of the water supplied is used for irrigation by the flower industry, the farming sector and for drinking water. Peasants and local farmers represent 90% of the water consumed for agriculture.

The river that supplies the water for the two towns in this region is the El Pisque River. The overlapping of two populations under the same river basin, as is the case for this river, requires the intervention of the government at a national level.

This Water council forms part of the El Pisque Sub-Basin. This Sub-basin or space for debate at a local level emerged as a result of the local agents' common rejection of the performance of the public supplier, EMAAP-Q. The internal structure of the El Pisque Water Council is an assembly, a board of nine permanent members, nine alternate members and a secretary.

Main Challenges: The main problem that the El Pisque Sub-Basin faces is that the government does not provide the amount of water required by local users. Also the quality of the water supplied is poor, as the river is quite polluted. According to the interviewees, "managing the water resources is a question of quality, but also of quantity".

Until the data collection, there was no official body responsible for water quality levels in the country. This meant that there was no legal framework that regulated the water treatment needed according to the different uses. In the case of the Quito region, the EMAAP-Q is working on improving the quality standards, but apparently this is still insufficient.

This Water council has been working to improve the water quality for a long time, but the lack of a legal framework is an obstacle to demanding action from the users. However, thanks to cases like El Pisque, the new version of the water law makes the source of emission responsible for the treatment of that water.

According to the interviewee from El Pisque Water Council, the basin council accomplishes its role as a space for discussion on issues related to water management. However, a pitfall for this process is that the water law does not recognise spaces for debate at a Sub-basin level, as it does at a basin level.

How the final Integrated Water Management Plan is going to guarantee a complete representation of all water users is a major challenge that the interviewees saw in the process. For him, all water users need to be considered in the decision-making process at the various levels of the water administration.

The Ayora Drinking Water Council

This Water council provides drinking water for 240 lots in the town of Ayora and the surrounding industries (just for kitchens and toilets).

The Ayora Water Council was selected to illustrate this process of study as a well-organised and very proactive drinking Water council. For instance, they are a reference point in the country for water treatment, as they already treat 98% of sewage, even though there is no legal regulation. They are also pioneers in applying a collection tax for solid waste. This region has not had conflicts on water management mainly due to the low water rates. For the last 10 years these rates have been: $1 /15m3 of water for domestic use (which represent 85% of demand); $2 /15m3 for local business (shops); and $4 /15m3 for industries. According to the interviewee, water rates respond to the rationale ‘who uses less pays less; who uses more pays more’.

Enabling Elements: Explaining this rationale to the various water users has been another factor for the Water council’s smooth functioning. Although they have not faced any water restriction, “the problem is that these (low) water rates do not encourage water efficiency”, states the interviewee.

The expectation from this process is that Water councils could take part in water volume allocation, as they represent the water users’ needs. In 2006, the Water council joined the National Water Forum, aiming to influence the Constitution and the new water law discussions. In 2007, most of Ecuador’s Water councils joined the forum following this step and aimed for these legal documents to review their role. These unprecedented gatherings of Water councils boosted the creation of the Ecuador Drinking and Irrigation Water Council.

The new platform groups up 10,000 Councils, which represent more than 5 million inhabitants. They pointed to the precarious water quality as the country’s main

problem. One of the reasons for this poor quality is that Ecuador's pipelines are made of already old galvanised iron, which wears away after a period of 15 years.

Mejia Municipality

The Mejia Municipality is located in the upper part of the Guayllabamba Basin, by the San Pedro River. According to their mayor, they are well aware of their responsibilities towards the populations of the lower river section.

Due to its position on the upper part of the river, Mejia's main priority was to improve water quality. An example of these efforts is the water treatment plan recently created by the new mayor.

As part of the multi-stakeholder process, this municipality attended the CODECAME debate space or Sub-basin. The CODECAME's main participants were Parishes[75] that were not part of any Water council, this enabled bottling companies to settle in the region.

The discussions within the CODECAME Sub-Basin were around the exploration of new water sources, as these are increasingly scarce in the region mainly due to a steady industrial demand. This debate served to share information on new sources among the local agents. The next step planned is to strengthen water councils in order to monitor water quality levels and to improve the water storage infrastructure.

Water companies attended the CODECAME meetings, as they are affected by the decrease in the amount of water and increase in pollution. These companies are geographically below the town of Mejia. However the municipality has traditionally demanded the companies' involvement in the town's water issues.

For the companies, their main interest is to obtain environmental permits to attend to their water needs. They also expect the new water law to set out clear administrative procedures and competencies for the different public agencies.

[75] A Parish in Ecuador is the lowest administrative unit, which corresponds to small communities. The administrative hierarchy in Ecuador from top to bottom is: Municipality, Canton, Neighbourhood, and Parish. Parish Councils are accountable for transmitting users' demands and needs to the upper levels of the administration, but they do not always do this.

Main Challenges: A clear definition of the roles of the Water councils and Parishes is a crucial aspect of improving water management and avoiding the current inefficiencies the interviewee identified as the main challenge for the ultimate goal of this process.

Enabling Elements: Knowing other local agents, as they had no relationship with any Water council, was the main benefit of the municipality from this process. The priorities, criteria and clear roles established in the process were a boost to the local agents' action.

A key element for the municipality's engagement in the process was the support of the mayor. "The mayor needs to understand that to be part of the multi-stakeholder discussions and search for solutions is key for them", stated the interviewee.

6.2.3. Private Sector- Flower Companies[76]

In the 1990s, a flower industry with a mix of national and foreign capital started to flourish in the upper mountains surrounding the Quito metropolitan area. The need for abundant and accessible water resources and the connection to a main airport, were the main elements attracting this industry to the region.

On the other hand, the absence of a good land use plan enabled this kind of industry, as well as bottling companies, to settle in the upper part of the water basin. Down the river from these industries, rural and indigenous populations depend on harvesting and small cattle herds.

The flower industry consumes a large quantity of water for irrigation and of chemicals to increase production performance, generating a significant environmental footprint in both quantitative and qualitative terms.

Before this multi-stakeholder process, the relationship of the industry with the water supplier EMAAP-Q (Quito's Public Enterprise for Water Supply) was exclusively through the company lawyers and based on the exchange of formal letters.

In relation to the flower companies' engagement in the multi-stakeholder process, this also changed during the process. At the beginning, their attendance was

[76] Private sector participants were the only group of agents that directly declined the invitation to be interviewed for the construction of this case study and purposes of the research.

basically as listeners, taking note of anything relevant to them without engaging in the discussions. According to FFLA (Foundation for the Future of Latin America), "they constantly gave the impression of lack of interest, as if their participation was too expensive for an outcome from the process". Later in the process their attitude became more open to debate, but they still did not engage in the discussions. The participants were senior managers of the company (decision-makers) who clearly had an expectation of getting some privileges in water allocation, as they are a local employer.

One of the companies' arguments during the process was the lack of financial resources to devote to actions outside their core mission. In the Randi Group's opinion, "companies are not familiar with dealing with people". According to FFLA, the motivation for the private sector to engage with the process is to follow up the water law revision, as this would potentially require the companies to take responsibility for the pollution generated.

Many businesses take part in or are represented in water councils.

Conclusion

This chapter has presented the main events that, between 2004 and 2010, drove the emergence and development of the multi-stakeholder process intended to create a new model of water management and governance in Quito.

This case study illustrates the multiple interactions between a number and diverse types of agents (public, private, community-based, academic, coordination agencies, international organisations), levels of the administrative structure (national, regional and local), past and present forms of functioning (i.e. Mingas and Water Councils), and various structural dimensions (geographical, legal, political, cultural, economic and even ecological) that are involved and define the functioning of a natural resource such as water in the context of the Quito metropolitan area. This chapter has shown how the interaction between these multiple elements and agents is what shapes the complex dynamics of the water functioning in the area.

This research work argues that the dynamic of multi-stakeholder collaboration described in this case study presents properties of complex adaptive systems. Therefore, this research proposes that the advance of complexity theory in the last few decades represents a new opportunity to reveal features of the functioning of multi-

stakeholder processes so far not fully grasped at a theoretical and practical level. The following chapter draws on the evidence presented in this descriptive section in order to explore this purpose.

This case study however presents characteristics that differ from the previous case study: (1) the process has not achieved yet a collective agreement; (2) it occurs in a different country, Ecuador; (3) the multi-stakeholder process deals with a different subject matter - water in this case - and has a different goal: the construction of a new water model; (4) the number of agents and types of agents is higher; (5) the levels of the administrative structure involved in the process is also higher; (6) the number of structural dimensions that influence the process is also higher in this case; and (7) the 'weight' that past events in the dynamics of this case study have is also more influential than in the Mandú Alliance experience. It is important to note that due to these particular conditions, such as the higher number of agents and variables present in this second case study, as opposed to the first one, the extension of the description and analysis of this second case study is larger than the first one.

This leads to an intriguing question in the field of complexity sciences: does the presence of higher number of agents, variables and diversity of existing conditions that influence the construction dynamics of collaboration mean that this system is more complex than the Mandú Alliance case study? Or does the higher level of order created by the Mandú Alliance mean that this system is more complex than this second one? In other words, is there a way to say that the Quito experience is more complex than the Mandú Alliance one or vice versa? In fact, despite this not being the goal of this research, there is no agreement on how to measure the complexity of a system (for more information on the various approaches to this see Mitchell 2009). The question that matters to this research is if despite these differences, do the same forces of order as the previous case study drive the Quito experience? What means that the Quito process has not yet achieved a collective agreement despite the fact that the time frame of the two processes is similar (around 6 years)? The following chapter explores these questions and finds answers to them.

Chapter 7

Case Study Analysis

"An Integrated Water Management Plan" Quito- Ecuador

Introduction

This chapter analyses the complex dynamics behind the inter-sector process presented in Chapter 6, which aimed at implementing an Integrated Water Management Plan for the Quito Metropolitan region (Ecuador). The period of analysis covers the events that occurred between 2000 and early 2010.

This case study shows how the outlook of a major water crisis in Quito leveraged agents' interest in seeking a collective solution to their common problem, the inefficiency of the existing water model. Agents from government agencies, private and public enterprises and various community organisations, came together to build a common solution, to create an integrated water management plan. The actions taken led to constitutional changes, legal revisions, the creation of the Fund for the Preservation of Water Resources (FONAG) and multiple multi-stakeholder discussions between urban and rural agents. These agents stemmed from different cultural identities representing all levels of the water administrative structure. These events reflect the diversity of agents, context of conditions, water needs and measures that interplayed in this multi-stakeholder process.

The outcomes and unfolding of the events in this process, however, raises questions about how inter-sector processes like this work, and how far can we manage them. For instance, why were the constitutional and law reforms not sufficient for installing a new management model? Was the creation of the Fund for the Preservation of Water Resources necessary to achieve the expected goal? Could the indigenous uprising and deaths have been prevented?

This research argues that the events and outcomes of this process reflect the complex behaviour of social systems. To illustrate this, a Complexity Theory approach and a Complex Dynamical Systems Theory perspective is used to explain and better understand this collaborative process.

The first part of the chapter explores the complex mechanisms that shaped the unfolding of the process at a macro level. The second part examines the behaviour of agents at a micro level in order (1) to understand the dynamics occurring at a collective or macro level, and (2) to explore the journey that agents from different social sector experience in achieving collaborative agreements. This structure of analysis aims at providing a better understanding of the interaction between collective and causality level dynamics of complex systems (Kauffman 1993; Holland 1995; Sawyer 2005), and to respond to the two main research questions of this work: What is the complex dynamic of inter-sector partnership processes in the two case studies investigated?; and first subsidiary question: What are the different perspectives that public, private and civil organisations have of the partnership process and their main challenges?

7.1. The Dynamics of the Multi-Stakeholder Process at a Macro Level

This first part of the chapter explores how the interaction between the system components (agents) with the multiple dimensions of the system structure help to explain the complex dynamics of this multi-stakeholder process at a macro level.

The system under study is the domain of water management in the Quito Metropolitan Area (QMA). The component parts of this system are the array of agents from water users to decision makers and who belong to this domain. In terms of the structure of the system, Appendix 11 presents a summary of the multiple dimensions that comprise this structure and the conditions they exhibited at the beginning of the process (2000) drawn from the previous chapter (6).

7.1.1. Featuring the Nature of the System

The starting point for this analysis is to feature the conditions and dynamics that the system showed at the beginning of this process of study; and how they drove the system to the brink of major water crisis. Mitleton-Kelly (2003a) refers to this initial multidimensional scenario as the "the problem space".

A first element hence that compounds the problem space in this case study is Quito's location at an altitude above 3,500m. Natural access to water at this altitude is restricted as ground water levels are low that the system depends more on superficial

flows of water and meteorological conditions. This means that water access in the system, at every specific point in time, is determined by the interplay of various physical and environmental variables that operate on a large scale.

A second element that constrains the functioning of the water sub-system in this area is technology. Over recent decades, several artificial means have been used to counterbalance the natural variability of water provision in the system. Examples of this are water transfers from the Amazon basin and reservoirs built in the 80s and 90s. These technologies proved however to be insufficient to keep up the Quito‘s growth rate.

From a system structure perspective, the introduction of these technologies aggregated a new dimension in the system. The degree of interdependence between these two kinds of variables - technology and the physical and environmental variables - therefore constrain the system behaviour. This points to an important feature of the system, the degree of coupling between variables (Kauffman 1993; Holland 1995). In this case study, these two variables seem to be highly correlated, albeit in an inverse fashion: when the level of water provision falls, the level of technology increases.

Linked to this feature, another property of complex dynamical systems that can be observed in this experience is its non-linear behaviour. Depending on the nature and degree of coupling between variables and the parameter values these variables present at each point in time, the same incoming signal in the system can exhibit a different behaviour (Bak 1996; Holland 1995; Kauffman 1993, 1995).

The possibility of creating a new dimension in the system structure reflects another important feature of complex systems, the capacity to tune the system (Kauffman 1993). A system can be tuned to keep providing its function in a particular way, within the boundaries of its capacity. This tuning can mean, however, that the system is shifted away from its natural balance, as is the situation observed in this case study. That is, as the water demand gets higher than the system’s natural capacity to restore it, this pushes the system to threshold values where it is less and less able to self-sustain or self-organise. In complexity theory this is referred to as *far-from-*

equilibrium[77] (Camazine *et al.* 2003; Berks *et al.* 2003; Kauffman 1993, 1995; Prigogine and Stengers 1985, cited in Mitleton-Kelly 2003a: 16).

As the system gets closer to this *far-from-equilibrium* point, its functions start to cross a critical point where it can no longer self-restore and a cascade of change propagates through the system (Bak *et al.* 1988; Fronczak *et al.* 2008; Paczuski *et al.* 1995). An example of this is the indigenous uprising that followed the publication of the new water law as this 'seemingly' went beyond the capacity of this group to cope with the repeated political abuses in Ecuador. This could suggest another crucial feature of this system, its *self-organised criticality* behaviour (Bak *et al.* 1988; Brunk 2000). This cascade of change is responsible for giving the system a new equilibrium that can eventually produce the collapse of some of its functions and the extinction of some of its components (Bartolozzi *et al.* 2006; Paczuski *et al.* 1995).

Signs then that the system is getting closer to this far-from-equilibrium point could be observed at the beginning of the process of study as for instance the increase of water and soil pollution, and overexploitation. The presence of these forces hinders the system's capacity to produce clean water, which sustained various functions of the system, such as: drinking water, agriculture, livestock, the water-based industry of the region (floral and bottling) and ecological functions.

This section argues that the problem space of the system stems from the interplay of multiple dimensions of the system structure - geographical and environmental variables - and its dynamic over-exploitation and water pollution (Mitleton-Kelly 2003a). Further to this interplay, this section suggests that the parameter values that these variables exhibit also define the system behaviour or problem space.

The following sections examine how from this problem space an alternative model of water management was built into the system.

[77] In far-from-equilibrium conditions an external perturbation pushes the system away from its existing norms. At the critical point the system would explore its space of possibilities, self-organise and co-evolve to either create a 'new order' or die. Furthermore, in far-from-equilibrium conditions we find that very small perturbations or fluctuations can become amplified into gigantic, structure-breaking waves (Prigogine and Stengers, 1985, cited in Mitleton-Kelly, 2003a:16)

7.1.2. Niche Opportunity

This section examines how the conditions that were pushing the system to the brink of a major water crisis also left the system other *space of possibilities* to explore. This refers to how as the system goes down an evolutionary path other niches of opportunity emerge (Kauffman 1993; Holland 1995).

Indeed, this was the perception of the local leader (water expert) who had navigated through different dimensions of the system, from policymaking, to various technical and research spaces. According to him, in 2000 the conditions of the system required, but also enabled, an approach to water management capable of accounting for the region new conditions such as population growth, while preserving the integrity (natural functioning) of the water system. For him, an integrated water management plan, which would also involve a more integrated governance model, would account for the natural variability of water provision, the diversity of water consumers, and the complexity of managing the system. However, what conditions enabled the construction of this new model or multi-stakeholder process?

The first condition was the gap left by the failure of the existing water model. The outlook of a water crisis encouraged most agents in the system to show an interest in the alternatives presented by an integrated water management plan proposed by the local leader. Hence a match between the system existing conditions and the new agent's features seems to be necessary to enter down a new niche of evolution (Holland 1995).

A second condition is the capacity of this leader to occupy and survive in the new niche. For this, the local agent searched for the support of other agents (local and external) to gather the capabilities necessary to fill in the new niche opportunity. After several years of conversation, the leader managed to leverage The Nature Conservancy's (TNC)[78] financial and technical support to promote an integrated water management model. Once again, the alignment (match) between the TNC's strategy and the leader's proposal was the main enabling condition for this interaction to take place. At a lower level of causality, the leader trajectory, credibility and network were the elements that allowed the connection with the TNC to be created.

[78] The Nature Conservancy (TNC) is a major USA non-for-profit organisation that supports land and water conservation in 34 countries around the world (http://www.nature.org/about-us/vision-mission/index.htm- Site accessed on June 2012).

Therefore the perception and knowledge that the local leader had of the system's dynamic; its capacity to propose new ideas (innovation) that fit into the system's conditions, to search for the resources to reinforce its position in the system and to manage resistance forces, seem to be the main capabilities that can be drawn from this agent behaviour to occupy the new niche.

The backup of the existing network of agents is another condition for the local agent to occupy a new evolutionary niche. In order to survive competition and major resistance forces, the local agent also searched for the support of the major water agent in the region, the Water and Sewage Metropolitan Enterprise of Quito (EMAAP-Q). EMAAP-Q is the only water supplier for the Quito urban region so due to (1) the number of water consumers that it attends; (2) the strategic position it holds in the system, between the government and the consumers; and (3) its financial power; it is considered the most powerful agent of the system. EMAAP-Q's interest in keeping a prominent position in a potential scenario of water management was the main reason to prompt its engagement in the process.

As a result of the interactions between the local leader, TNC and EMAAP-Q, and the enabling conditions in the system, the Fund for the Preservation of Water Resources (FONAG)[79] was created in 2000, aiming at developing a more integrated model of water management. This set of main conditions behind the creation of the FONAG is represented in the map that contains the common process of this inter-sector collaboration attached in Appendix 4.

[79] FONAG's vision is "to be the mobilizing agent that involves all actors in exercising their citizenship responsibly on behalf of nature, especially water resources" (http://www.fonag.org.ec/portal/lang-en/el-fondo/acerca-del-fonag.html- Site accessed on June 2012).

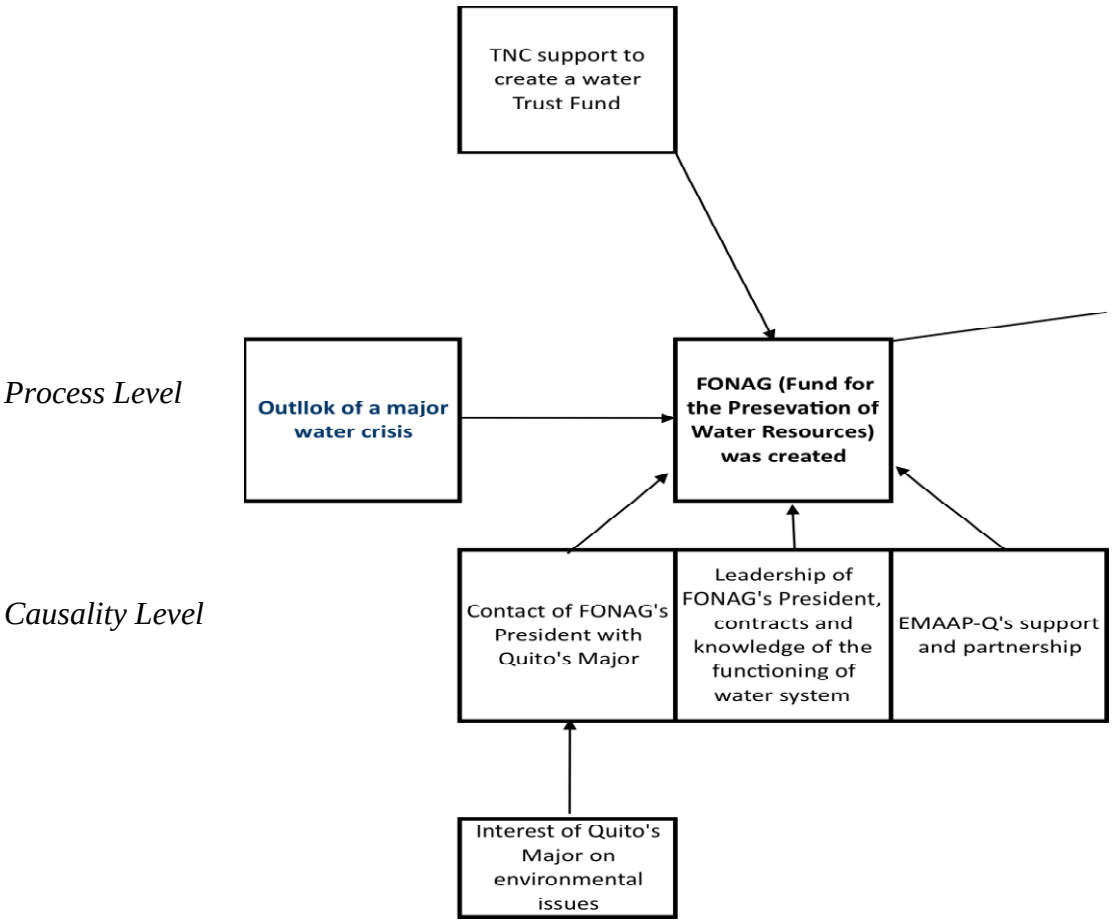

Figure 9- Main conditions underlying the creation of the FONAG taken from Appendix 4.

A first insight from this analysis is therefore how a system seems to have various space-of-possibilities for it to explore (Kauffman 1993; Mitleton-Kelly 2003a). As it moves along one possible path, gaps appear to be created giving rise to new niches of opportunity for agents to evolve. Kauffman (1993) brings the term 'niche' from biology to refer to the gaps or niches that a system constantly creates as a result of its ever-changing nature or evolution. According to him these niches offer new opportunities for local or distant agents to improve their fitness[80], and can be a source of innovation (Kauffman 1993). In relation to Kauffman's argument, this case study might shed new light as it suggests that the motivation for agents to occupy new

[80] The fitness of a species represents its degree of adaptation with respect to the external environment (Bartolozzi *et al.* 2006).

niches in social systems are not just intended to improve their individual fitness, but that of the system as well.

A final insight of this section is how the creation of a new path of evolution appears to create a higher level of diversity and complexity in the system (Holland 1998). This is represented by the creation of the FONAG and how it aggregates a level of specialisation in the system that increases the complexity of its dynamics, is explored in the following section.

7.1.3. The Emergence of a New Agent in the System – FONAG

The creation of FONAG (Fund for the Preservation of Water Resources) represents other properties of complex adaptive systems, the emergence of a new agent with a novel role in the system (Holland 1998; Halley and Winkler 2008; Goldstein 1999; Camazine *et al.* 2003).

According to Holland (1998) emergence stems from the interaction of the system component parts giving rise to novel and coherent structures, patterns, and properties in the system. Although Holland (1998) states that there is not a comprehensive method for studying emergence, he proposes to look at it in terms of the mechanisms and procedures as a way to understand complex systems.

This analysis argues that the creation of FONAG results from a main process, the interaction between its foundational partners[81]. As described in Chapter 7, the interaction between FONAG partners was possible due to the common interest they shared (tag formation) and the overlap between the institutions' strategies (match formation). This seems to be in line with Holland (1995) who argues that greater levels of aggregation produce 'match formation' and 'tag formation', which are crucial for understanding emergence and self-organised criticality.

Exploring deeper the nature of these interactions seem to indicate that FONAG's partners self-organised without external direction but according to a shared interest. Furthermore, the dialogue and negotiations that shaped the process of 'match formation' over the years also appears to have led to some degree of mutual influence in the behaviour of the agents. This mutual influence suggests that co-evolutionary dynamics were also behind the emergence of FONAG.

[81] The local agent, The Nature Conservancy (TNC) and the Water and Sewage Metropolitan Enterprise of Quito (EMAAP-Q)

This analysis also argues that the interplay between self-organisation and co-evolution enabled the processes of tag formation and match formation in this experience. From this it could be suggested that the interplay between these processes - tag formation and match formation - and these mechanisms - self-organisation and co-evolution - ultimately led to the emergence of FONAG. Therefore, FONAG's emergence would represent a new agent with coherent structure and identity that has become specialised to occupy the new niche in the system (Goldstein, 1999; Holland, 1995).

However, what conditions were necessary for FONAG to survive and compete in this new niche?

7.1.4. The Specialisation Process of the New Agent

To answer this question, this analysis examines the changes that occurred in FONAG during the process. These changes indicate how since its creation, FONAG has been through a specialisation process intended to (1) adapt to the system conditions and (2) influence the system's dynamic toward its ultimate goal, the creation of an integrated model of water management. This specialisation process seems to be in line with Holland's ideas (1995), as for a new agent to start functioning it requires the gathering of capabilities to play its role.

The first capability that FONAG required to start functioning was to search for the financial resources in order to operate. FONAG's legal status as a private Trust Fund allowed it to use the equity of its capital investment to support its actions, as explained in Chapter 7. Until 2004, however, this capital investment was not sufficient for FONAG to start functioning. Therefore, the period between 2000 and 2004 is considered a period of capitalisation or capacity building at a financial level. At a causality level, it is interesting to note how FONAG's legal status is an enabling condition of its financial capacity, a key element in the specialisation process of this agent.

A second stage of specialisation is FONAG's definition of its specific role in the system. This definition came through FONAG's development of its first major activity, a four-year training course (2004-2008) on Integrated Water Basin Management hired by the German Cooperation Agency (GTZ).

The training provided FONAG with the opportunity and resources - financial, human and time - to identify several gaps in the system that required action in order for it to accomplish its mission. The first gap in the system was the lack of complete and accurate information on water issues in the region. This information gap in the allocation of water volumes was an important cause of inefficiency in the existing water model. As a response to this need, FONAG created the Information System on Water Resources for the Guayllabamba Basin[82]. This collective database, nourished by the water users' contributions, represents a further step of FONAG specialisation in response to the system conditions.

Exploring further these enabling conditions at a causality level, which is behind the creation of the information system, shows that FONAG's affinity with this topic was also a variable that influenced its decision-making. From this analysis it can be surmised how the new agent specialisation process responds to a match process between the agent internal attributes and the gap in the system (Kauffman 1995; Stoker 1998; Levin 2005; Holland 1995).

The second gap identified through the training was the agents' lack of information about FONAG's role in the system. This was due mainly to FONAG's low profile during the capitalisation process (2000-2004). In response to this, FONAG put in place a communication scheme aimed at improving its institutional accountability. This scheme, run in parallel to the training, helped to improve the agents' perception about FONAG and to spread concepts related to integrated water management to a wider audience.

A third gap that FONAG identified was in relation to its own capacity to carry out its new role in the system. These were the need for strong mediator skills and a position in the system that would enable it to drive a multi-stakeholder process. However, the lack of internal attributes (Kauffman 1995; Stoker 1998; Levin 2005; Holland 1995) to build such facilitation skills, and the importance of holding a neutral position to avoid resistance forces, led FONAG to opt for a different strategy to acquire such skills, to create a multi-agent[83].

[82] www.infoagua-guayllabamba.ec
[83] Holland (1995) refers to the aggregation of simple agents into something that comes closer to a whole cell with multiple functions as a 'multi-agent'.

To integrate these additional capabilities, FONAG set up a strategic alliance with the Foundation for the Future of Latin America (FFLA)[84]. Here, FFLA provided the neutral image and mediator skills necessary for FONAG to play its role in conducting multi-party negotiations; while FONAG enabled FFLA to achieve one of its institutional goals, to enter and to specialise in the niche of water issues.

A first analysis of the behaviour of this new multi-agent reflects how sharing common rules was the main condition to enable these two agents to function as a unified entity. This set of rules reflects the 'boundary' between the parts of the multi-agent referred to by Holland (1995) in his studies of boundary formation as a mechanism of adhesion. This scholar states that: "boundaries provide a simple way of aggregating agents into layers somewhat like those in an onion, and they are used to constrain agent interactions" (1995: 117). The formation of multi-agents is hence part of the construction process of complex hierarchical structures (Holland 1995). This helps to explain how while FONAG and FFLA were two independent institutions, the creation of this multi-agent aggregated a new level of organisation and complexity in the system necessary for driving a new dynamic in the system.

From this section it can be seen how for a new agent to start functioning in a new niche a continuous specialisation process is necessary. According to this case study this process seems to occur in the interplay area between the agent's internal attributes and the system needs and resources (match process) (Holland 1995). For this specialisation process two strategies are possible: (1) introducing changes at an internal level of the agent and (2) building aggregative structures with other agents that present complementary capabilities.

However, what were the conditions and mechanisms in relation to this multi-agent that account for the dynamics observed in the system of study presented in Chapter 6?

7.1.5. The Construction of a Multi-Agent as a Unified Entity

In this regard, this case study shows how the creation of a new level of organisation and complexity in the system structure required further specialisation at this new level in order to be able to influence the dynamic in the system.

[84] FFLA is a reputed non-for-profit international organisation, whose work is to conduct multi-party negotiations on a range of socio-environmental issues (http://www.ffla.net/).

An analysis of the nature of this specialisation process reflects the construction process of a unified identity. The actions undertaken for this were: (1) a 'map of agents' that belong to the Quito Metropolitan water domain and (2) a diagnostic of potential conflicts among these agents. These actions provided the two institutions with a neat picture of the number and types of agents, their interactions, vested interests, conflicts, and the various dimensions that influenced the system's dynamic: legal, political and other contextual aspects. Furthermore, they revealed the location of agents in the system network structure and the governance model of the system.

These actions reflect how they enabled the two agents to build a better understanding and knowledge of the system configuration and its functioning. Furthermore, the discussion around these actions and outcomes allowed the two agents to co-evolve to a common point where they could behave as a single agent. This illustrates how co-evolutionary dynamics are an important mechanism in the specialisation process, necessary for agents to tune in with other agents and the context conditions as further explored below (McKelvey 2002; Mitleton-Kelly 2003a; Camazine *et al.* 2003).

In this particular case study, this specialisation process is also required to lay the foundation necessary to launch and coordinate a multi-stakeholder process. Finally, what was the influence that this specialisation process had in the system dynamic?

7.1.6. The Creation of a New Dynamic in the System

This section examines the influence of the various stages of specialisation discussed above in the system conditions, hence dynamics; and what are the complex mechanisms and processes involved in this process.

The four-year training - a bifurcation point in the system dynamic:

The first seeds of the construction of a new dynamic in the systems stems from the capacity built in the system as a result of this training.

The four-year period of this training enabled more than 1,000 people to be introduced to the ideas of integrated water management (source: FONAG). This meant that for the first time representatives from different governmental agencies,

public and private enterprises, academics, researchers and community-based organisations gathered and interacted around this particular subject matter.

Beyond the capacity built around water management, the training enabled participants to share perceptions about the system functioning, the roles of the agents in the system, their various perspectives, and the needs and challenges necessary to shift the existing model of water management to an integrated one. This better understanding of the system shifted the attitude agents had in relation to the role other agents played in the system and the need to undertake a multi-stakeholder dialogue process.

This shift in attitude is reflected by the interviewees that stated that during the first stage of the four-year training most of the participants had a distant and reactive attitude. As the training progressed, and participants began to better understand their institutional and personal roles, this attitude had started to yield to mutual interest. By the last part of the training, respect and trust had started to arise, enabling interactions to get stronger and as a result, collaborations started to emerge.

Therefore, the first influence that this training had in the system dynamic was to build the collective capacity necessary for collective work to emerge. Literature refers to the construction process of collective knowledge, respect, and trust as 'social capital' (Berkes and Folke 1998; Carpenter *et al.* 2001; Ostrom and Ahn 2003). According to Dietz *et al.* (2003), social capital facilitates agents' self-organisation and emergence, which is in line with the dynamics observed in this case study.

A second level of influence of the training in the system is at a structural level. The multiple interactions occurring during the training shifted the network structure of the system from a low connected and scattered universe of agents, to a more connected network with shorter links and stronger coupling. From a network theory approach this means that the training produced an increase in the number and strength of connections or couplings (Watts 2003; Kauffman 1993, 1995).

This shift in connectivity allows this analysis to explain the changes in the flow of resources observed in the system. This flow shifted from a top-down pattern with low exchange between levels of the system, to a widespread larger exchange between agents at all levels. Furthermore, according to Holland (1995), the processes of 'match formation' and 'tag formation' explain the flow of resources exchanged between agents. The presence of these two processes is reflected in the interviewees' statements that maintain that at the beginning of the training agents interactions were

random until they knew "who was who" (tag formation). Consequently, as agents increased their degree of mutual knowledge, interactions progressively shifted from random to clusters based on common interests (match formation).

This analysis illustrates how the four-year training meant a bifurcation point[85] in the system evolution towards a more self-aware, connected and collective dynamic. According to FONAG and FFLA expectations, these were signs of the construction process of an integrated model of governance.

The Influence of the Multi-Agent Strategy:

Similarly, the multi-agent strategy to conduct the multi-stakeholder process intended to create a new water management plan, influenced and shifted the system dynamics. This strategy involved actions such as: multi-stakeholder workshops; one-to-one meetings; and the reinforcement of debate spaces at a local level. Chapter 6 describes the content of these actions and the way they jointly searched to achieve the expected goal.

These actions, despite the fact that they did not accomplish the ultimate goal of having a new water plan, enabled representatives from the main water agents to build a common vision of the system as well as the inter-dependencies between each other and the need to work collaboratively to create a common solution. This common vision of the system functioning contributed to reinforcing the new dynamics already created by the previous training towards a more integrated model.

What were the conditions and mechanisms at play behind the multi-agent strategy that enabled it to have such an influence on the system dynamic?

The first condition was the "enabling environment" provided by the multi-stakeholder workshops (Mitleton-Kelly 2003a). These workshops represented a space for agents stemming from multiple sectors and levels of the system to meet, converse and interact. As a result of these interactions, agents created a collective awareness of the position they held in the system overall; and gained empowerment and ownership by working around ideas such as co-responsibility and multi-stakeholder governance. As these collective attributes were being constructed, they enhanced the agents' perception of the need to create an integrated model of water management. This

[85] This term is used in the sense used by Mitleton-Kelly (2003a: 11), based on Prigogine, as the splitting of possibilities into two alternative paths.

illustrates how the multi-stakeholder workshops improved the agents' capacity to self-organise as a collective unit. This no centralised, bottom-up source of order reflects the first complex mechanism at play behind this strategy: self-organisation.

Although there is no unified definition of self-organisation, there is a consensus that the term refers to a broad range of spontaneous pattern-formation that occurs through interactions internal to the system, without external direction, manipulation or control (Kauffman 1995; Camazine *et al.* 2003; Levin 2005). Therefore, this analysis argues that the self-organisation process that stems from the workshops and other actions of the multi-agent strategy partly accounts for the formation of the new dynamic observed in the system.

This case study illustrates, however, how an enabling environment is not a sufficient condition for self-organisation to emerge. Yet it can be observed how certain qualitative and quantitative conditions must be present for interactions to arise and evolve. The conditions that can be drawn from this experience are (1) to share a common goal, as it allows agents interactions to self-organise or be tuned towards a particular evolution path; and (2) to have a professional facilitator in the discussions (role play by FFLA in this case) to prevent major conflicts and resistance forces to emerge.

A second condition that enabled the multi-agent strategy to exert such an influence in the system dynamic was the diversity of agents present in the workshops. According to Kauffman (1995) even though the nature of self-organisation is known to be spontaneous or autocatalytic, a critical diversity must be reached in the system for these interactions to take place. In this experience, the 'critical diversity' stemmed from the different sectors, roles, levels of the system, cultural backgrounds, hierarchical positions and the like that agents represented. This is also consistent with Axelrod's (1997: 171) study of cooperation under Prisoner's Dilemma as he explains that: "the opportunity for interaction and convergence is proportional to the number of features that two neighbours [agents in the context of this research] already share". Therefore, this analysis argues that the combination of the above conditions and diversity of agents present in the workshops also accounts for the influence the multi-agent strategy had on the system.

The creation of this collective capacity in the system explains one of the most important processes behind the construction of multi-stakeholder collaborations in the context of this case study: the transition from individual to collective behaviour. This

insight is consistent with Holland's (1995: 11) ideas that state that: "complex large-scale behaviour emerges from the aggregate interactions of less complex agents".

However, is self-organisation the only mechanism that accounts for this transformation? What other mechanisms allow an explanation of the changes observed in the system and the events that followed? The next sections explore the presence of other two complex mechanisms: co-evolution and self-organised criticality (SOC).

7.1.7. Co-Evolutionary Dynamics

An analysis of the dynamics observed in this case study shows how a second complex mechanism also influenced the interactions between agents responsible for the emergence of collective behaviour, which is co-evolution.

Co-evolution refers to the 'reciprocal influence' that agents exert on each other as a result of interactions, which changes the behaviour of the interacting agents (McKelvey 2002; Mitleton-Kelly 2003a; Koza and Lewin 1998). Although examples of specific 'reciprocal influence' or co-evolution were not collected during fieldwork, this analysis argues that signs of the presence of this mechanism can be observed in this case study.

An example of this is the transformation that agents had in their perception of both the system functioning and the fact that an integrated model of management water was a better strategy than the existing one. The analysis argues that the construction of this broader perception could only occur through the mutual influence and change in behaviour that the exchange of ideas between agents over time. The argument for this is that just by having some degree of this type of co-evolutionary influence on each other views, agents were able to build a common ground around various topics such as the content that the new water law required to implement a new water management model, or even the fact that they all shared a common problem and responsibility for its solution.

This analysis argues that these two mechanisms - self-organisation and co-evolution - reinforce each other, amplifying their individual dynamics; hence their influence in the system. That is, for these particular collective outcomes to occur, the more self-organised agents are the more likely co-evolutionary dynamics are to take place. This is consistent with the arguments of some authors (Kauffman, 1995,

Camazine *et al.* 2003) who place co-evolution at the heart of self-organisation processes. Kauffman (1995) refers to this intimate interaction between self-organisation and co-evolution as 'a coupled dance'. Furthermore, Kauffman (1995: 216) states that: "co-evolution appears to be a powerful aspect of biological evolution as it extends beyond mutualism and symbiosis".

Therefore, this analysis states that both self-organisation and co-evolution were mechanisms at play behind agents' interactions; hence they both account for the transformation from individual to collective behaviour in this case study.

A question that has intrigued this author for a long time is: what are the limits of self-organisation and co-evolutionary dynamics? Can self-organisation occur endlessly? The following section addresses these questions.

7.1.8. Self-Organised Criticality (SOC)

The answer to this question comes from the property of 'self-organised criticality', the third complex mechanism that influenced agents' interactions and the emergence of the new dynamic in this cases study.

Bak *et al*. (1988), who coined and developed this concept argue and demonstrate numerically that dynamical systems with extended spatial degrees of freedom[86] naturally evolve into self-organised critical states. They define a critical state as the state of the system barely stable with respect to further perturbations. They go on to explain that a system seeks a "critical state" in order to show robustness[87] to small changes (Bak *et al.* 1988: 365). However, "this critical point can only be reached by the fine-tuning of a parameter (e.g. temperature) and so may occur accidentally in nature" (Bak *et al.* 1988: 364).

Following Bak *et al.*'s rationale, the parameters that have been tuned in this case study are the amount and type of information and knowledge that agents shared over the process of study. This tuning created an aggregative dynamic both at the agent and collective level of the system, which ultimately influenced the type and number of interactions between agents. An example of this aggregative capacity at an

[86] In physical systems the degrees of freedom refers to the dimensions of a phase space (system).

[87] Robustness is the ability of a system to resist change without adapting its initial stable configuration (Wieland and Wallenburg 2012).

agent level is the increase of knowledge on both water issues and the system functioning, which agents have at an advanced stage of the process of study. At a collective level, this aggregative capacity is observed in the increase of the self-organisation capacity and activism that agents exhibited in the dialogue spaces both at a local and regional level; sub-basin structures (water councils and the like) and basin councils, respectively.

This analysis argues that the continuous increase of these parameters - information and knowledge, also referred by Bak *et al.* (1988) as a perturbation - is bringing the system to a critical state where avalanches[88] start to occur (Paczuski *et al.* 1995; Bak *et al.* 1988; Fronczak *et al.* 2008). Evidence of this threat of avalanches are the creation of the National Council of Water Councils, the reinforcement of the National Water Forum, the collective allegations presented to the water law reform and the replication of FONAG in other parts of the country and even other countries in Latin America.

This is consistent with Bak *et al.*'s (1998) idea that activity in the self-organised critical state (SOC) can lead to anything from a shift of a single unit to an avalanche. Paczuski (1995) explains how the avalanche would stop when all sites in the system have again random numbers above a threshold value. Then, a new avalanche will start somewhere else in the system. Avalanches are the mechanism for the system to redistribute its energy across its lattice (Bak *et al.* 1988, Paczuski *et al.* 1995, Fronczak *et al.* 2008). Kubo and Sasakabe (2002) explain how this energy is dissipated at all length scales according to the connectivity between the sites (neighbours) of a system.

The presence of self-organised criticality in the system then also accounts for the transformation from individual to collective behaviour observed in this case study. Furthermore, it explains how the new dynamic created as a result of the multi-stakeholder process of study is spreading to neighbouring areas of the system. The expansion of this new dynamic depends on the connections existing in the system and the cascade of changes that it is causing.

These findings enable this analysis to draw several insights from this case study. First, that the presence of self-organised criticality in the systems of study

[88] An avalanches is when "a perturbation is propagated to the neighbours, then to their neighbours, in a chain reaction ever amplifying- since the sites are generally connected- that eventually propagates throughout the entire lattice" (Bak *et al.*, 1988: 367)

contribute to advancing the understanding that change and evolution are not a continuum in time but that they happen in the form of bursts or avalanches (Bak *et al.* 1988; Paczuski *et al.* 1995; Fronczak *et al.* 2008). A second finding is that the dynamics of avalanches, as introduced above, enable this research to explain how change spreads and is distributed across the system lattice. In this respect, three variables that determine the percolation dynamics in complex social systems can be drawn from this case study: (1) the parameter values already present in the system both at an agent and collective level; (2) the aggregative capacity of the agents involved in the dynamic which is dependent on their internal configuration (attributes and attitudes), as explored in Part II of this chapter; and (3) the degree of connectivity between agents in the system (Kubo and Sasakabe 2002; Bak *et al.* 1988; Paczuski *et al.* 1995; Fronczak *et al.* 2008).

This case study illustrates how to propagate change in the system in a particular direction or evolutionary path, such as a new model of water management, tuning agents' interactions and capacity to sustain that change is crucial. This is, despite the fact that connectivity was proved to be a key variable in order for percolation to occur, the pattern under which agents interact and resources flow seems to be fundamental to creating an aggregative effect at a collective level. Furthermore, to achieve this pattern, this case study shows how agents need to constantly specialise to achieve the capacity to function in the new dynamic. This specialisation process reflects the idea of the emergence of a new dynamic as a 'phase transition' between different behaviours of the system (Holland 1995; Kauffman 1993, 1995; Goldstein 1999).

The following section explores how other mechanisms and system conditions can also influence the system dynamic 'unexpectedly', if unknown.

7.1.9. Changes in the System Structure

In 2007, as part of the strategy of the newly created multi-agent - FONAG-FFLA - it the necessity was envisaged to introduce some legal changes to undermine eventual resistance to achieve the ultimate goal of this multi-stakeholder process of study - to create an Integrated Water Management Plan. This section examines how the expected moulding effect that the structure of the system plays in agents' behaviour

(Albert and Barabási 2002; Watts 2003; Kauffman 1993), had an unexpected outcome as regards the process goals, so what were the conditions and mechanisms that enabled that?

Resistance to the creation of an integrated management plan was identified during the four-year training and as result of the diagnostic of conflicts undertaken by FONAG and FFLA. The main reason for this resistance was the shift towards a more representative and bottom-up dynamic that an integrated plan represented as opposed to the current top-down centralised model that exists in the system. To counterbalance these resistance forces, FONAG-FFLA decided to influence the legal framework to back up their work. In 2008, after one and a half years of work and with the support of two international foundations, the Quito's Metropolitan Council approved the 213 Ordinance and various changes in the Constitution were enacted.

The new conditions introduced into the system by these legal reforms were: first, that the 213 Ordinance appointed FONAG as the agency responsible for the creation of an Integrated Water Management Plan for Quito's Metropolitan District. Secondly, the new constitution introduced concepts such as 'Basin Councils', 'integrated water management', water as a 'limited natural resource', 'co-responsibility' of the resource water, water as a 'strategic resource', access to drinking water as a 'universal right', and the like.

From a complex dynamic perspective, as foreseen by FONAG, these legal reforms represented a shift in the system structure both at a national and regional level. In complex systems, the structure of the system constrains the way the system's components behave, despite it not being the only way to influence complex behaviour (Kaufman 1995; Camazine *et al.* 2003). In Holland's (1995) terms, the structure represents the 'boundaries' of the system that define the collective rules, hence its behaviour.

What conditions enabled these legal changes to pass? The first condition is the propitious political climate. As discussed above, the affinity of the President Rafael Correa's ideas with environmental issues and the outlook of the forthcoming national elections were the main variables behind the favourable climate at a decision-making level. The second condition was FONAG's connection and credibility with this decision-making level stemming from previous works. The presence and nature of this connection provided the access and receptivity of FONAG's proposals at the political level. The third condition was the high quality of the recommendations

presented. Past corruption scandals involving NGOs in Ecuador could have hindered this negotiation process (negative feedback). Aware of this hitch, the multi-agent - FONAG-FFLA - searched for external resources (legal and financial support) to reinforce their capabilities and prepare strong arguments to be able to pass the legal reforms.

As a result of these conditions, strategies and mechanisms, FONAG gained the legal back up to (1) overcome resistance forces and (2) to have the recognition to occupy a central position in the system network to undertake this multi-stakeholder process. These reforms, however, introduce one more change that shifts the course of events in the process: FONAG's new financial formula. The 213 Ordinance also set that 2% of EMAAP-Q's revenues (from water billing) would be diverted to finance FONAG's mission.

This change triggered two different dynamics in the multi-stakeholder process: (1) a conflict of image stemming from FONAG's association with EMAAP-Q which hindered the former's credibility, as numerous agents, particularly at a local level, had a strong negative perception of the latter, the public enterprise; and (2) this financial formula increased EMAAP-Q's resistance to the process as it diminished its major capacity, the power given by its financial resources.

As a result of these changes in the system two major complex mechanisms gained strength in the system dynamic. First of all, historicity (Kauffman 1993; Mitleton-Kelly 2003a). This mechanism (historicity) is responsible for how past events or conditions existing in the system influence its current dynamics despite it does not determine them. An example of this is observed in the negotiation process of the legal reforms, where past corruption scandals involving NGOs in Ecuador influenced the attitude of decision-makers in relation to their suggestions.

A second mechanism that influenced the outcomes of the structural changes is the feedback process (Arthur 1994; Holland 1995; Kauffman 1993; Bak *et al.* 1988). This mechanism defines the nature of the influence that events have on the system; this can have a hindering effect (negative feedback) or an enhancing influence (positive feedback). Examples of positive feedback are: how the political climate enhanced FONAG's goals on water management; how greater information and knowledge amplified the agents' capacity to interact; or how the legal reforms enhanced the interest of some agents in the multi-stakeholder workshops. An example of positive feedback with a negative effect in the process is how the power structures

locked-in in the system determine the approval of the Water Law. An example of negative feedback is how FONAG's conflict of image dampened the agents' attitude towards the multi-stakeholder discussions.

Furthermore, this case study illustrates how a dampening effect (negative feedback) can lead to an enhancing effect (positive feedback) in the system dynamic according to the existing conditions. An example of this is how the government rejection of the agents' recommendations for the new Water Law had two effects on system dynamics. While it hindered most agents' interest in discussions about the new water plan, it also enhanced the self-organisation capacity of indigenous people, which led to the protests in the streets of Quito.

This analysis argues, therefore, that the interplay of these complex mechanisms - historicity and feedback - account for the shift in the course of events in this case study. However, a third mechanism introduced above - self-organised criticality (SOC) - accounts for the cascade of events that followed the effect of these structural changes in the system dynamic.

The interplay of these three mechanisms can be observed in the fact that although FONAG's conflict of image was counterbalanced by the alliance with FFLA and its leading position in the system, this negative perception remained in the system as a positive feedback. As the government turned down the agents' recommendations to the water law reform, this, together with the negative perception of FONAG and past events of centralised government in the country (historicity), together hindered agents' interest and credibility in the process and in its major driver, FONAG. In parallel, the rejection of agents' recommendations to the water law amplified the indigenous capacity to self-organise (positive feedback) that led to protest marches in the Quito streets. Past events of indigenous protest in Ecuador (historicity) led the police to raise its resistance (positive feedback), which led to the death of one indigenous person. This death provoked a political crisis that led the government to dismiss SENAGUA's (Water Secretariat) Secretary in the light of his lack of capacity to manage the situation; and to the revocation of the 213 Ordinance, which consequently removed FONAG from the limelight in the new system dynamics. However, this research does not imply that these changes or even the political crisis were necessarily negative for the process in the absolute sense of the term (damaging); instead it means that these events hindered the course of the process built from this multi-stakeholder process.

This cascade of events reflects again the presence and functioning of self-organised criticality in the system of study, and how it interplays with other mechanisms such as feedback processes. The different responses that agents showed reflected the dissimilar aggregative degree and/or capacity that agents demonstrated. This analysis argues that this dissimilarity, together with the degree of connectivity agents presented at the time of the cascade, is what defines the non-linear behaviour and unpredictability of the system (Albert and Barabási 2002; Watts 2003; Kauffman 1993).

The first insight that can be drawn from this section is how changes in the structure constrain agents' behaviour; hence the probability distribution of avalanches occurring in the system (Kaufman 1995; Camazine *et al.* 2003. Holland 1995). This is consistent with Fronczak *et al.* (2008) who state that avalanche dynamics and the network (system) structure influence each other. Furthermore, these authors claim that the critical behaviour (that leads to the avalanche) occurs not 'on' the network structure but 'in' its structure. This is consistent with the events observed in this case study, as the origin of self-organised criticality behaviour stems from the internal configuration of the agents (attributes and attitudes) and not from the system structure itself.

A second insight is how the cascade of events in this experience reflects the interplay of two major properties of a complex adaptive system: its aggregative capacity and its non-linear behaviour. Bak *et al.* reflects this same idea in his study of the dynamics of non-linear diffusion to explain how a perturbation behaves (1988). Ponzi and Aizawa (2000) also investigated how self-organised criticality can emerge from the frustrated attempts of the system to synchronise, as is the case represented in this study.

This section has illustrated how the system evolution left an opportunity for a new dynamic to emerge in the system. It has argued that certain conditions were necessary both at a micro and macro level for new agents to occupy and survive in this new niche. This first part of the chapter has focused on examining the mechanisms and processes that determined these conditions and processes at a macro level: FONAG's specialisation, self-organisation, co-evolution, historicity, feedback processes and self-organised criticality. Furthermore, it has explored how self-organised criticality, the connectivity of the network and the pattern of agents' interaction, and hence, flow of resources, accounted for the emergence and

propagation of the new dynamic in the system. The next part of the chapter examines how the specialisation processes of the other agents were involved in the process in order to complete the analysis of the micro dynamics that sustain the macro dynamics analysed. To answer the second research question on what the different perspectives of public, private and civil organisations are of the partnership process and their main challenges, this section tackles this analysis according to the different social sector to which agents belong.

7.2. Multi-Stakeholder Process at a Micro or Agent Level

This section will at use a complex theory approach to explore the complex mechanisms and processes that influenced agents' behaviour and capacity to build on multi-stakeholder processes. For this an analysis according to the different social sector will be undertaken to examine the different perspectives and the challenges that agents faced in creating such a collective dynamic.

7.2.1. Public Sector

Changes in Sub-System Structure and Dynamics:

As presented in the case study description (Chapter 6), the Quito public structure for water management was split into various agencies: Water Secretariat (SENAGUA), Secretariat for the Environment, Public Enterprise for Water Supply in Quito (EMAAP-Q), Ministry of Urban Development and Habitation (MIDUVI), Water Councils, Municipalities, etc.

These multiple agencies held a part of the various functions related to water issues at different levels, however, according to the interviewees, they were weakly coordinated. From a complex theory perspective, this means that this sub-system (the public sector) is fragmented, loosely inter-connected yet inter-dependent in its functioning. This loose inter-connection is also exhibited between the different levels of administration in these agencies: national (Water Forum, National Council of Water Councils), regional (Basin Council) and local level (Water Councils[89]. municipalities, etc).

[89] Water Councils are public agencies that deal with the allocation of water volume to local users - farmers, peasants, municipalities, etc - and the maintenance of water-infrastructure.

From a complex dynamic perspective, the loose inter-connectivity is what defines both (1) the weak exchange of resources (information, knowledge, decision-making, and the like) between levels of the sub-system; and (2) how higher levels of the system constrain the dynamics occurring at a lower-level with top-down dynamics (McKelvey 2002; Holland 1995). Overall, these conditions explain the centralised model of governance, hence the limited capacity of this sub-system to adapt to changes. This behaviour is one of the main reasons why the system was driven to the brink of a major water crisis.

Changes in Connectivity with the Rest of the System:

At the beginning of the multi-stakeholder process, public agents from different levels held the highest number of connections with the rest of the agents and sectors in the system. Furthermore, their central role in the system, as responsible for water management and their control of the top-down dynamics, makes these connections the most influential of the system network.

The nature of its connectivity is however qualitatively different from the rest of the sectors. For example, EMAAP-Q's (public water supplier for urban areas) relationship with their consumers was just through billing, and the consumers' communication with the EMAAP-Q's was through the customer's claims window. Along these lines, the connectivity of public agents from a high-level with public structures at a local level (water councils and the like) equally reflects this bureaucratic behaviour and even an illegal recognition in decision-making spaces at a higher level. This legal feature of the system structure illustrates how public and other local agents are both prevented from developing their own dynamic and influencing these top-down dynamics due to its lack of endorsement of decision making.

Less bureaucratic was the relationship with private agents. A weak legal framework to constrain their behaviour has enabled private agents to behave according to their own interest, hence the dynamic. Nevertheless, as a result of the multi-stakeholder process, stronger forces are requesting that these loose structural rules are reinforced as private agents are overexploiting and polluting water springs.

The nature of the public agents' connectivity with other agents in the system has shifted over the multi-stakeholder process, however. The main forces for this change of behaviour are that public agents became aware of their negative

institutional image and their lack of flexibility to respond to the consumers' demands. An example of the outcomes of this awareness process is that EMAAP-Q developed a corporate social responsibility strategy, which aimed to improve its image and to reduce resistance forces to its power position. In relation to the changes of connectivity between the levels of the sub-system, the main changes stem from the reinforcement of the existing public debate spaces at a local level, and the increase of connectivity and inter-dependence at the regional and national levels. These changes have enabled agents at a local level to increase their interactions, and that, together with having a common goal and facilitated discussions, enabled self-organisation to emerge, as discussed in the first part of the chapter.

In general terms, it can be observed how the sub-system public sector has increased its inter-connectivity with the rest of the system components and how the nature of these connections has also evolved quantitatively and qualitatively, yielding to self-organisation. However, the *inter-dependence* between public agents in the system is still weak, which still hinders the emergence of major co-evolutionary dynamics at this sub-system and at the system level.

Changes in the Sub-System Governance Model:

In terms of how the behaviour of public agents evolved over the multi-stakeholder process, this shows two stages of change.

The first stage is when public agents allowed the introduction of changes to the system structure (213 Ordinance and Constitution), hence bringing the system dynamics towards a more integrated water-management model. This was caused by a change in attitude influenced by the various multi-stakeholder workshops, where public agents started to perceive the need to change the system functioning - the water model. This desire to change exhibited at higher levels of the public sphere, and the influence of the multi-stakeholder process in other regional and local agents enabled self-organisation and co-evolution dynamics to emerge at a collective level. This led to stronger bottom-up dynamics, pushing the public-sector sub-system far-from-equilibrium to change its behaviour (centralised model) (Prigogine and Stengers 1985, cited in Mitleton-Kelly 2003: 16). However, the clash between these forces triggered the resistance of agents at a high-level in the public structure. It was here that a second state of behaviour, hence dynamic, is observed in the public agents.

Regardless of the numerous suggestions to review the Water Law towards a more integrated model of water management, public agents passed a version that still responded to a centralised model of water management. This move backwards from openness to the change demonstrated before reflects how the presence of path-dependence (Kauffman 1993; Mainzer 2007) defines a second stage of behaviour. This can be observed in the 'frozen effect', using Kauffman's terms, that the publication of the new Water Law had on the rest of agents' behaviour as they saw how the government reverted to a centralised model of governance, as it was in colonial times. The positive feedback that former structures of functioning have in the system reflects the presence of path-dependence. The influence that past events have on the current dynamics (agents' behaviour) reveal a second mechanism at play in this second stage of behaviour: historicity.

The behaviour of agents within the public sub-system was however dissimilar, as there were conflicting positions on whether to create an integrated management model. On one side, decision-makers rejected the reforms of the Water Law; on the other hand, President Rafael Correa named a new team for the Water Secretariat (SENAGUA) to develop a new strategy to achieve an integrated model of water management, together with FONAG.

This represents Kauffman's idea that various behaviours can be observed in a system - frozen components and melting components - as the system approaches a poised state, a collective agreement in the context of this research (1993, 1995). The relevance of this sign for a transition in the system behaviour or regime is discussed in Chapter 8, 'Comparative Analysis'.

7.2.2. Community Representatives

Changes in Sub-System Structure and Dynamics:

The major influence of the multi-stakeholder process was in the community-sector structure and dynamic.

Before the multi-stakeholder process, this sub-system structure was comprised of several small clusters of local agents and many isolated individual agents, with low connectivity between each other. The multi-stakeholder workshops and the reinforcement of debate spaces at local and regional level served however to increase

the *inter-connectivity* and *inter-dependence* of community agents among themselves and with agents from other sectors.

The multi-stakeholder process therefore shifted the structure of the community sub-system by increasing the number of clusters at a local level - CODECAME, El Pisque and La Chimba - and the number of agents connected to them. Consequently, a significant number of less connected agents remained scattered in the sub-system structure.

These changes in the sub-system structure led to changes in its dynamic. A greater inter-connectivity of local agents enabled greater interaction and hence greater inter-dependence as resources were exchanged: information, knowledge, etc. This led to a better self-organising capacity of community agents as their perception and understanding of the system functioning and their role within it shifted over the multi-stakeholder process. This capacity also involved co-evolutionary dynamics between the more-connected agents such as the FONAG, EMAAP-Q, regional and local authorities and local communities, among others; as more agents influenced each other more unity was observed.

Changes in the Connectivity of the Sub-System with the rest of the System:

As discussed above, the connectivity of community agents with other agents varied along the process mainly in relation to the reinforcement of public spaces at a local level. This was mainly due to the influence of Randi Group, employed by FONAG to increase participation at a local level such as in water councils.

The lack of legal recognition of these Councils at a higher level of the government meant that despite these changes, local agents had a weak influence in the structure and dynamic of the system at a macro level. From a network structure perspective, this meant that the connectivity between community and public agents was strong but with unequal *dependence*, as the former depended on the latter. Despite that, the multi-stakeholder process allowed bottom-up forces to start to counterbalance the top-down ones, pushing the system governance model to far-from-equilibrium, as the indigenous uprising did with the existing ‘status quo’, provoking a political crisis and a change in direction of the multi-stakeholder process (Prigogine and Stengers 1985, cited in Mitleton-Kelly 2003a: 16).

In relation to the private sector, community agents had two types of connections with enterprises. First, flower and bottling companies were the main employers in the communities. Secondly, in some locations, communities claimed and gained the companies' sponsorship for events such as festivals. In other locations there was no participation of these companies in community life.

The nature of the connection between these two types of agents shows a degree of inter-dependence where communities provide human and environmental resources and companies enable the economic development of the communities. This relationship is one of the causes behind the dampening influence of industrial actions on the water system (negative feedback). The balance of this inter-dependence has not changed much as a result of the multi-stakeholder process, as the lack of active participation of private-sector agents in the process actions prevented them from co-evolving.

Changes in the Sub-System Governance Model:

The community sub-system did not show a structured governance model before the multi-stakeholder process as reflected by its scattered network structure. As explored above, this was the reason behind the weak bottom-up dynamics observed at the beginning of the process. Nevertheless, signs that the multi-stakeholder process is shifting the governance model of this sub-system can be observed by the creation of the National Council of Water Councils.

7.2.3. Private Sector

Changes in Sub-system Structure and Dynamics:

Private agents' reluctance to be interviewed made the task of analysis difficult. However, questions in relation to their behaviour and evolution over the multi-stakeholder process were posed to other agents.

In terms of connectivity within this sub-system, this seems to have remained the same over the process. The causes for this are: first, the lack of incentives to change their behaviour as they benefit from a loose legal framework; and secondly, the dependence that community agents have on them - employment, local economy, and philanthropy - hinders external influence on shifting this behaviour.

Furthermore, the low and distant participation in the multi-stakeholder process events prevent them being influenced by the new dynamics emerging in the system. According to the FFLA, the companies' participation in the process was more to ensure that there would be no changes that could interfere with their current status quo.

Changes in the Connectivity of this Sub-System with the rest of the System:

In relation to the *connectivity* and *inter-dependence* of private agents with the other agents in the system, this seems to be 'low-to-medium', according to the terms discussed in this case study on the degree of agents' connectivity.

As described above, the connectivity between private agents with community agents was of an unequal inter-dependence due to the employer-employee power relationships. In contrast, the nature of the connection with public agents is more balanced, enabling them to behave according to their own internal dynamics and interests.

Changes in the Sub-System Governance Model:

In terms of the sub-system governance, the lack of major forces from the system and the structural conditions (legal framework) that constrain their behaviour, their governance model has not shifted much over the process. However, the conditions that sustain this situation have changed as a result of the multi-stakeholder process as tighter norms to regulate their negative influence in the water system dynamic are strongly claimed by the rest of agents of the system.

Conclusions

This chapter has illustrated how an evolutionary approach to complex dynamical systems serves as an explanatory framework for investigating the behaviour of a complex social system, similar to Chapter 6, which analysed the Mandú Alliance experience. Therefore, in order to answer the main research question on what the complex dynamic of inter-sector partnerships is, this theoretical approach has shed new light on the mechanisms, processes and properties that determine multi-stakeholder collaborations both at a macro and micro level.

The first contribution of this chapter has been to feature the nature of the system of study as a complex system. This has illustrated that the system of study exhibits all the properties defined by Holland (1995) present in all complex adaptive systems. These are: aggregation; tagging; nonlinearity; flows; diversity; internal models; and building blocks (See Chapter 2 for full definition).

The second contribution was to reveal the mechanisms and processes that have driven this multi-stakeholder process and their interplay. In this regard, this experience illustrates how greater inter-connectivity and more balanced inter-dependence led to greater self-organisation and co-evolution. It has been discussed how these two mechanisms are crucial for the transition from individual to collective behaviour. The creation of collective behaviour has been discussed as being fundamental and a sign of the emergence of new dynamics in the system and the creation of new levels of complexity, such as multi-agents. This can be observed in the different influences that the two created new structures FONAG and the water management scheme have on the overall system. While the former has a lesser influence, the latter has started to create a new dynamic in the system, mainly due to the scale of the collective behaviour created by these structures.

Two conditions were discussed as required for increased complexity to happen as per this case study. First, that the number of interactions, which enabled collective properties to emerge, is higher than the number of agents in the system (Kauffman 1993). The collective properties identified were: self-organisation, co-evolution and self-organised criticality. As discussed in Chapter 8 (Comparative Analysis) the absence of this property in this case study, alternatively to the former case study, explains the reasons that a system reaches a collective agreement or a poised state.

Secondly, for these interactions to happen, certain enabling conditions need to be present in the system. These conditions were: diversity of agents, number of agents per type of agent, overlapping interests to sustain interactions, a common collective goal or interest, agents' attributes and attitudes to change, structured spaces for interaction, mediation of these interactions towards a common goal, a minimum time period for these interactions to evolve (for self-organisation and co-evolution to take place), the support of external agents to create a new scenario of evolution and the resources to develop a phase transition in the system dynamic.

Another important insight from this case study is how the process of aggregation both at a collective and at a system components level is responsible for

two related but different outcomes. First, the emergence of higher levels of complexity in the system; and secondly, the percolation of change in the system lattice that leads to the distribution of the new dynamic across the system. As argued above, the mechanism that regulates this behaviour is self-organised criticality (SOC).

Furthermore, this case study has shown how unpredictability (apart from the non-linear behaviour of these systems) also comes from the lack of knowledge that agents have of the complex dynamics of the system (Marion 1999). Here, it has been discussed how failing to understand the presence of mechanisms such as path-dependence, historicity and feedback processes prevents agents from tuning (managing) their system accordingly.

Finally, this chapter also proves the relevance of the analytical approach proposed in this research of combining a macro and a micro level approach to fully understand the complex dynamics of inter-sector collaborations. This approach has proved suitable for shedding light on the second research question of this work on what the different perspectives are that agents from public, private and civil organisations have on the partnership process and their main challenges. In this regard this analysis has shown how both the location of the agents in the system, the system's role, its capacity to change and to influence change, and the connection and dynamic of the agent with the rest of the system, were the main variables that determined the specialisation path to engage and sustain collaborative work.

In terms of capacities that influenced agents' specialisation in working collaboratively, the main ones were: the capacity to learn, to introduce changes at an individual level and to influence the dynamics of the system. Therefore, this illustrates the velocity on which agents specialise to work collaboratively is related to the capacity of the system to reach a stable state or collaborative agreement (Bartolozzi *et al.* 2006, Kauffman 1993).

The next chapter explores the similarities and differences that the two case studies analysed in this research work show in terms of their complex dynamics. The fundamental questions that guide the analysis of that chapter are: Are there patterns of behaviour that go beyond the difference in context? What role do the context conditions play in these patterns?

Chapter 8

Case Studies
Comparative Analysis

Introduction

This chapter presents the comparative analysis undertaken between the two case studies explored in the former chapters. This analysis aims to discover: i) a common pattern of behaviour in the construction of inter-sector partnerships, and ii) the generic complex principles or mechanisms that drive the behaviour of this pattern.

Complex scientists such as Holland (1995) and Stacey (2007) argue that in order to find regularities generic to an object of study, a diversity of conditions need to be sought. Following this rationale, the selection of the case studies was made to account for the larger number of differences possible between experiences, including the topic of collaboration, the context conditions, the motivations to undertake collaborative work, and other criteria presented in Chapter 3.

This comparative analysis is in two stages. The first stage of analysis is the actual task of making a comparison between the complex dynamics inferred from the individual analysis of the two processes of study, presented in Chapters 5 and 7. For this, the main mechanisms and sub-processes that are common to the two experiences, both at a macro and a micro level are explored in the first and second sections of the chapter to search for regularities. The first section then explores the similarities and differences between case studies in relation to the mechanisms that shape the emergence and evolution of multi-stakeholder collaborations. The second section looks across the sub-processes and properties agents present at a micro level to also note similarities and differences that allow the drawing of general patterns of behaviour. The second stage of this analysis is to draw a common pattern of behaviour from the previous comparative analysis. This pattern is presented in the Conclusion section of this chapter and the generic principles and mechanisms that drive this pattern are discussed. This comparative analysis has produced two additional outcomes. First, it provides insights both in relation to the general

behaviour of social systems as complex systems, and the specific functioning this behaviour has due to the human and social nature of these systems. This larger picture as to how complex social systems behave - different types of regime they can display, forces and dynamics that drive changes of regime, and the like - enable us to better comprehend the role that multi-stakeholders play in the overall system dynamic, the second additional outcome of this research. These additional insights are noted throughout this chapter. The practical implications of these outcomes are discussed, however, in the Conclusions chapter of this thesis (Chapter 9).

8.1. Regularities of Complex Behaviour at a Macro Level

8.1.1. Gap Formation and Niche Opportunity

Chapters 5 and 7 discussed how the multi-stakeholder processes promoted in each case study represented a new dynamic in those particular systems. A comparative analysis of these two examples reveals that both cases exhibit a similar pattern in relation to the dynamical process, mechanisms and sub-processes that led to the outset of multi-stakeholder collaborative processes. The first common sub-processes are 'gap formation' and 'niche opportunity'.

Holland (1995) refers to gap formation and niche opportunity when discussing the creation of diversity in a system. He states that "each kind of agent fills in a niche that is defined by the interactions centering on that agent. If we remove one kind of agent from the system, creating a 'hole', the system typically responds with a cascade of adaptations resulting in a new agent that 'fills the hole'" (Holland 1995: 27). The presence of these two sub-processes and their correlation can be observed in the two case studies. In the Quito case study, the failures of the existing model of water management left a gap in the system dynamic that is intended to be occupied by an integrated model of water management conducted by the agents involved in the process of study. In the Brazilian experience, the absence of effective public policies that offer educational and employment opportunities to young people in coastal communities in Piauí State, created a gap in the system that has turned into a 'niche opportunity' for several agents to create a new dynamic.

The first insight from this research is therefore that as observed by Holland in other kind of systems, the processes of 'gap formation' and 'niche opportunity' also seem to drive the creation of new dynamics in the social systems such as multi-

stakeholder processes. An insight in relation to the particular functioning of these sub-processes in the systems of study is that they can also occur at a system level in addition to the species level proposed by Holland (1995). This can also be observed in Quito's case study where the mismanagement of water over the decades has created a gap in the water functioning at a system level in relation to drinking water, industrial and livestock activities and ecological services. An integrated water management plan emerges as an alternative model to restore these functions at a system level. The creation of this new model is also consistent with Holland's argument that gap formation and niche opportunity allow the creation of diversity in a system (1995).

A second insight from this comparative analysis is that it is not just the cascade of adaptations that defines the outcomes of these processes - gap formation and niche opportunity - but also, the structure the system exhibits at that particular time (Albert and Barabási 2002; Kauffman 1993). This can be also observed in the Quito experience as the gap in water provision was created as a result of two context conditions, as discussed in Chapter 7: (1) the negligent behaviour of agents accountable for this service in meeting the customers' needs; and (2) the failure of the existing water management model to enable the water system in this region to maintain its multiple functions, risking its equilibrium. These functions are in relation to the capacity of the system to self-organise both qualitative (to maintain its recycling function as superficial and underground resources are increasingly polluted) and quantitatively (to maintain its homeostatic level of water as exploitation exceeds the natural reserves). These elements represent the structural parameters and values that determine the conditions and dynamics of the 'gap' created in this case study. Linking this evidence with the former insight this shows that the structure of the 'gap' created is correlated with the type of dynamics present in the 'niche opportunity'.

Similarly in the Mandú Alliance case study, the process of 'gap formation' responds to structural and dynamical conditions existing in the system. The geographical distance of coastal communities from Teresina (366 Km away), political centre of the region, turned out to be a barrier for this public support to reach these population groups, at least where education and employment policies matter. This dysfunctional regulatory dynamic, together with the diminishing influence that tourist companies have on the communities' economies, and other structural conditions such as lack of political will at a local level, were the main reasons for the formation of a gap in the system. These examples help to advance Holland's observations by

illustrating how the way structural and dynamical conditions of the system interact influences the formation of 'gap formation' and 'niche opportunity' in social systems.

The third insight in this comparative analysis is how the creation of a gap in the system is followed by a cascade of adaptations, which enables a new agent to occupy the new 'niche' (Holland 1995; Kauffman 1993; Brunk 2002). In this regard, two additional features can be drawn from this research. First, that when the cascade of adaptation occurs at a system level, as in two cases studied, another cascade of adaptation or specialisation occurs at an agent level allowing the new agent to occupy the new niche. This can be illustrated by the processes that preceded the creation of FONAG (Brazil) and the Mandú Alliance (Ecuador), new agents that occupied the niche left in the systems of study by previous dysfunctional dynamics. For instance, the formation of the Mandú Alliance resulted from a series of adaptations that several agents made over more than a year to create a new agent capable of occupying the new niche and creating a new dynamic in the region. Other examples of adaptation are the legal and constitutional reforms made in the Quito case study to enable the new agent to create a new dynamic. The cascade of adaptation occurring at an agent level is extensively discussed in the second part of this chapter.

A second feature of this cascade of adaptations resulting from the process of gap formation is related to the self-organised criticality (SOC) behaviour of the system. The two case studies show how as the system reaches a *critical state*[90], a cascade of adaptations give rise to a new dynamic that seeks to restore a new equilibrium (Arthur 2013; Brunk 2002; Frigg 2003). This shows how these two concepts that arise from different disciplines, biological systems (Holland, 1995) for 'gap opportunity' and 'niche formation' and physical systems for SOC (Bak *et al.* 1988; Fronczak 2008; Paczuski 1995), seem to represent related dynamics. That is, the idea that a gap is created as a result of the interaction of structural and dynamical conditions of the system, as described above, seems to represent the idea of *critical state* defined by Bak and co-workers when describing SOC behaviour. Similarly, the process of a new agent occupying a 'niche opportunity' or 'gap created in the system, seems to relate to the creation of a new dynamic described by SOC.

[90] Bak *et al.* (1988: 365) define critical state as the state where the system "is barely stable with respect to further perturbations"

Finally, the creation of new agents and new dynamics resulting from the processes of ‘gap formation’ and ‘niche opportunity’ reinforces the role that these processes have in the creation of diversity in the system, noted above. This insight is consistent with Holland, who states that diversity of complex adaptive systems (CAS) is a dynamical pattern that evolves over time as a result of progressive adaptations. Each new adaptation opens the possibility for further interactions and new niches. Therefore, “diversity is neither accidental nor random” (Holland 1995: 30). The observation of two more properties of these systems, self-tuning and multi-functionality, help to characterise the dynamic nature of diversity.

Self-tune the systems

The comparative analysis shows that in the two cases for study, the formation of a gap in the system seem to occur regardless of the conditions that led to the dysfunction in the systems. In other words, as a dynamic evolves over time, new spaces of possibilities open as a result, regardless of the type of dynamic. In contrast, the case studies show that the conditions under which the ‘niches’ are occupied seem to have a significant influence on the outcomes of the multi-stakeholder processes. This can be observed in the fact that the cascade of specialisation and adaptation that followed the entrance of agents in the new niches responded more to a strategy to occupy and survive in the new niche than to a strategy to restore the conditions that have led to the gap formation. This reflects a property of complex adaptive systems, the capacity of the system to self-tune in order to restore its balance (Kauffman 1993).

An example of self-tuning to maintain the same balance in the system can be drawn from CARE-Brazil strategy to provide sustainability to the programmes developed with young people. To grant the continuity of these programmes, CARE Brazil is planning to progressively step back to allow the Mandú Alliance to occupy its niche of work. This reflects how local agents are able to act to maintain and even reinforce the current balance of the system dynamics, as Mandú Alliance represents a stronger support on the multi-stakeholder alliance to provide these services as opposed to the current dependency of these programmes from international funds (CARE International).

A final observation drawn from this comparative analysis in relation to this property is that the cases of study illustrate how social systems can be both ‘tuned’

(top-down dynamics) and 'self-tuned' (bottom-up dynamics), leading to different evolutionary outcomes. While in top-down dynamics, agents seem to search for their individual fitness, bottom-up dynamics seem to seek collective fitness. A second insight is that self-tuning does not seek to restore the former balance of the system but to establish a new one. This new balance would stem from the interactions of the new set of agents present in the system after a niche has been occupied. This reflects the 'dynamical equilibrium' nature associated with complex adaptive systems (Kauffman 1993; Bak *et al.* 1988; Fronczak 2008; Paczuski 1995).

Multi-Functionality:

In line with the analysis of the formation of niche opportunity by means of gap formation, the comparative analysis shows another pattern common to the two cases of study - the capacity of social agents to play different yet somehow related roles in the system. Holland (1995) refers to this property as 'multi-functionality'[91].

Examples of this can be observed in both case studies as the gaps created in the systems are occupied not just by one single agent but by a set of agents (multi-agents[92]). The creation of a multi-agent is an important finding of this research as it illustrates the various possible strategies agents can use to occupy a niche, either single of multiple agents. Furthermore, this research shows how multi-agents can deploy various patterns of interaction to occupy a new niche as represented by the interconnected way in the case of the Mandú Alliance, and the collaborative way in the case of FONAG, and its partners EMAAP-Q and FFLA (Holland 1995).

A second insight is in relation to the capacity agents involved in collaborative work, either single or multiple, display to play various functions in the system. Examples of agents more capable of playing a diversity of roles are the Floravida Institute in the Brazilian case study, where the company is also a community agent; FONAG in the Ecuador case study as it combines the production of information with their role as coordinators of the multi-stakeholder discussions, among others. According to Holland (1995) this capacity is related to the competitiveness of agents

[91] Holland (1995) refers to multi-functionality when agents specialise within the multi-agent to play different roles.

[92] A multi-agent is when "agents, with a fixed structure, will be aggregated into a more complex variable structure" (Holland 1995: 109).

to evolve. He states: “individual agents in the aggregate [referring to a multi-agent form] can adapt over successive generations, to take advantage of the specific environment provided by the others agents in the aggregate” (p.116). In this cue, the cases of study show that for aggregates or multi-agents to survive, their members 1) must be capable of evolving as part of the multi-agent or aggregate at the same time that 2) they maintain their individual functions in the systems. This illustrates Holland’s argument that agents with a diversity of functions in the system are in a better position as their diversity of skills, obtained from their diversity of roles, enable them to develop more complex tasks (Kauffman 1993, 1995). This reveals how in a general way but more specifically to build and maintain inter-sector partnerships, the diversity of functions of social agents is one of the causes behind increased fitness at an agent level.

A third insight in this regard is how agents show different types or periods of activity to be part of and evolved in a new niche. The cross-examination of the evolution FONAG and the Mandú Alliance had over time shows that there were periods when agents were mainly adapting to the new context conditions to be able to perform both their new and original functions in the system; and other periods when agents slow down their adaptive activity and play a more influencing role in the system dynamic. This seems to be in line with Kauffman’s hypothesis that evolution happens through alternative stages of poised state and bursts of changes in systems that present different types of dynamics (1995, 1998). In this vein, this work sets up the hypothesis that the evolutionary pattern behind multi-stakeholder processes combines stages of adaptation and change with periods of stability and greater influence.

8.1.2. The Emergence of Inter-connectivity

A second property that was crucial for the construction of inter-sector collaborations in both case studies was the inter-connectivity between agents.

A cross analysis of the two case studies shows a similar pattern in how connectivity between agents arises both in the first stages of agents’ interactions and over the rest of the collaborative processes. This pattern shows that inter-connectivity emerged provided certain conditions were present both at a system and at agent level: (1) the capacity of the agent to interact and keep interactions, (2) the diversity of

interests (diversity of coupling) agents offer to other agents to sustain interactions, (3) the existence of a minimum diversity of agents thus of interests in the system, (4) a space agents share that also shows certain requirements, as discussed below, and (5) a minimum time of interactions. However, the case studies show that inter-connectivity would eventually increase according to this pattern provided no other forces, internal or external to the system, interfere with the process of increased inter-connectivity (Mckelvey 2002).

To investigate these insights in relation to the behaviour of other complex adaptive systems, Kauffman's findings of the increase of connectivity in a metabolism (1993) is used as an analogy for this analysis. Kauffman (1993: 346) explains that as the space of possible organic molecules increases, "the number of kinds of organic molecules will increase, but the number of reactions by which they interconvert will also increase". Therefore, for this author, the degree of inter-connectivity of a system is a function based on the space for possible connections, the kinds of agents and the number of interactions. In the context of this research, the space for the emergence of possible new agents depends on the number of kinds of agents (diversity of agents) and the potential of inter-connections between agents (diversity of coupling).

This illustrates that Kauffman's function for the increase of inter-connectivity shows a similar behaviour to the pattern of inter-connectivity observed in the two case studies. This work shows however that there are other variables that account for the difference observed between case studies. A first variable is the size of the system. While the diversity of agents (type of agents) is similar in both case studies (public, private, non-for-profit and academic agents), in the Quito experience, the number of individuals from each type of agent is higher than in the Mandú one. Consequently, the space of possible connections (diversity of coupling) among agents is also higher in the Quito experience than in the Mandú Alliance. A second variable is the time scale required for inter-connectivity to arise. That is, the more exposed agents are to interactions, the higher the probability of inter-connectivity arising. Linking the two variables, this research shows that the higher the number of agents, the higher the space of possible connections, hence the longer the time span necessary to achieve an agreement (Kauffman 1993). This shows how both the size of the system and the time scale are two fundamental variables of the dynamics of inter-connectivity. Therefore, it can be concluded that the types of agents, the space for possible connections, the

number of interactions, the size of the system and the time span for interactions are the variables behind the increase of inter-connectivity in the social systems studied.

An additional insight in this analysis is that all these variables need to present a critical value or minimum threshold that once crossed, allows a connected whole to emerge. This can be observed in the formation process of collective behaviour in both case studies. The analysis of both case studies (Chapters 5 and 7) showed the diversity of types of agents, the number of agents by each type, the effectiveness of these interactions and a minimum time scale for interactions (under a shared environment), were the variables that determined the emergence of collective behaviour in both experiences. This is in line with Kauffman's (1993: 337) observations on biological systems: "at some level of complexity a percolation threshold is reached and collective autocatalysis emerges". Furthermore, this research also shows that for a connected whole such an inter-sector partnership to emerge, the number of possible transformations derived from the interactions must grow faster than the number of entities (Kauffman 1993).

Another variable common to the increase of inter-connectivity in the two cases studied is an enabling interacting environment. Here, the role played by the training and coaching in providing the environment conditions for the agents' interactions to occur was crucial in both multi-stakeholder processes. As noted in the former chapters, the training provided an environment for agents to share their views, perspectives, roles and expectations; it reinforced dialogue and collective constructions; and hindered conflict and differences. These environmental conditions enabled agents to co-evolve during a period of time and ultimately, allowed agents' partnerships to emerge. This reveals that a critical time period must exist for connectivity dynamics (inter-connectivity and co-evolution) to be able to lead to the emergence of collective outcomes.

Finally, the role that external agents played in boosting agents' inter-connectivity, collective constructs such as a vision of the territory and a common goal, and the emergence of new dynamics, were other crucial variables in the dynamics of study. These external agents and their role in the system dynamics are referred in the literature as 'bridge agents' (Watts 2003; Holland 1995; Albert and Barabási 2002).

This analysis shows how the dynamics of inter-connectivity observed in the two case studied display similarities with Kauffman's function of connectivity.

Additionally, this analysis has illustrated how the variables involved the inter-connectivity function of the systems of study need to present a minimum value or critical parameters for collective outcomes such as inter-sector partnerships to emerge. Finally, this research has shown how other variables such as time for interaction, certain enabling conditions and a 'bridge agent' were also crucial for inter-connectivity to increase, thus part of the connectivity formulation in social systems. This means that similarly to other complex adaptive systems, connectivity is a systemic property of complex social systems (Albert and Barabási 2002).

8.1.3. The Influence of Path-Dependence and Historicity in the System Dynamic

A third set of mechanisms that a cross-examination proves is common to both case studies in influencing the construction process of inter-sector collaboration is *path-dependence* and *historicity* (Arthur 1990; Mitleton-Kelly 2003a)

The Quito case study illustrates how the power structures and mind-sets present in the system were reinforced (positive feedback) as a result of the multi-stakeholder process, showing how agents' behaviour was still locked in these former ideas. An example of this path-dependence is how as the discussions of the multiple stakeholders in Quito were reaching a collective agreement, the strong power structures of the existing governance model were reinforced, preventing the process from evolving to this collective agreement.

An example of historicity is also visible in the Quito case study in how a past of centralised government had moulded agents' behaviour, who showed disbelief and 'frozen behaviour' (using Kauffman's terms) when confronted with the possibility of change. This case study also shows how the history of confrontations between the Ecuadorian government and indigenous people had also influenced the attitude of indigenous groups (reluctance and disbelief) when invited to engage in the multi-stakeholder process.

These examples illustrate that the system's previous conditions (historicity) and 'lock-in' dynamics that self-reinforce over time (path-dependence) influence the system's dynamic. Furthermore, they show how the 'lock-in' dynamics can be present in the system structure such as governance models, and agents' behaviour, such as immobility (frozen behaviour). The influence of these mechanisms (historicity and

path-dependence) in the system's dynamic can be either 1) to enhance the emergent new dynamic in the system (positive feedback) or 2) to hinder it as in the Quito examples presented above. This analysis shows therefore the role historicity and path-dependence plays in the system dynamic and two types of responses, enhancing or hindering effect, an event can trigger in the system.

The presence of these mechanisms in the case study reveals another crucial feature of complex adaptive systems; they are embedded in a context that already has a 'web of transformation' taking place (Kaufman 1993; Buckley 1998) The relevance this web of transformation has for the system has been explored by Kauffman (1993) in relation to how non-genetic organisms reproduce. He states that the information that determines the evolution of an autocatalytic set "is stored not in a stable, inert structure such as a template-replicating DNA but in a self-consistent web of transformations. But the particular web found is a function of the history of the environments to which the autocatalytic set [collective entity in this research] has adapted" (Kauffman 1993**:** 333). Kauffman (1993: 408) sustains that "some of the sources of order lie outside selection". This statement has challenged the fundaments of evolutionary biology as it points to the way biological systems reproduce. This work considers that this statement can also have a fundamental implication for complex social systems as according to the analysis presented above in relation to the influence the web of transformation existing in the system has in the new dynamic, can also reveal another ordering force for social systems.

8.1.4. Co-Evolutionary Dynamics

A fourth mechanism common to the two case studies is co-evolutionary dynamics. The comparative analysis reveals how complex social systems can exhibit two types of co-evolutionary dynamics using Kauffman's observations in biological systems as an analogy for this analysis: evolutionary stable strategy (ESS) and Red Queen behaviour. This seeks to explore the conditions that led each system of study to a dissimilar evolution scenario or regime despite the similarities they exhibited both in time scale and stages of evolution.

As a reminder of Kauffman's (1993) conceptual framework presented in Chapter 2, he notes that co-evolution concerns populations that are adapting on

coupled fitness landscapes[93]. The two possible scenarios of co-evolution in Kauffman' systems are: (1) evolutionary stable strategies (ESS), which is when "the phenotypes of the coevolving species stop changing at a balance which is stable in the sense that any other mixture of phenotypes attempted by any species in the ecosystem will be less fit" (p. 242); and (2) a Red Queen regime, which results from "an unceasing evolutionary process in which all species continue to change" (p. 242). These regimes, according to Kauffman (1995), are a function of three variables or parameters: the number of connections (K), the degree of coupling between species (C), and the number of species present in the system (S). The conditions that lead an ecosystem to settle into the ordered, evolutionary stable strategies regime (ESS) are (1)

> "if either epistatic connections, K, within each species are high, so that there are lots of peaks to became trapped on, or [2] if coupling between species, C, is low, so landscapes do not deform much at the adaptive moves of the partners. Or [3] an ESS might result from a third parameter, S, the number of species each species interact with, is low, so that moves by one do not deform the landscapes of many others" (Kauffman 1995: 226).

On the other hand,

> "this Red Queen regime tends to occur when [1] landscapes have few peaks to get trapped on, thus when K [number of connections] is low; [2] when each landscape is deformed a great deal by adaptive moves of other species, thus when C [degree of coupling between species] is high; or [3] when S [the number of species in the system] is high so that each species is directly affected by many other species" (Kauffman, 1995, p. 227).

Chapter 5 analysed how the Mandú Alliance experience is in line with Kauffman's description of evolutionary stable strategies (ESS). Alternatively, Chapter 7 discussed how Quito exhibited (metaphorically) Kauffman's two types of regimes: some components in the system show ESS while the rest of them exhibit Red Queen

[93] According to Wright (1931) "the distribution of fitness values over the space of genotypes constitutes a fitness landscape" (cited in Kauffman 1993: 33).

behaviour. The first insight from a comparative analysis in both case studies reflects that Kauffman's function of co-evolutionary dynamics involving the variables: the number of connections (K), the degree of coupling between species (C) and the number of species in the system (S), is similar to the co-evolutionary function of the two cases of study. Taking the Mandú experience as a first example, the alliance represents the system reaching (metaphorically) an evolutionary stable strategy (ESS). The number of species (S) and the a degree of coupling among agents (C) was sufficiently low for the agents involved in the alliance not to be too much altered by the changes occurring with each single agent over the process. At the same time, the number of possible inter-connections (K) among agents was sufficiently high for them to have various possible peaks or overlapping topics of interest on which to collaborate.

In the Quito case study, which exhibits (metaphorically) a mixture of the two regimes: evolutionary stable strategy (ESS) and Red Queen behaviour, Kauffman's function of co-evolutionary dynamics is also present. Here, the conditions of the system differ from the previous case, as the number of overlapping interests or possible inter-connections (K) was not sufficient for agents to get trapped in. At the same time, the number of agents (S) and the degree of coupling between agents is high so each species is directly affected by many other species. Basically, then, the opportunities of reaching a major collective agreement (peak of fitness) moved faster than the capacity of these agents to chase them. Based on this, Chapter 7 argued that the system presented a Red Queen behaviour at a system level as agents were constantly affected by the changes made by other agents while trying to achieve a collective stable strategy. The ESS in this case would have been to create and approve an integrated water management plan. However, despite the ESS not being able to be achieved at the scale of the process, small groups of agents at different moments of the process managed to find a common interest (local peak), around which working collectively was more interesting than working individually. An example of this is the creation of the FONAG[94], which represented a local optimum or peak for three major agents of the system (EMAAP-Q[95], The Nature Conservancy and local leaders). At

[94] Fund for the Preservation of Water Resources (FONAG)

[95] Water and Sewage Metropolitan Enterprise of Quito (EMAAP-Q)- public enterprise that represents the government interests in water issues.

this peak, working collectively represented a better opportunity for these agents to influence the system dynamics through a new model of management. Another example is the creation of the National Council of Water Councils, which represented a stronger position for local Water Councils to work on issues common to all the regions.

The fact that the two case studies exhibited different co-evolutionary scenarios - ESS and Red Queen behaviour, using Kauffman's terms- enables this research to shed light to the presence of two fundamental hypotheses stated by this author for complex social systems (Kauffman 1993: 280). First, that successful co-evolution requires that the "fitness landscapes present sufficient ruggedness[96] to offset the richness of couplings between landscapes". This can be observed in both case studies as almost all agents involved in the collaborative process presented sufficient ruggedness (diversity of domains of interests) in their landscapes to be able to interact with other, allowing co-evolution to emerge. Examples of these are the agents that were Mandú Alliance members and the most active agents involved in the Brazilian case study. Secondly, Kauffman (1993, 1995) argues that co-evolutionary processes depend on the structure of the fitness landscapes and how readily each species is deformed as populations move across them. The second section of this chapter examines this in detail and shows how the agents' internal structure also influences their behaviour and capacity to interact.

Furthermore, this research illustrates that in the case of the two social systems of study Kauffman's hypothesis can apply to other scales in the system beyond the species or agent level started by this author. That is, the structure of the system can enhance or hinder agents' behaviour, and hence influence the possibility of co-evolutionary dynamics to emerge at a collective level. An example of this is how the legal reforms introduced in Quito both at a national and regional level influenced agents' behaviour in different ways. For some agents, this reform hindered their interest in being part of the multi-stakeholder process to design a new water scheme; for others, as is the case with the indigenous groups, it reinforced their unity (co-

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[96] Kauffman (1993: 280) defines ruggedness as "the variants of traits of the species that represents the space of possible interactions with other species".

evolutionary dynamics) and opposition to the content of the reforms which led to the uprising in the Quito streets.

This last example leads to another pattern common to both case studies, how co-evolutionary dynamics are intrinsically coupled with self-organisation (Kauffman 1993, 1995), as examined below.

8.1.5. Collaborative Dynamics as a Poised State

Cross-examination of the two case studies shows another major finding of this analysis, that collaborative dynamics enable social systems to self-organise to a point where the average fitness is the highest for a larger number of agents. Another two major findings of this research are first that a collaborative agreement or inter-sector partnership represents a poised state[97] in the system dynamic, using again Kauffman's terms as an analogy for analysis. That is, a state where the system is poised between a too-ordered regime and a too-chaotic one. Kauffman 1993, 1995) also refers to this intermediate regime as a 'complex regime' or 'at the edge of chaos'.

Drawing on these concepts, an analysis of the two cases for study seems to indicate that the two systems evolve towards this phase transition or edge of chaos as a result of their collective construction. The Quito case study represents an example where the water management system was frozen at a stage where agents could not spontaneously self-organise away from the poor peak that represented the traditional water management model. The creation of the FONAG starts to melt the kind of evolutionary stable stage (ESS) regime created by the traditional water model as the new dynamic created by the multi-stakeholder process evolves. However in the last stage of the process of study, the system exhibits a behaviour similar to Red Queen, whereby agents are constantly introducing changes in order to achieve a better regional optimum in water management. Nevertheless, these changes altered the landscape of other agents faster than the agents' possibility to reach a poised state or inter-sector agreement. As illustrated by this case study, this means that neither the traditional water management model, former ESS type of behaviour, nor the current Red Queen type of behaviour, represents the highest fitness for the majority of the agents in the system, merely for a few.

[97] A poised state is a steady state attractor (Kauffman, 1993, 1995)

Similarly, the Mandú Alliance experience illustrates how multi-stakeholder processes enable the system to self-organise and provided there are no other interfering forces, to naturally evolve into a poised state between a too-ordered regime and a chaotic one. In this case, the multi-stakeholder process that yielded to the creation of the alliance 'broke' the former evolutionary stable strategy (ESS) type of behaviour where agents were trapped in poor local peaks. Similarly to the former case study, the multi-stakeholder enables a system to self-organise and to naturally evolve to a poised state at a fitter peak where a larger number of agents present a higher fitness. This poised state is a state of collective agreement or inter-sector partnerships, that is, the Mandú Alliance.

A crucial insight from a comparative analysis in relation to co-evolutionary dynamics then is that as self-organising dynamics are present in social systems (bottom-up forces), this will naturally tend to evolve towards a state that is poised between a too-ordered regime and a chaotic one. Furthermore, at this intermediate state or edge of chaos, the two case studies show that average fitness is higher than at the former one for most of the agents in the systems studied. This point of highest fitness or poised state is the state that this research refers to as multi-stakeholder agreement or partnership. These findings seem to be in line with Kauffman's second hypothesis on the development of co-evolution. He argues that this evolution tends to favour strategies that lay in a phase transition between the chaotic behaviour of the Red Queen regime, and the too-ordered behaviour of evolutionary stable strategy (ESS), near the edge of chaos (Kauffman 1995). This scholar argues that this is because ecosystems deep in the ordered ESS regime are too rigid, too frozen due to conflict constrains to co-evolve away from poor local peaks. In the Red Queen, chaotic regime, on the contrary, species (agents) climb and plunge on leaving fitness landscapes before they can reach a poised state. Therefore species (agents) at this stage have low overall fitness. Fitness turns out to be highest at the intermediate position between the order and chaos regime, near the poised stage position. Here the fitness peaks are the highest possible and still attainable in the time scale available. Therefore, the transition between order and chaos appears to be the regime that optimises average fitness for the whole ecosystem (Kauffman 1995).

Based on this analysis and the similarities this presents in relation to the behaviour of other complex adaptive systems that this research sets two major conclusions or hypothesis of work.. First, multi-stakeholder processes are a phase

transition in the system's dynamics. Occasionally, as in the cases studied here, multi-stakeholder processes allow the system to move to the intermediate regime or so called 'edge of chaos'. The cause for this is that multi-stakeholder processes allow systems to self-organise by enabling collective properties to emerge such as self-organisation, co-evolutionary dynamics and self-organised criticality (SOC), as explored below. As these properties are at play and the new collective dynamic percolates throughout the system, agents tend to prefer to be poised around peaks that represent higher fitness for a larger number of agents than (1) very high fitness for fewer agents (ordered regime) or (2) lower fitness around poorer local peaks (chaotic regime) (Kauffman 1995).

This leads to the second major conclusion or working hypothesis of this research, which is that inter-sector or multi-sector partnerships represent a poised state in the system's dynamics where agents either optimise their capacity to co-evolve or they are trimmed away by the evolution of the process. In other words, collaborative work represents peaks or optimum states where each agent is locally happier as long as other agents do not deviate from their own fixed strategy. This hypothesis does not claim that such a combination or equilibrium is stable over time but is dynamical. That is, this poised state would last as far as agents are able to evolve, better here than in another peak. This is in line with the idea that evolution is a dynamical equilibrium state argued by complexity scientists (Kauffman 1993, Axelrod 1997).

Finally, another major conclusion is that social systems seem to be able to move from an ordered regime to a chaotic regime without reaching a poised state at an intermediate regime, as illustrated in the Quito case study. The main cause that can be drawn from this experience is that path-dependence forces (new water law) plunged the fitness position already created by the multi-stakeholder process bringing the system into a critical state that triggered a cascade of changes. As a result, the system shifted from an ordered regime to a chaotic regime.

8.1.6. Properties of the System at the Edge of Chaos - Resilience and Robustness

A comparative analysis of the implications that the transition to a complex regime or edge of chaos has for the systems of study reveals another pattern common to both

experiences - multi-stakeholder processes increase the resilience[98] and robustness[99] capacity of the system to respond to internal and external changes.

Respondents from both case studies were interviewed about whether the system was more able to respond to internal and external changes as a result of the multi-stakeholder process and what the signs were for this. The answer was a unanimous yes. The signs for it were 1) systems showed a shorter response time for the majority of the changes occurring (efficiency); 2) these responses were also more effective due to the larger number and diversity of agents involved; and 3) the systems were more flexible to attend and to adjust these responses to a larger range of changes.

These insights seem to indicate that multi-stakeholder processes do not just increase the fitness of the agents involved in the collective dynamic, but as a result of this, the overall fitness of the system both in its capacity to respond to and adapt to changes (resilience) is also increased. This property prevents the system being influenced by many perturbations, thus being more robust. These observations are in line with Kauffman's (1995) idea that self-organisation generates structures that benefit from natural selection. This is that "they can evolve gradually into a more structural stability (redundancy)", where "many mutations cause no or only slight modifications in the behaviour [of the system]" (p. 188). For Kauffman this means that the system is more robust. It is in this sense that Kauffman states that self-organisation and selection are two sources of order.

8.1.7. Emergence - a Dynamical Construct and a Phase Transition

A cross-examination of the fifth complex mechanism present in both case studies – emergence – seems to reinforce the former insight that multi-stakeholder collaborations can represent a phase transition towards the edge of chaos or complex regime (Kauffman 1993, 1995).

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[98] Kauffman (1995: 208) considers that an agent is resilient according to "how easily each landscape is deformed by the adaptive moves of the players".

[99] For Kauffman (1995: 188) robustness is another name to refer to 'redundancy', as the property systems exhibit "that many mutations cause no or only slight modifications in the behaviour".

A comparative analysis of the two case studies shows how the emergence of a novel pattern in the system such as collective work or partnerships, is the result of a specialisation process of the system components (agents) as a response to changes in the system. A crucial property of this novel pattern or dynamic is that it represents a new coherent structure with its own identity (Goldstein 1999; Kauffman 1993, 1995; Holland 1995). Examples of emergence are the creation of the FONAG (Fund for the Preservation of Water Resources) in the Quito experience and the Mandú Alliance in the Brazilian one.

Chapter 5 and 7 discussed the specialisation processes occurring at an agent level for each case study. A cross-examination of these specialisation processes reveals the two experiences exhibit some common features. A first common feature is that the specialisation processes began by agents interacting as a response to a shared interest or problem. In the case of Quito, The Nature Conservancy (TNC), the Water and Sewage Metropolitan Enterprise of Quito (EMAAP-Q) and other local leaders created the FONAG as a response to the water management crisis that the country faced. In the Brazilian experience, the Mandú Alliance emerged from the interaction of four local agents: CARE Brazil, EMBRAPA (Brazilian Public Research Enterprise for Agriculture and Livestock), Piauí Federal University (UFI) and the Flora Vida Institute, who responded to an opportunity to bring external resources to support local needs (young people). An insight from this analysis is therefore that the creation of new agents reflects how agents specialise as an adaptive response to new conditions stemming both from a new opportunity or a crisis.

A second feature common to the specialisation process for both case studies is that the emergence of new agents in the systems exhibits two underlying processes - 'tag formation'[100] and 'match formation'[101] (Holland 1995). In both cases, agents first gathered because they shared a common interest or problem, which represents what Holland (1995) refers to as 'tag formation'. Other instances of tag formation can be observed on many occasions in the two experiences: agents gathering to attend Water Council meetings or to discuss legal reforms, in the Quito case study; and agents

[100] According to Holland (1995: 12) tagging is "a mechanism that consistently facilitates the formation of aggregates".

[101] According to Holland (1995) the degree of adhesion between two agents is determined by the degree of match between their adhesion tags.

gathering to respond to the Kellogg Foundation offer or to attend the Cajueira Films Festival, in the Brazilian experience. These examples illustrate an important insight into the construction process of multi-stakeholder collaborations; how tag formation is the first driving force for agents to interact. Additionally, this reflects that the dynamic intrinsic to agents' interactions is a process of 'match formation', where agents exchange some kind of resource (information, knowledge, capabilities, and the like) around an overlapping interest. This shows how tag and match formation reflect the first stage of the specialisation process that lays behind the eventual emergence of a new dynamical pattern of collaborative work.

Once the connections are made, and provided certain conditions for increased interactions are provided, a third similarity between the case studies can be observed. That is that self-organisation and co-evolution are the means (complex mechanisms) for agents to specialise at a collective level in order to undertake collaborative work. An indicator of this second stage of the specialisation process is that no central control influences the interactions between agents (Goldstein 1999; Kauffman 1993, 1995; Camazine *et al.* 2003). In this regard, both case studies present a similar action (training) intended to strengthen local agents' capacity to specialise at a collective level to perform a collaborative work. As discussed above, the training periods offered the environment and other enabling conditions necessary for agents to self-organise and co-evolve (Mitleton-Kelly 2003a).

Finally, a fourth common feature is how the processes behind the emergence of a new pattern (collaborative work) - tag formation, match formation, self-organisation and co-evolution - produced greater levels of aggregation both at an agent and a system level (Holland 1995; Kauffman 1993; Goldstein 1999; Bak 1996; Brunk 2000). This process of aggregation can be found in many instances of the two systems studied. A clear example of this is the aggregation process observed in the agents' capacity to work collaboratively, explored in more detail in the second section of the analytical chapters (5 and 7). Nevertheless, aggregation can be found behind the evolution of many other processes observed in these experiences such as level of awareness of the need to shift to a more sustainable model of water management in the Quito region or the aggregation process behind the indigenous outbreak. This is in line with Holland's (1995: 11) idea that, "complex large-scale behaviour emerges from the aggregate interactions of less complex agents".

Two main insights can be drawn from these fourth similarities between case studies. First, emergence is responsible for transforming individual behaviour into collective behaviour. From a theoretical standpoint, this shows that emergence is a dynamical aggregative construct where agents at a micro level progressively specialise giving rise to a new pattern at a macro level. A closer look at this dynamical construct in the context of this research revealed that it exhibits threshold values that mirror variables that define the specialisation processes discussed above. The various threshold values these variables can display explain the different outcomes an emergent process can produce. In the context of this research, these outcomes can be from the creation of a new entity or multi-agents such as FONAG and the Mandú Alliance, to the emergence of a new dynamic in the systems such as collective behaviour, also referred to 'partnership culture' in the Brazilian case study. This behaviour observed reflects a fundamental property of complex adaptive systems, its non-linear behaviour (Watts 2003; Kauffman 1993, 1995; Holland 1995). The emergence of collective behaviour as a new dynamic in the system, in both case studies, is in line with the ideas of many scholars who argue that a dynamical construct is associated with the arising of new attractors in systems (Goldstein 1999; Kauffman 1993, 1995; Holland 1995).

Furthermore, the comparative analysis also shows that the progressive distribution of this dynamical construct (collaborative work) is also similar for the two case studies until the point of evolution met by the Quito experience. This distribution ranges from its minimum threshold value where the first signs of collaborative behaviour emerge; evolves across a critical point where a new agent emerges; and scales up to higher threshold values where further levels of specialisation occur, both at the individual and new collective level as the inter-sector partnerships evolve over time.

Finally, the major second insight that can be drawn from this comparative analysis is that multi-stakeholder partnerships drive systems to a shift of regime. Kauffman explains how the ever-increasing diversity of the biosphere is due to a natural law, a creative tension between what he refers to supracritical[102] and

[102] Supracritical behaviour is when "the probability of catalysis [interactions between agents in the context of this research] is sufficiently high, or the diversity of kinds of food molecules [topics of interest, skills, in the context of this research] is sufficiently high, or both". Then

subcritical[103] behaviour (1995). However, to answer the question of what prevents life dying from a super-explosion of diversity Kauffman formulates the following hypothesis: cells, bacteria, birds, man have developed over the past 3.45 billion years an upper limit on the molecular diversity that can be housed within one cell; a limit on the molecular complexity of the cell, a boundary between the supracritical and subcritical regime exits. He states that: "communities of cells might evolve to the subcritical-supracritical boundary" (Kauffman 1995: 126). A broader description of these types of behaviour is included in Chapter 2.

Kauffman's ideas serve once again as an analogy to investigate how multi-stakeholder processes can be a source of diversity and complexity creation both at an agent and a system level. Considering the unit of analysis here is a social system and not a cell, it can be observed how multi-stakeholder interaction are a source of diversity creation as illustrated by the various new agents created over the two case studies: FONAG, the Mandú Alliance, the National Council of Water Councils, etc. In this research higher levels of complexity at an agent level seem to stem from the higher number of 'building blocks'[104] provided by a higher number of kinds of social agents (Holland 1995). At a system level, the increase in complexity seems to stem from two main elements: (1) the increase in the diversity of agents in the systems of study contributed to increase the space of possible interactions; and (2) the fact that multi-stakeholders processes enabled the emergence of collective properties of the system such as self-organisation, co-evolution and self-organised criticality, which helped to restore the capacity of the system to self-tune. The systems increased capacity to self-organise, as opposed to the mainstream top-down forces prevalent in both case studies, enabled them to create higher levels of diversity at a system level thus, opening up their space of possible evolution paths. This analysis sheds light on how self-organisation enables social systems to remain at the boundary between supracritical and subcritical behaviour.

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the system "generates an explosion of new kinds of molecules that in turn catalyze the formation of new kinds of molecules" (Kauffman 1995: 118)

[103] Subcritical behaviour is "when the probability of catalysis is low, or the diversity of kinds of food molecules is low, or both, the generation of novel kinds of molecules soon dwindles to nothing" (Kauffman 1995: 118)

[104] Holland (1995) refers to 'building blocks' as the parts of a system that can be used by selection and learning to compose higher levels of complexity in a system.

8.1.8. Self-Organised Criticality (SOC)

A less known mechanism present in the two case studies is the capacity of social systems to display self-organised criticality behaviour. The emergence of a new attractor, the creation of new agents or multi-agents, the increase of complexity in the system, the cascade of events, and the trimming away of less fit agents, are indicators that a mechanism that restores the balance of the system while opening up a new space of possibilities for it to evolve existed behind the complex dynamics of the cases studied.

Complexity scholars are exploring the concept of self-organised criticality originated in physical systems into a range of other systems including social systems (Bak *et al.* 1987; Brunk 2000; Frigg 2003; Fronczak *et al.* 2008; Paczuski *et al.* 1995; Bartolozzi *et al.* 2006). Bak *et al.* (1988) argues and demonstrates numerically that dynamical systems with extended spatial degrees of freedom[105] in two or three dimensions - these systems are common in physics, biology and social systems - naturally evolve into self-organised critical states[106] without detailed specifications of the initial conditions. "This critical state can be reached only by fine tuning a parameter (e.g. of temperature), and so may occur accidentally in nature" (Bak *et al.* 1988: 364). Furthermore, activity in the self-organised critical (SOC) state takes place in terms of bursts, or avalanches[107] (Bak *et al.* 1988; Fronczak *et al.* 2008; Paczuski *et al*. 1995). The initiation of a new avalanche in the critical state can be viewed as the injection of a single particle into the system (Paczuski *et al.* 1995). Bak *et al.* (1988) and Fronczak (2008) agree that systems seek a critical state in order to show robustness to small changes. Avalanches are the mechanisms for the system to

[105] In physical systems the 'degrees of freedom' refers to the dimensions of a phase space.

[106] Bak *et al.* (1988: 365) define critical state as the state of the system where "it is barely stable with respect to further perturbations". Kauffman refers to this critical state as poised state.

[107] An avalanche is when a perturbation is propagate "to the neighbours, then to their neighbours, in a chain reaction, ever amplifying since the sites are generally connected with more than two minimally stable sites, and the perturbation eventually propagates throughout the entire lattice" (Bak *et al.* 1988: 367). "Turbulence is a phenomenon where self-similarity is believed to occur in *both* space and time" (Bak *et al.* 1988: 364)

redistribute its energy across its lattice (Bak *et al.* 1988; Bak and Paczuski 1995; Ramos *et al.* 2009; Paczuski *et al.* 1996).

A deep analysis of the two case studies reveals regularities that could suggest the presence of self-organized criticality and some particular features related to the social systems of investigation. Complex avalanches seem to be present through different events but functioning similarly in the two case studies examined. In the Quito case study, the government's rejection of the agents' recommendations for the new water law provoked a cascade of events that started with the indigenous uprising in the streets of Quito; this was followed by the renovation of the SENAGUA (Water Secretariat) team, the revocation of the 213 Ordinance that entitled FONAG to design an integrated water management scheme, and so on. In the Brazilian case study, the visible outcomes produced by the Mandú Alliance and the professional mobility meant that the 'partnership culture' percolated in the region; hence institutional partnerships were created outside the alliance; agents from the region started to demand to join the alliance; and finally, the Mandú values and culture have been copied by many other agents in the region who seek strategies to improve their fitness.

A fundamental insight from this analysis is that the appearance of avalanches seems to be related to the aggregative nature of the system components (Bak *et al.* 1988; Kauffman 1993). In both cases, a critical point in the aggregative capacity of some agents has been crossed, which seems to have triggered the avalanche of changes described above. Another feature observed in the systems of study is that these avalanches or complex cascades serve to spread a dynamic in the system and to restore its balance. In the Mandú Alliance experience, the cascade of events is helping the culture of partnerships to percolate throughout the region; in the case of Quito, the avalanche of events occurring after the publication of the new water law broke the momentum created by the multi-stakeholder process and restored another balance in the system. Hence, this research suggests that avalanches described above enabled a new dynamic to scale up or percolate across the system lattice regardless of the nature of the dynamic and the conditions already present in the system.

A final insight from this interdisciplinary research is that what Kauffman (1993) refers to as a poised state, seems to be the same idea that Bak and co-workers refer to as self-organised critical state. This could explain the cascade of events that

followed the creation of the Mandú Alliance in the Brazilian case study and confirm the research's conclusion stated above that an inter-sector partnership represents a poised state in the system dynamic.

8.2. Complex Dynamics at a Micro Level

The former section has explored the mechanisms common to the case studies for making individual organisations work collaboratively. However, as discussed above, the existence and functioning of these mechanisms seems to respond to the pattern of interactions agents experience at a micro level (Kauffman 1993, 1995; Holland 1995). The second part of Chapters 5 and 7 analysed the dynamics both case studies present at a micro level. The different journey agents face when working collaboratively due to their dissimilar institutional background has been examined in these sections.

This section explores the similarities and differences between case studies of the processes occurring at an agent or micro level in order to identify common patterns. Furthermore, it seeks to understand what the forces are that move agents to work collaboratively.

To investigate the behaviour of single agents as opposed to collective behaviour as explored above, this section draws on Holland and Kauffman's work. First, it uses Kauffman's concept of *fitness*[108] in coupled landscapes as an analogy to explore agents' capacity to engage and remain into collaborative work. Furthermore, it draws on Holland's (1998) idea that agents present an internal structure (attributes) that shapes their behaviour. However, as explained in the former analytical chapters, to account for the behaviour agents exhibit in their internal structures in the cases under investigation, this work describes them in terms of *attributes*, to refer to the capabilities agents present and *attitudes*, to refer to the ability agents display to introduce change. Finally, it also builds on Kauffman's (1993) idea of 'specialisation process' to examine the changes occurring in the agents' capability over time.

[108] Kauffman (1993) understands the fitness of a species as the degree of adaptation with respect to the external environment. Bartolozzi and co-workers (2006: 500) explain that: "highly adapted species will hardly undergo any successful, spontaneous mutation. At the opposite of the scale, it a species has a very low degree of fitness it needs to mutate in order to survive and its mutation automatically influences the other species belonging to the same environment".

This section therefore combines these ideas to explore the agents' internal structures that explain the level of fitness and degree of adaptation agents exhibit in the case studies.

8.2.1. Selective Evolution at an Agent Level - 'Specialisation Process'

The first common pattern that can be drawn from a comparative analysis of the two case studies under investigation is that agents go through a specialisation process to be able to engage in collaborative work. A closer look at the nature of these specialisation processes across the experiences reveals that they present two dimensions or sub-processes: (1) a specialisation process to be able to perform the collaborative task (integrated water management in the case of Quito; and community development of young people, in the case of the Mandú Alliance); and (2) a specialisation process to be able to work collaboratively, that is to undertake collective decision-making, share responsibility in planning and execution, and adapt their internal systems and other qualities to be able to work collectively.

To keep exploring the journey that agents undertake to collaborative work this section integrates these findings as an ordering principle for analysis and seeks the similarities and differences across agents to specialise in these two dimensions.

Agents' Distribution in the System Network:

A first similarity that stems from a deeper analysis of the agents' specialisation process is that those agents who showed the main attributes (capabilities) required for the collaborative tasks also had a better attitude (capacity) to engage in collaborative work. Likewise, those agents that were less reluctant to work collaboratively also faced a longer journey or more challenges in their specialisation processes. A few exceptions or intermediate cases were however observed, suggesting that the correlation between attributes and attitudes can display multiple combinations. The Brazilian case study is an example of this. Here, it can be observed that CARE Brazil is the fittest agent in the system to perform the specific task of collaboration; EMBRAPA and Piauí University are on the other hand, the agents less fit to undertake the collaborative task; and the Floravida Institute is the exception to the rule. This is reflected in the fact that at the initial multi-stakeholder process, the

Floravida Institute presented weak attributes (capabilities) for undertaking the collaborative task, yet a strong attitude for introducing the changes necessary to achieve it. This illustrates how agents' attributes and attitudes influence their specialisation process when performing the collaborative task.

A second insight from cross-examination at a micro level is that agents' distribution in the system network also seems to influence their specialisation process. If we picture a multi-stakeholder process as a network of nodes (agents) around a centre (collaborative task), it can be observed how the agent's position in this network influences its fitness capacity. That is, the closer agents are to the network's centre, the fitter they are for performing collaborative tasks (Kauffman 1993, 1995; Albert and Barabási 2002; Watts 2003). This illustrates how the agent position in the system network in relation to the particular task of collaboration influences the specialisation necessary to improve its fitness position (Holland 1995; Kauffman 1993). The reasons that can be drawn from this research to explain this distribution are: (1) agents closer to a local peak (collaborative task) already exhibit a degree of fitness necessary for them to occupy this niche; and (2) the collaborative task works as an attractor for agents who already display those qualities and also for those agents who have an interest in improving their fitness, as in the case above of the Floravida Institute.

Influence of the Institutional Background in the Fitness Distribution:

A second general insight drawn from a comparative analysis of the case studies suggests that the institutional background influences the fitness distribution of agents in the system network, hence their specialisation process.

In both case studies it can be observed how at the beginning of the process, agents from the same social sector (public agents, private agents, non-for-profit agents (NGOs) and academy) showed similar fitness and faced similar specialisation processes. The mixture of legal identities many of these agents show blurs the task of drawing patterns across sectors. Examples of this mixture of legal profiles are: the public enterprises (EMAAP-Quito), governmental research centres (EMBRAPA-Brazil), universities that work as active community agents (Salesian University-Quito), and the like.

A general behaviour that can be observed across the various institutional backgrounds, however, is that, at the beginning of the process, NGOs and other

community-focused or community-based agents - such as the Salesian University, water councils, and the like - were the fittest agents both to perform the collaborative tasks and to work collaboratively. They also showed a strong attitude for introducing the changes necessary to adapt to the dynamics emerging from the multi-stakeholder process. Their specialisation process was therefore quite straightforward, featuring the need to adapt to the new partners, support them in their specialisation processes and make room in the new niche (collaborative task) for other agents to enter too.

A second group of agents were those that had a business culture either from a public or private background - EMAAP-Quito or Floravida respectively. At the beginning of the process, these agents presented weak attributes (capability) or experience in relation to the collaborative task, however they showed a strong attitude or interest in engaging in the multi-stakeholder process. This shaped the high degree of learning and adaptation these agents displayed in their specialisation processes. As a result, in the last stage of the case studies, these agents showed one of the more challenging institutional journeys with the largest differential fitness improvement. This differential is drawn considering the fitness agents show at the beginning of the process as opposed to the one at the end of the processes study. A very different situation is observed for the bottling and flower companies in the Quito case study, as these agents neither exhibited the attributes nor the attitude for engaging in the multi-stakeholder process. Despite this, other participants from this case study noted that these agents introduced some changes and thus had some kind of specialisation even with a low degree of participation in the multi-stakeholder process.

A third group of agents was those that had a civil servant background such as the EMBRAPA and Piauí University in the case of Brazil and all public agencies. A comparative analysis shows that these agents exhibited weak to middle capability (attributes) reflected in a good knowledge in some issues related to the collaborative task; however they exhibited a low capacity to introduce changes in their institutional structures (attitude). The rigid institutional structure of these institutions (too-ordered behaviour as expressed by Kauffman) hindered the specialisation gained at an agent level from percolating across the systems.

From this analysis it can be drawn that the agent's attributes (capability or skills) and attitudes (ability to introduce changes) influence its fitness position in the system (Holland 1995; Kauffman 1993, 1995). Furthermore, it also suggest that the fitness of an agent has to be defined according to a particular function of the system

such as the tasks of collaboration and not as a generic property of agents. The position the agent occupies in the system network in relation to that particular function also seem to define its fitness. Hence, the agent attributes and attitudes, in the way these terms have been defined in this research, and its position in the system network in relation to the task of collaboration seem to be the three main variables that influence the fitness degree according to these case studies.

Furthermore, this comparative analysis has illustrated how all agents go through a specialisation process both to be able to engage in the collaborative task and also to remain in it. That is, agents need to constantly specialise to keep up with the changes in their context, whether this is to remain in their same position or to occupy another local or distant niche in the system (Kauffman, 1993). In other words, those agents that are able to introduce the required changes in the required time frame are more likely to engage in the collaborative work, hence improve their fitness, than those agents that are not able to adapt to or evolve to the changes introduced by the new dynamic. These last agents are finally washed away as it was observed in the Mandú Alliance case study with the two agents who abandoned the multi-stakeholder process. Finally, this analysis also showed how the specialisation process seems to depend on the agents' position in the system network in relation to the particular task of collaborations, similarly to the former analysis done in relation to the fitness.

This analysis suggests that specialisation in social systems, as the ones investigated in this research, is an intrinsic function of evolution and selection. This is in line with the ideas discussed by Kauffman for biological systems (1993, 1995).

Conclusion

This chapter has undertaken a comparative analysis of the two case studies in order to provide answers to the second research question: What are the main generic principles that underpin the construction of inter-sector partnerships from a complexity dynamical systems approach?

The major insight from this comparative analysis is that regardless of these differences the two case studies share a common pattern of functioning both in relation to the construction process of multi-stakeholder collaborations, and the complex principles that shape this pattern. A key feature of this pattern is that while it presents a linear sequence of occurrence (Loobark 2007), its generic principles

(complex mechanisms and sub-processes) are complex and context-specific, hence behave differently according to the conditions and non-linear nature of the systems in which they are embedded.

A cascade of failure of the mainstream dynamics over time created a gap in the system in relation to two population groups: a lack of professional opportunities of young people from coastal communities in Piauí (Brazil) and major failures in water access for Quito consumers (Ecuador). Agents internal to the system started to respond to these gaps in services. The types of response varied according to the agents' perception of the situation: from the perception of a 'shared problem' (Quito) to the perception of 'shared opportunity' (Brazil). External agents, in both case studies, provided the resources for internal agents to occupy, adapt to and co-evolve in the new niche. These resources were mainly financial, conceptual and provided access to relevant connections in the system network (i.e. policy-makers in the Quito case study). These external agents were referred to as 'bridge agents' (Watts 2003; Kauffman 1993) as they play the role of bringing resources to the system. Tag and match formation, connectivity, social capital and bridge agents are the main principles that drive the formation of a niche opportunity from a gap in the system.

The emergence of a new agent to occupy the niche opportunity is the second stage of this process. Interconnectivity, match formation and emergence are the main principles that drive this state. New connections and increased inter-connectivity among agents internal and external to the system enable the creation of the new agents. Internal and external agents stemmed from similar or different sectors, therefore held different degrees of diversity of locations in the system, and perspectives, roles and influence in the system dynamics. The presence of other enabling conditions such as access to additional resources, trust, and shared interest, enabled the creation of the new agents (multi-agents): FONAG[109] (Ecuador) and first group of participants in Kellogg's Foundation training (seed group of Mandú Alliance). The formation process of these multi-agents varied between case studies, marking another major differential point in the evolution of the multi-stakeholder process. The multi-agents are the steering agents of a new dynamic in the system, which marks the third stage of this construction process.

[109] Fund for the Preservation of Natural Resources (Ecuador)

The creation of a structured process for multi-stakeholder discussion is the hallmark of this third stage. The interacting agents at this stage are among the multi-agents and target population groups (water consumers and young people from communities). At this stage the diversity of agents in all the variables noted above, is similar between case studies. Dependence on external resources to develop the multi-stakeholder discussion is a feature of this stage. Greater inter-connectivity is the first major underlying principle of the multi-stakeholder discussion. The action of this principle is noted in the system network, which steadily shifted from scattered low connected nodes (agents) to a network structure with a higher number of connections and strength of coupling. The enabling conditions for multi-stakeholder discussions were: the number of agents capable of interacting and keeping interactions; the diversity of these agents; the collective spaces structured to provide information of common interest, boosting reflection and enlargement of vision on the system functioning; the building of common horizons; spaces facilitated by a neutral party who also plays the role of managing conflicts; and a minimum time-scale for interactions to shape individual behaviour (perspectives, visions, interests, roles, expectations, knowledge and the like). The main outcome of the multi-stakeholder discussions was the construction of collective identity and behaviour, a backbone process for the creation of partnerships and a new dynamic in the system. Partnerships among participants already emerged during this process, as observed in the Brazilian case study between the Floravida Institute, CARE Brazil and local communities.

The degree of collective identity and behaviour varied among processes. Some of the variables that influenced this difference were the size of the system, agents' attributes (velocity to introduce changes in internal structures, interest in the process and topic, degree of participation (time for interactions), hierarchical position within the organisation) and external perturbations to the process. Another major difference was the role and position in the system of the steering agent. While FONAG was the 'official' steering agent of the discussions, it was also a new competing agent in the system. Behind the formation of the Mandú Alliance, the steering agent (coaches of Kellogg Foundation) was not an internal agent to the system, thus there was no competition.

The complex mechanisms that initially drive this collective construct are first, self-organisation and co-evolution. As agents start to interact according to their own interests (self-organise), they also start to exert a mutual influence among themselves

and accommodate their behaviour to each other (co-evolution). As these two processes reinforce each other, the system steadily increases its collective capacity (aggregative process) and enters the region of collective behaviour. This region presents threshold values. A sign to identify that the system has entered this region is that agents find that their individual fitness is higher by acting collectively rather than individually. Both case studies show signs of having entered this region; however only the Brazilian one managed to create an inter-sector partnership. Why is this? This analysis showed that the Brazilian experience had crossed a critical point within the threshold values of the construction of collective behaviour. As the system crosses this critical point, it poises at a state where the participants are able to agree on a set of common norms, objectives and division of roles so as to work collectively and collaboratively. This is the state of multi-stakeholder agreement or partnership.

However, despite the difference in achieving a partnership (poised state), both case studies show a similar dynamic in relation to the four stages of this pattern of inter-sector collaborations construction. As the collective constructs enter the region of collective behaviour, and before reaching a critical point, they start influencing the system dynamics. Examples of this are the construction of the National Council of Water Councils and the influence in the National Water Table that stems from the Quito multi-stakeholder process; and the various collaborations between agents that resulted from the creation period of the Mandú Alliance. While the mechanism that regulates the dynamics of percolation in the system seems to be self-organised criticality, the cascade of changes, in this particular case, signals an underlying process: emergence. Emergence is therefore the mechanism that accounts for the construction of new patterns, FONAG and the Mandú Alliance, and the new attractors in the system dynamic. This research argues that, as the system enters the region of collective behaviour, it already starts exhibiting new properties: resilience, adaptation capacity, robustness and capacity to innovate and perform complex tasks. Again these properties seem to show threshold values that grow as the collective capacity grows. For agents to remain in this poised state, multi-functionality and constant adaptation seem to be a key features for inter-sector partnership to endure.

The creation of collective behaviour also requires constant specialisation or adaptation at an agent level. This signals the constant interaction and influence between the various levels of the system, micro, meso and macro level. Both case studies show that agents' specialisation occurs in two dimensions: working

collaboratively and performing the new tasks or role assumed as part of the collective agreement, at the same time as the individual one. The variables that determine agents' specialisation process(es), common to both case studies, were: capacity of the agent to learn and to introduce changes in their internal structures (perception, beliefs, etc) and behaviour; institutional background (dynamic and culture surrounding the agent); agent's location in the system network in relation to the topic of collective action: and the starting conditions of the agent (level of knowledge, connectivity, skills, etc) also in relation to the topic of collective action. Selection appears to be a permanent organising mechanism at all levels of the system dynamic and for both case studies. It shapes the dynamics by reinforcing the influence of those agents that represent the 'building blocks' (Holland 1998) of the dynamic under construction, while it eliminates those agents with 'selfish behaviour' (Kauffman 1993). The presence or absence of external or internal perturbations during the construction processes at all levels of the system is a crucial element to enable spontaneous behaviour, order creation and the percolation of the dynamic across the system. The consequences of external perturbations (i.e. revision of water law) can be observed in the Quito case study, while the Mandú process lacks this. Both experiences had measures in place to manage internal perturbations such as institutional agendas, conflict of interest, competition and the like.

A final stage common to both case studies is the expansion of the new dynamic created in the system and system re-equilibrium. During the construction of collective behaviour or as a result of it (partnerships), a series of actions are developed that percolate through the system influencing its dynamics. As mentioned before, the principle that regulates the percolation dynamics through cascades of change seems to be self-organised criticality. However, both case studies show how this expansion is coupled with an attraction dynamic, consisting mostly of agents who seek to improve their fitness. Examples of this are the interest of other countries to create a FONAG (Fund for the Preservation of Water Resources) to also implement an integrated model of water management (Ecuador case study) and interest in joining the Mandú Alliance by various organisations in the Parnaiba region (Brazil case study). The property that regulates both the dynamics of attraction and expansion (influence) for both case studies is the degree of connectivity in the system network.

This section shows how the pattern behind the creation of inter-sector partnerships responds to a sequence of stages of construction regulated by a series of

complex mechanisms that work in an intertwined manner and produce an aggregative result. The role that every complex mechanism or sub-process plays in the system and the outcomes it has in the system dynamic is what this research refers to as a generic principle. This pattern of behaviour answers the second research questions.

Differences between case studies have been crucial to better understand the particular behaviour of these principles or mechanisms under dissimilar conditions. Additionally, these different realities have provided a better understanding of properties social systems display as complex systems. The practical implications of these properties together with the pattern presented above are discussed in the following chapter, Conclusions.

Chapter 9

Conclusions

This concluding chapter summarizes the main arguments of the thesis, underlines the main topics discussed and sets up the main conclusions both in response to the research questions and some additional insights. The practical implications of these conclusions and lines for further research are also included in this chapter.

This research has used a complex dynamical systems theory as an explanatory framework to study the complex dynamics of inter-sector partnerships (ISPs). The Introduction explored the major socio-political transformations that led to the emergence of ISPs internationally. This section addresses how and why inter-sector partnerships emerged as an alternative to offset the failures of the previous State, business or civil society-centred models. Here, Ecuador and Brazil are presented as two locations where ISPs are taking place for a sufficient period of time as to be possible to study their dynamics. The main criteria for the selection of the two case studies of this research are also introduced in this section. A second section defined what an ISP is and explored the main forms, motivations, benefits (outcomes) and costs associated with them. This section elucidates how the definition of ISPs displays features of what have come to be termed 'complex systems'. A third section introduced the theoretical frameworks that have most influenced the study of inter-organizational relationships (IORs) according to Robinson et al. (2000). This section argues that most of the theoretical frameworks traditionally used have paid insufficient attention to the complex and dynamic nature of IORs. Based on the previous analysis, this section claims that there is a need for a new theoretical approach capable of accounting for the synergetic (emergent), complex and dynamic nature of ISPs. The advance of complexity theory is presented as an alternative to tackling these issues as it focuses on interactions and the patterns that emerge from them. In this regard, the two works that have most advanced the application of this new theoretical approach to the study of social interrelations are presented. Finally, this chapter sets out the research objectives and questions of the thesis. This analysis

shows that neither the literature of inter-organizational collaborations nor the literature of complexity theory have addressed these research questions.

Chapter 2 presents the theoretical framework of complexity theory. This chapter sets the language and conceptual framework used to investigate the complex dynamics of inter-sector partnerships in this research. It presented the various waves of influence of systems ideas in sociology. It shares third wave concerns with the emergence, component interactions, and relations between levels; and also the ideas developed by second-wave theorists about dynamical systems such as self-organizing, non-linear behaviour, attractors and far-from-equilibrium, among others. Furthermore, here it is explained that this research draws on the work of Stuart Kauffman (1993, 1995, 2000), a main contributor to the current knowledge of complex dynamical systems theory; and John Holland (1995, 1998), who provides the most comprehensive account of the properties of complex adaptive systems (CAS). Here it is explained that while Kauffman offers a conceptual framework to analyse the forces that drive the creation of order and evolution, Holland describes generic properties of complex adaptive systems to explore the agents' behaviour at a micro level.

This chapter claims that an analysis of the dynamics both at a macro and a micro level is necessary to understand the dynamics of collaboration at a process level (meso level). This chapter explained the innovations that this research includes to overcome the main criticisms that the transfer of complexity theory to the social arena has received. These are in relation to 1) the use of complexity ideas as an analogy to deduce new knowledge on the complex behaviour of ISPs; 2) to transfer the ideas of complex behaviour to human action from the new knowledge produced in this research, after exploring their applicability to explain dynamics of social change processes; and 3) the focus and levels of investigation which is the emergent, dynamical and evolving dynamics of ISPs processes using both a macro and micro level of analysis. The latter focuses on the attributes human agents present that shaped their change in behaviour to work collaboratively.

Chapter 3 discusses the fact that new methods of enquiry are necessary to study social processes from a complex dynamical systems perspective. This section discusses two main arguments to sustain this claim. First, social processes such as those under study are context and history specific (Brunk 2002; Leach *et al.* 2010; Reynoso 2006; Stacey 2007). Therefore the modelling tools used as the mainstream method in the field of complexity theory, would not explain how ISPs relate to

different contexts (Bak 1996; Holland 1998; Wolfram 2002). Second, the human nature and dynamic of social processes requires methods that access the different narratives around a system study and under the perspective of the protagonist (Chambers 1994; Leach *et al.* 2010, Stacey 2007). This means a shift in the role the researcher's needs to play, from being an observer to being a facilitator of the narrative construction (Leach *et al.* 2010; Reynoso 2006; Stacey 2007). Based on these arguments, qualitative methods are presented as the most accurate and adequate for the study of complex social dynamics (Reynoso 2006). The methods and strategy adopted are: case study, participatory tools and semi-structured interviews.

The methodology is designed in three stages to account for both the purpose of theorizing and advise practice. A first stage describes two cases of inter-sectors collaboration; a second stage investigates the complex dynamics of these two experiences using a complex dynamical systems approach; and a third stage draws a common pattern of behaviour and the complex principles that drive it. A combination of a deductive and inductive approach is used over these stages. Here it is argued that this aims to set the bases of a new methodological approach named 'qualitative dynamical modelling'. Additionally, the fieldwork experience both in terms of main contributions and limitations of this methodology are noted. A final section discusses how the methodology considers the ethical considerations of fieldwork, such as bridging the gap between theory and practice, and to using this research to build local capacity in the locations of study.

Chapter 4 introduces the first case study, the Mandú Alliance experience in northeast Brazil. A first section introduced the main events that hindered or facilitated construction of the Mandú Alliance as a collective entity and its evolution. Here Kellogg's external role in boosting and supporting the first agents' interactions; the alignment of the agents' different perspectives and interests through dialogue, shared concepts and values (identity); and the construction of a collective goal, are noted as the main events that enabled it to overcome the dampening forces stemming from both internal conflicts and external influences. Other determining strategies and processes were: to have a clear division of roles; to have the institutional autonomy to work both individually and collectively (multiplicity of roles); a strategy that fits all the parties' interests; a flexible communication and governance model; a pool of common resources; and to work to decrease the Alliance's dependence on specific leadership roles and financial resources. This case study illustrates how this

construction process also provoked changes at an organizational and individual level. The second section of this chapter explores the different perspectives and challenges that occurred at an agent and organizational level. This chapter describes how the Mandú Alliance became a model for local and regional organizations looking for ways to increase their impact and institutional capacity. This experience also reflected how Mandú represented an alternative strategy to policy-making as governmental agencies were part of the different programmes of action of the Alliance. Finally, this research claims that the changes produced as a result of the multi-stakeholder process help to increase the agents' resilience[110] capacity and discussed the elements that contributed to it.

Chapter 5 analyses the complex dynamics of the construction process of the Mandú Alliance. This is the first of the three analytical chapters that comprise this research. This analysis was structured in two parts: 1) a description of the mechanisms that explain the emergence of this multi-stakeholder process at a macro level, and 2) the dynamics perceived at a micro level resulting from the former ones. The first part of the chapter analysed the contextual conditions that the system displayed at the beginning of the process. This illustrated the complex non-linear behaviour of the system in which the Alliance was embedded. The niche of opportunity for this process to emerge created by the failure of the existing policy model in the Parnaiba region is also discussed here. The role of the Kellogg Foundation as a 'bridge agent' (Watts 2003) is examined. Here it is argued that Kellogg's training not only enabled the creation a common project for the participants but, more importantly, it contributed to the creation of collective behaviour. This chapter claims that the transition from individual to collective behaviour is the key process behind the creation and evolution of the Mandú Alliance. The complex mechanisms that governed this construction process such as self-organization, co-evolution and emergence, are analysed. As a result of the dynamics that occurred at a macro level, the analysis held that a cascade of adaptations occurred at a lower level-organizational and individual level. Examination of the dynamics at a micro level suggested the agents to some degree required a specialization process to be able to work collaboratively. Changes in the agents' 'internal configuration', referred in this

[110] Resilience in this context is understood as Folke *et al*. (2005: 443) definition as the "capacity of a system to absorb disturbance and reorganize while undergoing change so as to still remain essentially the same function, structure, identity, and feedback".

research as ‘attitudes’ (ability to introduce change) and ‘attributes’ (capabilities) are observed. Here, it is argued that the agents’ capacity to learn different kinds of languages, technical, academic, and that of the various institutions and communities; and to introduce changes in their individual and organizational behaviour, seem to be the key variables for the degree and efficiency of the agents’ specialization. The experience of the Floravida Institute is explored as an example that reflects the most significant case of adaptation. This case study shows how learning is a crucial attribute of agents to be able to work collaboratively (Stacey 2007).

Chapter 6 presents the second case study, the multi-stakeholder processes intended to build an integrated water management plan for the Quito Metropolitan Area. Similarly to the former case study a first section introduces the main events that influenced- both enabling and hindering- the evolution of this process. A second section examines the different perspectives and challenges agents faced to engage and remain in the process. The first sections started by presenting the background conditions at the beginning of the process. From here the chapter moved to presenting FONAG’s (Fund for the Preservation of Water Resources) creation and the role played by external agents in this; and FONAG’s role in conducting the multi-stakeholder process towards its intended goal. Here the various strategies used to influence the process, from legal reforms to the coordination and production of information related to water management, were described. Finally, the outcomes the revision of the existing water law had for this collaborative process is explained. The second section of this chapter presented background information on the main participants, the enabling elements that contributed in their institutional journeys to collaborative work, the main challenges encountered and, when possible, their perception by third parties. A revision of the dynamics at different levels of the system, local, regional and national, is also included together with the agents’ description.

Chapter 7 analyses the Quito experience from a complex dynamical systems perspective. As in the previous case study, this analysis explores both the macro and micro level dynamics that influenced the events observed at a process or meso level. In the first part, macro level, this chapter argues that the situation of water crisis lived in Quito seems to be pushing the system far-from-equilibrium and opened up a niche opportunity for the emergence of this collaborative process. Unlike in the previous case study, this started with the creation of a multi-stakeholder institution to conduct

the collective construction, the FONAG (Fund for the Preservation of Water Resources). This analysis examined the construction process of FONAG and how it managed to survive the competition to occupy this niche and play its role in such a sensitive area under complex conditions. As part of this, the changes introduced in the system's structure and their influence on the system dynamic is explored. The transition from individual to collective behaviour is claimed to be the core dynamical process behind the construction of multi-stakeholder collaboration and partnership. The complex mechanisms behind this transition process are investigated in this chapter.

This chapter argues that the cascade of events spreading the culture of collective action and values associated with the new model of integrated management are a signal of this collective construction. The mechanism that seems to be in charge of this percolation dynamics, self-organized criticality, is presented and its various manifestations in this case study are discussed. Here it is argued that this same mechanism also appears to be responsible for spreading the new model of water management and ideas. The path-dependences present in the system are discussed as being responsible for dampening the momentum reached by the multi-stakeholder process at the moment of data collection. How macro-level dynamics are mirrored in the agents' specialization process at a micro level is analysed. Here, an analysis of the specialization process according to types of agent is undertaken to provide answers to the second research question. However, the blurred boundaries of the traditional sectors and the various combinations of legal figure and institutional goals present hampered this analysis. Nevertheless, this chapter argued that the agents' institutional structure (hierarchy, decision making and communication models) and dynamics are the main dimensions that shaped the changes are observed at this micro level.

Finally, Chapter 8 presents the results of the comparative analysis undertaken between the two cases of study examined in former chapters. A common pattern of construction of multi-stakeholder collaborations, and the complex principles that drive it, are presented and discussed here. The chapter is structured to reflect the comparative analysis (sections one and two) that lead to the common pattern of behaviour (conclusions section). This analysis shows the pattern behind the creation of inter-sector partnerships responds to a sequence of stages regulated by complex mechanisms that work in an intertwined manner to produce an aggregative outcome:

collective behaviour and inter-sector partnerships. The next section presents the pattern and focus of each stage to discuss their practical implications.

Answers to the Research Questions and Practical Implications

This section explores how this research provides answers to the research questions and what are the practical implications that arise. In relation to the first research question: what is the complex dynamic behind the inter-sector collaboration process of each case of study? This question has a double objective: 1) to explore the applicability of using complex dynamical systems theory to explain two different empirical processes of inter-sector collaboration; and 2) to provide two examples of scenarios that describe the complex dynamics of multi-stakeholder process under heterogeneous conditions. This second objective was intended to provide a diversity of strategies, possible outcomes and contextual conditions around the topic of inter-sector collaborations to provide a reference point for the practice of practitioners and policy-makers. This objective is part of the research methodology to bridge the gap between academic production and practice. These scenarios are covered by the analysis provided in chapters 5 and 7.

In relation to the applicability of using a using a complex dynamical systems theory to investigate two different empirical processes of inter-sector collaboration, chapters 5 and 7 also provide the basis for evaluation. These chapters show how this theoretical approach offers both a comprehensive *investigatory* and *explanatory* framework to better understand: *what* mechanisms drive multi-stakeholder process under a diversity of conditions, *why* these mechanisms arise and *how* they work. This research claims that a distinction between these two roles of complexity theory is important to be made. This researcher considers that the study of complex social dynamics will always require an investigatory approach capable of inducing the particular context and history specific dynamics embedded in every social change process. In other words, generalizations between different context-conditions would not be possible at this level of analysis when leading with complex social dynamics. For this role, this researcher considers that due to the shared nature of social change processes with other complex adaptive systems (CAS), complexity theory in general seems to be a suitable framework to provide analogies to investigate complex social dynamics. A lack of literature on the complex dynamics of social systems makes

however the task of explanation so far more limited. This is mainly due to the lack of scientific production on this subject matter. This research shows however that a new understanding on the particular functioning of complex social dynamics emerges from the application of complexity theory as an investigatory framework. Therefore, this researcher suggests that the advance of this new understanding and the creation of a structured framework of ideas are necessary to deal with social change processes and complex social dynamics in general. Finally, for the production of this new theoretical framework on complex social dynamics the deduction of patterns of behaviour from empirical evidences are necessary both for the purpose of theorising and guiding practitioners and policy makers. Finally, this research claims that the combination of these two roles – explanatory and investigatory, which is associated with the inductive and deductive perspectives used in this work, are necessary for the study of complex social dynamics.

The way this research has planned to validate the outcomes of this exploratory work comprise a theoretical (analytical design) and a practical dimension. At a theoretical level, this research has used a methodological design that first presents empirical evidence of inter-sector collaborative processes to then, draw out the complex mechanisms that can explain the empirical evidence (deductive approach). The degree of accuracy that this analysis matches the empirical evidences is a first stage of validation. A second validation is undertaken through the comparative analysis of the two case studies. While analysis shows a similar pattern in the dynamics, it also validates the applicability of this theoretical framework. Based on the outcomes obtained at these two stages of validation, this research corroborates that the concepts of complexity theory used in this work provide an adequate framework to investigate and explain social processes such as the construction of inter-sector partnerships. The practical dimension of this validation strategy is to use the pattern of ISP construction drawn from cross-comparison to support empirical action, as discussed below in discussing the practical implications of this research.

In relation to the applicability of transferring ideas from complexity theory to sociology, this research has shown that the social systems studied, despite exhibiting dissimilarities from other types of systems due to their human nature display properties and behaviour similar to complex adaptive systems. Therefore this research demonstrates that given certain preconditions (see chapter 3, measures to overcome the main criticisms of this transfer), the ideas of complexity theory can be transferred

to social systems. In this sense, this work provides two outcomes. First, it draws insights in relation to both the general behaviour of social processes as complex dynamical systems, and the specific functioning that this behaviour has due to the human and social nature of their components. Secondly, a better understanding of how complex social systems behave reveals the role multi-stakeholder processes play in the system dynamic. Based on these observations, it may be concluded that this research contributes to the literature of both complexity theory and inter-organization collaboration. An example of the first set of outcomes is provided below. However, due their large number, the rest are noted over the three analytical chapters (5, 7 and 8). The most significant ones of the second set of outcomes are briefly presented in this chapter.

A first major insight drawn from this research is that inter-sector partnerships represent a poised state in the dynamics of the system. As explained in chapter 3, a poised state is a local combination of actions or strategies such that each agent is locally happier as long as other agents do not deviate from their own fixed strategy, and therefore this action is considered optimal (Axelrod 1997; Kauffman 1993). Complexity theorists have proven that as the ecosystem climbs towards a poised state (or ESS equilibrium), agents' average fitness increases (Kaufmann 1993, 1995; Axelrod 1997). An example of poised state is the Mandú Alliance. This inter-sector partnership reflects a steady state in which all agents are at a local optimum. The payoff the Alliance members get might not be the best for a particular agent but each player is better off not changing his strategy as long as the other players' strategy remains unchanged. Based on the analysis of poised state in the two case studies this research argues that the state of partnership or collective agreement represents a poised state in the system dynamic.

Kauffman's calculation of fitness at the poised state is based on average values of the agents' fitness. The cases examined in this research show that better average fitness is more likely in early stages of a collaborative process. However, as the partnerships self-reinforce over time, higher absolute values of fitness can be found. This research argues that the calculation of average offers a static picture of a poised state or partnership and it is not representative of its dynamical evolution. The Mandú Alliance provides an example of how by working collaboratively agents' fitness moves from lower and variable values among its members, to higher values for all of them as the partnership consolidates. This shows how while average values are

always higher at a poised state than outside it, it does not provide an accurate measure of fitness in dynamical processes. This research suggests that a description of fitness through threshold values would represent a better indication of the behaviour of this parameter. An example of the implication of this calculation of fitness is to assess the outcome of collaborative strategies, as the higher the fitness of a larger number of agents the stronger the influence (attractor) the partnership has in the system dynamic. This research suggests that the evolution of fitness values over the collaborative process can be an indicator to assess the efficiency of a strategy.

These first insights provide answers to the questions formulated at the beginning of this research: Why do social agents seek to work collaboratively? And, What are the payoffs agents get from this strategy? The answer would be that inter-sector partnerships represent a strategy where a larger number of social agents have higher fitness as opposed to the strategy of working individually. Therefore to improve their fitness would be the agents' first driving force to engage in collaboration. From the case study we may conclude that the payoff agents get from inter-sector collaborations are: to gain an impact that goes beyond their individual capacity; to strengthen their capacities by learning from other agents; to reinforce their institutions by bringing in collaborative work; to gain visibility and credibility by working in partnership. These answers become particularly relevant to reinforce practitioners' inter-sector collaboration payoffs gain their transition costs particularly over time.

This argument is still reinforced by a better understanding of the role a poised state or partnership represent in the dynamic of the system where it is embedded. This leads to a second major insight from this research: multi-stakeholder processes represent a phase transition (Loorbach 2007) in the process dynamics towards the complex regime or edge of chaos. Kauffman (1993) refers to the idea of poised state discussed above as the complex regime or edge of chaos. He explains however that the complex regime or edge of chaos is just one of various possible co-evolutionary scenarios, being these: ordered regime, complex regime and chaotic regime. As concluded above, social agents would tend to search for partnerships as they represent a state of optimum fitness. However, *how* a set of agents or system reaches a poised state (partnership)? What forces drive systems towards the poised state or edge of chaos?

This research suggests that multi-stakeholder processes allow systems to transit towards the complex regime or edge of chaos as they enable self-organizing forces and other systemic properties to arise. These forces are: self-organisation, co-evolutionary dynamics, emergence and self-organised criticality. The contribution that this research makes in this regard is to provide details on the conditions necessary for this transition to occur under heterogeneous conditions (chapter 5 and 7); and by presenting a pattern (chapter 8) that explains how these forces interplay to enable the system to transit and eventually to be poised at the complex regime or edge of chaos. Additionally, this research shows that systems cannot naturally evolve to the edge of chaos unless the enabling conditions for this phase transition to occur are provided. Here, this research shows that the role of an external agent to provide resource for this transition is crucial. Furthermore, dynamics existing in the system can be enhanced (positive feedback) by the mechanisms of path-dependence and historicity preventing the system from attaining this evolutionary path, the edge of chaos (Arthur 1990). What is the relevance of a system to evolving towards the edge of chaos? The answer to this question stems from the final major insight of this research: multi-stakeholder processes increase the resilience capacity of the system driving the system towards the edge of chaos. The case studies investigated showed how the collective behaviour that is created as result of the multi-stakeholder process allows the system to increase its capacity to respond to internal and external changes (resilience), and to avoid being influenced by perturbations (robustness). Furthermore, the case studies also show how at a poised state or partnerships, agents are more able to innovate and perform more complex tasks, as illustrates by the innovations their actions bring to the system and the capacity they show by this.

These insights have important practical implications as they provide practitioners with a better comprehension of both 1) ISPs as a strategy that offers better fitness values despite their transitions cots; 2) the payoffs of ISPs increasing over time as the partnership gains influence in the system dynamic; 3) an ISP can also represent a transition for the system to higher fitness values as it enters the region at the edge of chaos. At this evolutionary regime, the system shows higher resilience, robustness, and capacity to innovate and perform more complex tasks. These insights can be crucial at different levels. At an organizational level, it provides an explanatory framework and tools for practitioners to reinforce their strategies to promote or improve inter-sector partnerships. This contribution is particularly relevant in the light

of current efforts that internationally are being made to raise the levels of response the most vulnerable populations groups but also locations have face natural disasters, climate change and other large disturbances that shake social systems, including financial crisis.

An example of insight in relation to the functioning of social processes as complex dynamical systems is in relation to the presence of regulatory forces in social systems. This research sheds light on how the process of 'gap formation' is related to the presence of complex cascades. As illustrated in both case studies, the process of gap formation results from a cascade of 'dysfunctions' produced by the dynamics responsible meet the needs of the population groups involved in these experiences - young groups of coastal communities (Brazilian case study) and water consumers in the Quito metropolitan area (Ecuador case study). However, lack of evidence from other disciplines, to the knowledge of this researcher, prevents this work from suggesting the ubiquitous nature of this relationship in social systems. Nevertheless, the practical implication of this insight would be to make practitioners aware of the process of creation in social systems.

A second example is in relation to how Kauffman's (1993) ideas on co-evolutionary processes converge with Bak *et al.*'s (1988) theory in two main respects, discussed in chapter 3. First, Bak and co-workers' study of avalanches demonstrates the same characteristic distribution between size scale and frequency that Kauffman proves to occur in co-evolutionary ecosystem, a power law distribution. In this sense, what Kauffman (1993: 255) refers as "packets" (Kauffman's punctuation) of co-evolutionary change, is similar to Bak *et al.*'s idea of the burst-like nature of avalanches. Secondly, for Kauffman (1993), avalanches are associated with fluctuations of low fitness, reason why they may engender both extinction and speciation events. Extinctions events would be expected because of low fitness, while specialization events might be expected at low fitness according to the number of directions of improvement. The convergence of these authors' ideas is crucial to explain the presence of self-organized criticality behaviour in the complex social systems of study.

In relation to the subsidiary research question: How do agents' institutional background influences their pathways towards collaborative work? Chapter 5 and 7 were designed also to address this research question. This question was intended to address i) the processes that occur with all types of agents as a result of collaborative

dynamics; and ii) the specific processes, if any, that occur within each type of agent or social sector: public, private, non-for-profit and academia. This research shows that a sectoral approach to the analysis of social dynamics is not adequate anymore as the innumerable types of legal figures and roles organizations have nowadays blur the traditional boundaries of social sectors. The two case studies reflect this diversity of new social actors, such as public enterprises (EMMAP-Quito), non-profit organizations funded by corporations (Floravida Institute- Brazil) or private funds (CARE Brazil), State research centres (EMBRAPA-Brazil), academia (Piauí University-Brazil), academia as a community development agent (Salesian University-Quito), and the like.

Despite this fact, this research shows how several institutional conditions influenced agents' behaviour in their journey towards collaborative work. As noted in chapter 5 and 7 these are: institutional culture, institutional language, internal communication policy and mechanisms, governance structure (hierarchical structure and decision making), and geographical distribution. Both case studies show how these elements influenced the agents (institutions) capacity to adapt to the demands stemming from the multi-stakeholder processes. These variables have to be considered, however, according to the particular conditions of the collaborative process as they show different degrees of values; hence, they can produce dissimilar outcomes. Ultimately, these variables determine the capacity of the institutions to perform a new role under the collective agreement, to play multiple roles (the original of the institution and the collective one) while maintaining institutional independence, are necessary attributes organizations need to be able to work collaboratively.

Based on these variables two patterns of behaviour can be drawn from the case studies. A first pattern of behaviour is that those institutions which are further away from the subject of collaboration; showed more divergent values, institutional mechanisms and hierarchical structure; and were geographically more distant, and were those that went through more challenging processes of adaptation to engage and remain in a collective agreement. Examples of these in the Brazilian experience were EMBRAPA (research centre) and Piauí University. In the Ecuadorian case study, these were the EMAAP-Q and all governmental agencies. A second pattern of behaviour is agents' individual attitudes (capacity to introduce changes) and attributes (internal capabilities and resources), which determine agents' specialization process. As noted before this specialization process varied mainly in relation to the role of the

agent and the topic of collaboration, the personal and institutional background and the collaboration culture. Here the variables common to both case studies are: learning capacity, age, communication skills, degree of responsibility within the institution, connectivity of the agent within the institution and credibility. These variables also influenced the capacity of individual agents to introduce changes within their own institutions.

The practical implication of this analysis by sector contributes first to providing a better understanding of the challenges, processes and mechanisms agents face to engage in collaboration according to their particular institutional background and internal composition. Secondly, organizations can use the variables that influence agents' specialization processes presented above to plan the necessary actions, both at an institutional level and an individual level, to work collaboratively. A final contribution is the practical scenarios provided by the two case studies, which can support organizations to improve their strategies by drawing on other experiences and lessons learnt.

The second research question is: What are the generic principles that contribute to the construction of inter-sector partnerships from a complex dynamical systems theory? This question aims at drawing out a common pattern of the construction and evolution of inter-sector collaborations, and the complex mechanisms that drive this pattern.

Chapter 8 presents the pattern and analysis that provides the answers to this research question. This pattern shows how despite the differences between case studies, the construction of ISPs share common generic principles. These generic principles refer to the properties, complex mechanisms and sub-processes systems need to exhibit to create inter-sector partnerships. This chapter demonstrates therefore that systems that display certain conditions can be tuned or geared for certain behaviour (complex mechanisms) to arise. Provided there are no major internal or external disturbances in the system, this behaviour would eventually lead to the emergence of collective behaviour and partnerships. To attain the state of partnerships, this chapter noted that this construction process presents various stages, which are regulated by several complex mechanisms and sub-processes. The empirical evidences investigated in this research show a construction process of five stages. This section briefly presents these stages and main principles that drive them in order to assess their potential practical implications.

The first stage of this process refers to the transformation of the gaps created in the system by existing dynamics[111], into niche opportunities for new dynamics to arise. The main generic principles that influence this stage are 'tag and match formation', connectivity, social capital and 'bridge agents' (Watts 2003; Holland 1995; Ostrom and Ahn 2003). In practical terms, this first stage is crucial for practitioners to perceive that a gap in the system needs to be transformed into a 'niche opportunity' for an agent to be able to survive in it. Furthermore, this stage shows that due to the way complex adaptive systems evolve, any strategy would eventually leave gaps in the system as the system conditions are in continuous change. This is particularly relevant to policy makers in the definition of social policy that seek to attain whole populations. This stage is also crucial for shedding light on the *system conditions* that influence the transformation of gaps into niche opportunities (connectivity of the system, agents' perception of the existing gap and potential opportunities, and the like), and the *resources internal* (social capital, agents' attributes) and *external* to the system that can be mobilized for a particular purpose. The role of an external agent seems to be an effective strategy at this stage, as illustrated in the case studies.

The second stage of this pattern refers to the rise of a new agent (multi-agent) to occupy this niche opportunity. Agents' connectivity in the system network structure, inter-connectivity, match formation and emergence are the main principles that drive this state. The pattern shows the connections the new agent has within the new niche is crucial to leverage resources to occupy the new niche and to build the level of inter-connectivity necessary for the new agent to emerge. 'Match formation' (Holland 1995), measured in terms of shared interests, is the main principal for this inter-connectivity to increase. In practical terms, this stage is crucial to defining the strategy to occupy a niche opportunity, which will ultimately produce collective agreement and work. To guide this design, the case studies illustrate various possible strategies to occupy a niche opportunity, their outcomes and how these outcomes influenced to achieve the ultimate goal of inter-sector partnerships.

[111] This analysis referred to 'dysfunctional dynamics' however this is a subjective appreciation of the particular situation agents encountered in the case studies examined in this work. Gaps are always created in the system as dynamics evolve (Kauffman, 1993), so in that sense all dynamics always turn 'dysfunctional' over time as system conditions change.

The creation of a multi-stakeholder process (collective dynamic) in the system is the core of the third stage of this construction pattern. Both case studies showed the fundamental importance that having a multi-stakeholder process over a minimum period of time had for the construction of multi-stakeholder partnerships and the subsequent influence these had in the system dynamic. An important insight from this research is, however, that these processes need to be structured and conducted under certain conditions for collective outcomes to emerge. The importance of these conditions, referred to in this research as 'enabling conditions', lies in the fact that they allow the mechanisms of self-organisation and co-evolution, to arise in the system dynamics. As these mechanisms self-reinforce over time, they shape the system network structure (number and strength of coupling) and produce an aggregative outcome: collective behaviour. In practical terms this explains the differences between inter-sector partnerships that can be found in society and the different outcomes they produce. Many organizations that work in partnership or promote them have the same questions (Porter 1985; Austin 2000): What are the differences between the type of partnerships we observe?

A fourth stage of this pattern is the level of collective behaviour and the influence it can have in the system dynamics. A major insight from this research is that the construction of collective behaviour represents the creation of a new dynamic in the system and that it is from this new dynamic that inter-sector partnerships emerge. This is collective behaviour as any aggregative process presents threshold values. As a critical point in these values is crossed, inter-sector partnerships would eventually emerge. A crucial feature of this stage is that as collective behaviour represents a new dynamic in the system it opens up a new evolutionary path in the system dynamic. The Quito case study provides an example to illustrate the last point. This experience shows how, even though a collective agreement or partnership had not been achieved yet, the multi-stakeholder process had created a new dynamic in the system (collective behaviour) that was influencing the systems dynamics in different ways (partnerships such as National Council of Water Councils; structural changes such as the Constitution reform; and the like). These are steps towards a new evolutionary path.

Other outcomes (systemic properties) that emerge at this stage in the creation of an inter-sector partnership is its increasing capacity to 1) respond to internal and external perturbations or disturbances (resilience and robustness) and adapt to them;

and 2) perform more innovative and complex tasks. An example of the later is the tasks of collaboration the case studies explored envisage: an integrated water management plan (Ecuador) and integrated programmes in the field of Education, Citizenship and Income Generation (Brazil). Again, these systemic properties present threshold values due to the aggregative nature of the underlying dynamic.

These four stages can have significant implications for practitioners by providing a framework to create awareness of the construction of collaborative dynamics and multi-stakeholder partnerships. This pattern, its stages and principles, also provide practical guidelines to support organizations to consider the crucial elements in their strategy design. As noted before, the case studies provide examples of various strategies, outcomes and influence in the system dynamics that can support organizations' strategy design. Furthermore, the key aspects within this pattern can also be used by organizations as indicators to both monitor the progress of their strategies and better manage their impact assessment. For instance, an indicator to identify that the system has entered the region of collective behaviour is that agents involved in the multi-stakeholder process start finding that their individual fitness is higher by acting collectively rather than individually. Finally, to gain awareness of how multi-stakeholder processes build higher capacity in terms of resilience, robustness, complex tasks and innovation capacity, is particularly relevant for organizations working in the fields of Sustainability, emergency, climate change mitigation, and other capacity building strategies.

This research demonstrated that the rise of the generic principles that ultimate drive inter-sector partnerships require constant specialization and adaptation at an agent level. An insight that has practical implications in this regard is the evidence that specialization occurs in two dimensions: 1) in relation to the actual task of collaboration; and 2) to the qualitative aspects of working collaboratively (learning capacity, attitude, and the like). Organizations can benefit from this insight and the variables that determine agents' specialization process(es) noted above, by selecting agents that show attributes more attuned with these variables and by planning actions oriented to reinforce agents' specialization in these two dimensions. This would ultimately improve the efficiency of strategies to promote inter-sector partnerships.

A final stage of this pattern concerns the way the changes stemming from multi-stakeholder processes percolate the system influencing its dynamic. This research showed how self-organized criticality through complex cascades is the

principle that regulates the percolation of change in the system. The attraction role the new dynamic plays in the system and the connectivity the system displays are the mechanism and property that determine the dynamics of this generic principal. In practical terms, these insights can shed new light for organizations to better understand how change can be scaled up and design strategies accordingly. At the light of this research, a major component of these strategies should be to reinforce the connectivity between the source of action and their beneficiaries or target groups.

This pattern represents then a theoretical and practical contribution of this research. At a theoretical level, it has demonstrated that common principles operate at a generic level in complex social systems. Furthermore, it has shown that these principles seem to behave similarly in the social system examined as they do in the complex adaptive systems from where theories originate. These findings contribute to advancing the literature on both complexity theory and inter-organization collaboration theory. At a practical level, this pattern offers a tool for understanding how the various stages in the construction of inter-sector partnership build upon the former ones, creating its aggregative nature and that of its outcomes. Furthermore, this pattern provides the generic (complex) principles, main contextual variables and systemic properties that influence each of these stages. Moreover, the definition of these stages is also intended to warn practitioners that they represent 'bifurcation points'[112] in the construction of inter-sector partnerships. In practical terms this means that various strategies are possible at each stage of this process. However their outcomes can hinder this aggregative process, as observed in the two case studies examined in this work. Therefore, this tool aims to signal the various strategies necessary for the construction process to unfold towards the ultimate goal of creating inter-sector partnerships. However, and this is a big however, it is important to note that this pattern is in relation to the specific type of multi-stakeholder collaborations and partnerships investigated in this work, defined in chapter 3. As explained above, the more diverse the systems conditions are from the ones used to create this pattern, the more dissimilar the outcomes of these generic principles would be therefore the construction process could vary.

This brings this thesis to its final conclusion, the main argument used for the selection of this research approach. The fact that since societies and social processes

[112] This term is used in the sense used by Mitleton-Kelly (2003a: 11), as "the splitting of possibilities into two alternative paths".

behave as complex dynamical systems both theory and practice require new approaches capable of dealing with, explaining and guiding practice accordingly. This means a fundamental paradigm shift from traditional theoretical approaches that address parts of the system without grasping the emergent behaviour of the whole. As Kauffman (1993: 351) states "There is no mystery in the resulting holism. Turn it into pieces and the system is dead".

In this cue, this research has moved away from the traditional research and methodological approaches in the field of study, inter-sector partnerships, and has designed a methodology intended to explain their complex dynamics. This methodology strategy is based on the deduction of common patterns of behaviour from empirical evidence, and their complex principles. This work has demonstrated that the study of social processes requires a research approach capable of: 1) looking at interactions between the system dimensions and components: cultural, political, economic, environmental, but also, governmental agencies, corporations, research centres, and community groups, to mention but a few; 2) looking across the multiple levels of the system, international, national, regional, local and other intermediaries level; and 3) explaining how the interrelations between the these levels play out differently in dissimilar contextual conditions and historical paths. This research approach also requires specific data collection methods capable of explaining the multiplicity of narratives, perspectives, needs, types of knowledge, languages, vested interest, conflicts and the like the system displays. This research has named this methodology strategy as 'qualitative dynamical models'. This methodology provides a framework intended to advance further theory and practice in an intertwined dynamical construct. At a practical level, the next step would be then to use the pattern drawn in this research to guide practitioners in their pursuit of creating, reinforcing and advancing inter-sector collaborations. At a theoretical level, the next step would be to test the applicability of this methodology to the study of other social processes and context-conditions that influence complex dynamics.

Practical Implications of this Research Approach at a Policy Level

This research presents a theoretical approach that represents a fundamental shift from traditional approaches to the study of inter-sector partnerships and social dynamics in general. It argues that traditional approaches are as varied and deeply rooted as the

traditions of social and political science in which they are embedded. They conceive the idea of a policy-maker or a manager as an external designer and even a model of society that can be applied to all situations, as they draw on the notion of a single balance in nature (Leach *et al*, 2010; Stacey 2007). In contrast to this approach, complexity theory offers a distinct and complementary approach to science. One that identifies the rules of interaction between agents in a system that instead of trying to control the variability of society with a single model, offers responses on how to adapt to and respond to it (Loorbach 2007; Leach *et al.* 2010; Rihani 2002; Stacey 1995). In this sense, this research demonstrates that the study of the complexity of inter-sector partnerships can be made without breaking the system into different domains of enquiry.

In relation to policymaking, this research contributes to addressing the following questions: what models of governance enable the system to reach states of optimum adaptability and complex behaviour? And what are the dynamics and values that comprise these models? This research argues that to answer these questions a new approach by policymakers is needed. Leach *et al.* (2010) propose an alternative approach to the politics of Sustainability based on the vision of policymaking as a process and based on the understanding of societies as complex dynamical systems. Here the authors describe this process as 'incremental, messy and complex', whose implementation involves discretion and negotiation', where 'technical experts and policy makers mutually construct policy' (Leach *et al.* 2010: 128). For them, this requires an understanding of more complex underlying practices of systems framing and of the mechanisms of decision-making and implementation.

This research also makes also a contribution to governance models based on multi-stakeholder processes by providing a better understanding of *how* these processes work, *why* organizations from different sectors engage into collaborative work and what are they main payoffs. That is, this research offers not only a framework for the study of inter-sector partnerships but also a reference point for how collective behaviour and processes are built. It shows that these processes are aggregative dynamical constructs; driven by mechanisms that are context-specific; that can be geared towards certain outcomes; and where managing internal and external perturbations is key for success. Furthermore, this research contributes to better understanding *what* influence these processes can have on the system where they are embedded, core aspect of governance models. In turn, this work is also a

reference work for policymakers to envisage how to reach more resilient and robust states, where payoffs are more equally shared by a higher number of parties, the complex regime.

This research reflects the view of Leach *et al.* (2010) on policy making as a process in which problem discussions, policy definition and implementation are intertwined, instead of existing in clear separate stages. It also reflects that policymaking and practice are interrelated and in constant dialogue. This points to a model of policymaking capable of responding to the social needs in a more efficient way, with more inclusive and representative responses. Particular examples of this approach to policymaking can be observed in this research. The Brazilian experience illustrates a case were public agents are integrated in the Mandú Alliance's programmes: Education, Citizenship and Income Generation. This means public policy is involved with other agents' agendas; visions are shared both in relation to the problems, needs and solutions; and priorities, execution and responsibilities are decided mutually.

Limitations of this Research

Some obstacles both at a theoretical and methodological level have been found in applying this research approach that might mirror the limitations of this work. The first one refers to the difficulty of grasping ideas in the theory of complexity. Many authors state that complexity theory is not a single theory but a set of theories and concepts that study the dynamics of systems that display complex behaviour (Mitchell 2009; Waldrop 1982; Lewin 1999). This makes the task of investigating the theoretical concepts that underpin this work an arduous task. This is aggravated by the multiple disciplines, languages and concepts that nourish the theory of complexity, which have developed various schools of work within this new scientific domain (Reynoso 2006; Mitleton-Kelly 2003a). This multi-disciplinarity has made the task of searching for the conceptual frameworks that explain the dynamics observed in social system a kind of 'treasure hunt'. An example of how research from different disciplines refer to the same property of complex system is noted in chapter 3 in relation to the convergence Kauffman's (1993) and Bak *et al.* (1988) make to refer to the same phenomena despite using different terms.

The deductive approach that has guided this work has made the exercise of literature review more focused on the concepts or mechanisms that were drawn from the data analysis. Time constrains of the thesis completion and the difficulties noted in this section have however limited a more extended revision of literature on the insights of this research. A final obstacle encountered at a theoretical level is regarding the proliferation of works that apply the concepts of this increasingly popular complexity theory in an opportunistic and superficial manner (Stacey (2007). This makes the transfer of insights from other applications of complexity theory to this research a risky exercise. Given the lack of references in the literature of the use of complexity theory to this research topic, this work has opted for focusing in the original sources of complexity theory and including measures to overcome the main criticisms that the transfer of complexity ideas to sociology has received (Stacey 2007; Sawyer 2005: Castellani and Hafferty 2009).

A second major difficulty in applying this research approach has been found at a methodological level. This refers to the difficulty this researcher had in finding tools that account for collecting and representing the multiple agents, variables and perspectives that influence a complex, dynamic and multi-dimensional subject of study. In relation to data collection, Chapter 3 discussed the set of methods and strategies necessary to apply a complex systems approach for data collection, and presented the main difficulties encountered during fieldwork. These referred to having access to necessary resources for data collection (large rooms with large walls, electricity), having access to all the multiple perspectives of the subject of research, avoiding interfering in the processes of study, being able to manage the conflicts that arise, having sufficient time to complete the discussion of the process, and the like.

The exploratory nature of this work in using a mix of qualitative methods for the study of complex dynamics despite the references in the uses of group dynamics (Leach *et al.* 2010; Stacey 2003) and the limitations of the tools used, such as cards, types and colours, represent two obstacles at a methodological level. The limited number and difficulties encountered with tools that allow representing the data collected for the purpose of sharing them during fieldwork, academic work and future applications of this research, represent another limitation of this work. In this respect, despite the limitations in representing complex dynamics, the software Netlogo was used to create a map of the complex dynamics of study. However, the need of any user to buy a version of this software to be able to open the map files, and the size of

the printed copy of these maps, limited the task of representing and sharing the outcome of this thesis. Further advanced computing tools for representing would have helped to overcome these limitations.

Lines for Future Research

In terms of future lines of research, this work claims that caution is necessary in the advance of complexity theory in the social sciences. The spread of modelling tools to 'demonstrate' certain behaviours of complex systems, also known as 'toy models' (Ramalingam 2009) is putting at risk a more challenging and necessary approach to 1) deduce complex social behaviour from real life experiences, and 2) the application of a complex systems' perspective by practitioners of all kinds. Following this rationale, the use of complexity theory as an explanatory approach around topics of primary social interest, and not of other institutional agenda (Leach *et al.* 2010; Reynoso 2006), is necessary to advance the understanding of the complex behaviour and dynamics of our current societies. In this venture, a better comprehension of the principles, processes and variables, that according to each particular social context, drive certain patterns of behaviour can contribute to advancing both new theoretical models on complex systems, and tools to support the actions of policy-makers and practitioners, as intended in this research.

A specific gap that requires further research is the dynamics of attractors and complex avalanches in social systems. This is particularly relevant to advancing understanding on how change percolates across the system, and how this influences and shapes system behaviour at its different levels (macro, meso and micro). A clear understanding of this would be particularly relevant for impact assessment in any field of praxis.

Further research is also necessary to understand phase transitions between different types of complex regime (ordered, complex and chaotic) in social systems. This research contributed to understanding how social systems can exhibit different behaviours at the same time. Also, that transition among these regimes is not linear; that is, social systems can shift from an ordered to a chaotic regime without crossing the intermediate state of complex region or edge of chaos, as observed in the Quito case study. But is an ordered regime or a chaotic regime good or bad? What aspects is this related to? This research claims that a better knowledge of phase transitions in

social systems and of the social implications of the different types of regimes, are particularly relevant topics from a perspective of Sustainability. That again is of practical and scientific concern as it would enable a better understanding of the consequences of intended or unintended scenarios, manage risk and uncertainties.

Research is needed in the specific area of ‘edge of chaos’, as this seems to be the state of optimum behaviour of complex systems. This research has contributed to better envisaging how to attain this state in social systems. However, further research is necessary to know how and why social systems move from this regime to a chaotic regime, as noted by Lewin (1999). Finally, research is required in relation to the methods for data collection and appraisal (policy making) that derive from further application of complexity theory both to theory and practice.

Appendix 1

Example of Questionnaire for Participatory Enquiry

- ✓ What is the process and topic of research?
- ✓ What key actors are involved in the process?
- ✓ What are the roles of these actors in the system functioning?
- ✓ How the main problem affects these actors?
- ✓ Who are the actors more affected in the process?
- ✓ What are there specific framings of the problem and of the system dynamics?
- ✓ What are the actors less represented or heard in the causes of the problem?
- ✓ And in the multi-stakeholder discussion?
- ✓ What were the main events that influenced the process so far?
- ✓ What were the main difficulties and challenges of these events?
- ✓ And the strengths of these events, process or actors?
- ✓ What are the main causes of these events?
- ✓ What have been the main strategies to overcome them?
- ✓ What influence have these events had in the system functioning?
- ✓ What were and are the main conflicts among the actors?
- ✓ What strategies have been used to overcome these conflicts?
- ✓ What were and are the main risks or threats to the process and its goals?
- ✓ What are the main enabling elements of the multi-stakeholder discussions?
- ✓ What are the internal or external conditions- from any dimension and level of the system- that can potentially or indeed affect the process development?
- ✓ Can these conditions (internal or external) be controlled? How?

Appendix 2

Example of questions for Semi-Structure Interviews

- ✓ Which are the reasons for searching to build-up a partnership between your organization and the other two sectors (government, corporations or civil organizations)?

- ✓ Which are the organization's expectations from this partnership process?

- ✓ Which are the actions taken so far to build up the partnerships?

- ✓ Which were the opportunities coming either from the contest or the organization, on which the partnerships is based? Why do these opportunities arise?

- ✓ Which constraints have been found so far? Why are there such constraints?

- ✓ Which constraints are envisaged for future stages of the partnership? Why?

- ✓ What is the strategy of the organization for addressing those constraints and opportunities found so far to build the partnerships relationship?

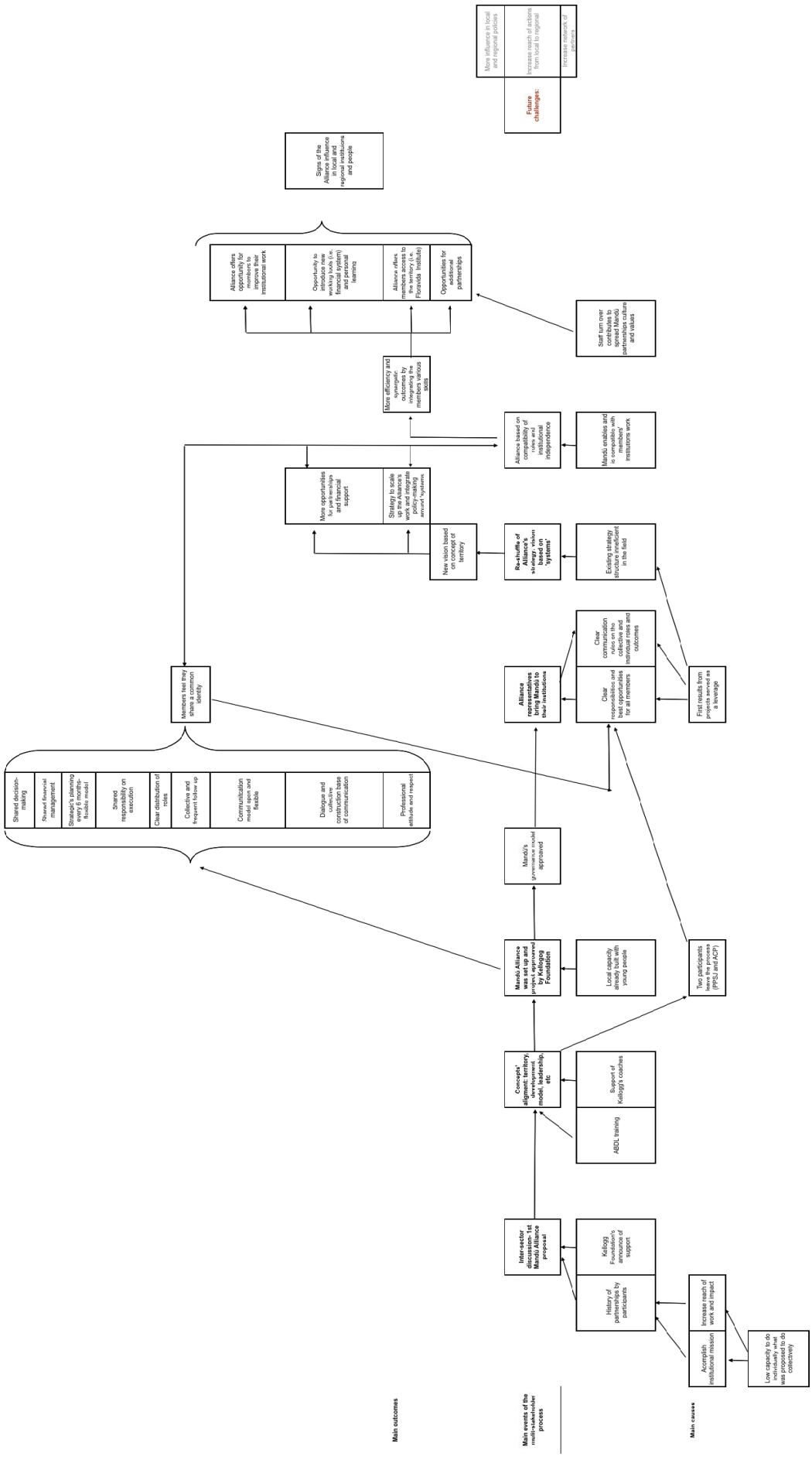
- ✓ Which are the risks of this strategy: cost, image, etc? If applicable, what are the lessons learnt from the former experiences?

- ✓ What would you like to know from other inter-sector partnerships successful experiences: lessons learnt, strategy, key factors of their processes, main tools, etc?

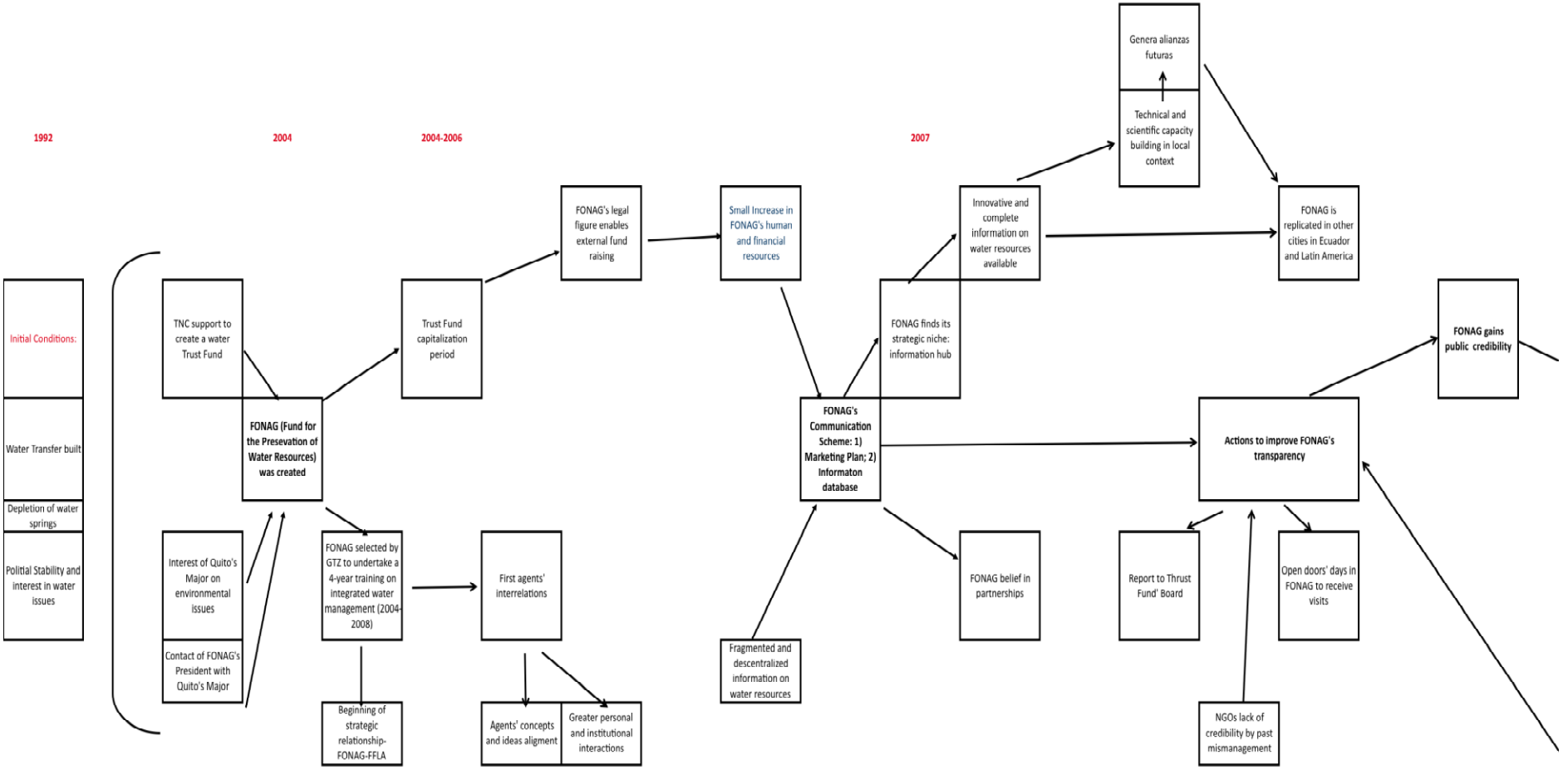
- ✓ Would you be interested in knowing about challenges faced by other organizations in building up ISPs? (Yes/No) Why?

- ✓ Would you be interested in knowing about these research outcomes in order to assess the interest and efficiency in supporting your own challenges? (Yes/No) Why?

Appendix 3- Mandú Alliance Case Study: Common Process of Inter-sector Collaboration



Appendix 4- Quito Case Study: Common Process of Inter-sector Collaboration



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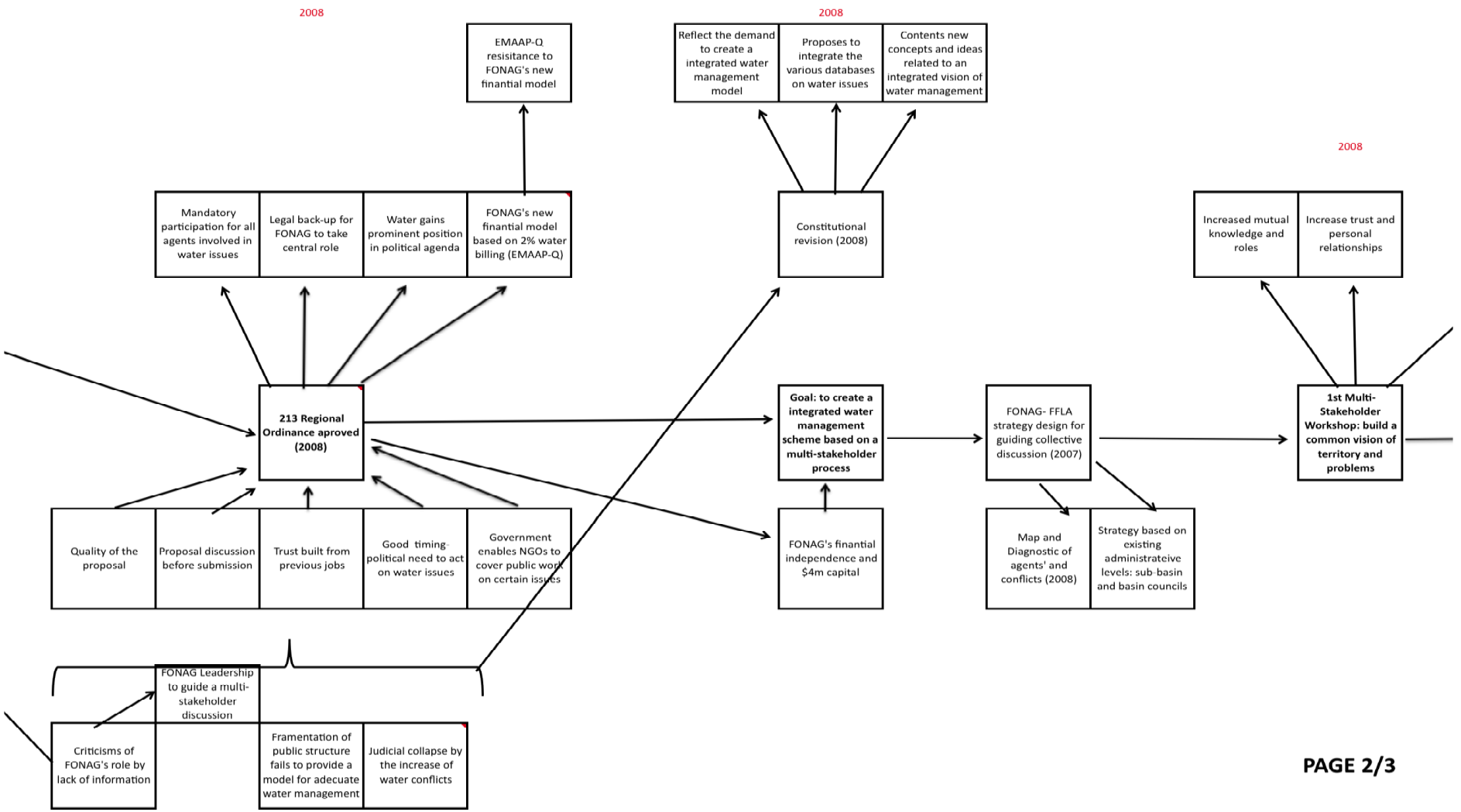
2008
EMAAP-Q resisitance to FONAG's new finantial model
2008
Reflect the demand to create a integrated water management model
Proposes to integrate the various databases on water issues
Contents new concepts and ideas related to an integrated vision of water management
2008
Increased mutual knowledge and roles
Increase trust and personal relationships
Mandatory participation for all agents involved in water issues
Legal back-up for FONAG to take central role
Water gains prominent position in political agenda
FONAG's new finantial model based on 2% water billing (EMAAP-Q)
Constitutional revision (2008)
213 Regional Ordinance aproved (2008)
Goal: to create a integrated water management scheme based on a multi-stakeholder process
FONAG- FFLA strategy design for guiding collective discussion (2007)
1st Multi-Stakeholder Workshop: build a common vision of territory and problems
Quality of the proposal
Proposal discussion before submission
Trust built from previous jobs
Good timing- political need to act on water issues
Government enables NGOs to cover public work on certain issues
FONAG's finantial independence and $4m capital
Map and Diagnostic of agents' and conflicts (2008)
Strategy based on existing administrateive levels: sub-basin and basin councils
FONAG Leadership to guide a multi-stakeholder discussion
Criticisms of FONAG's role by lack of information
Framentation of public structure fails to provide a model for adecuate water management
Judicial collapse by the increase of water conflicts

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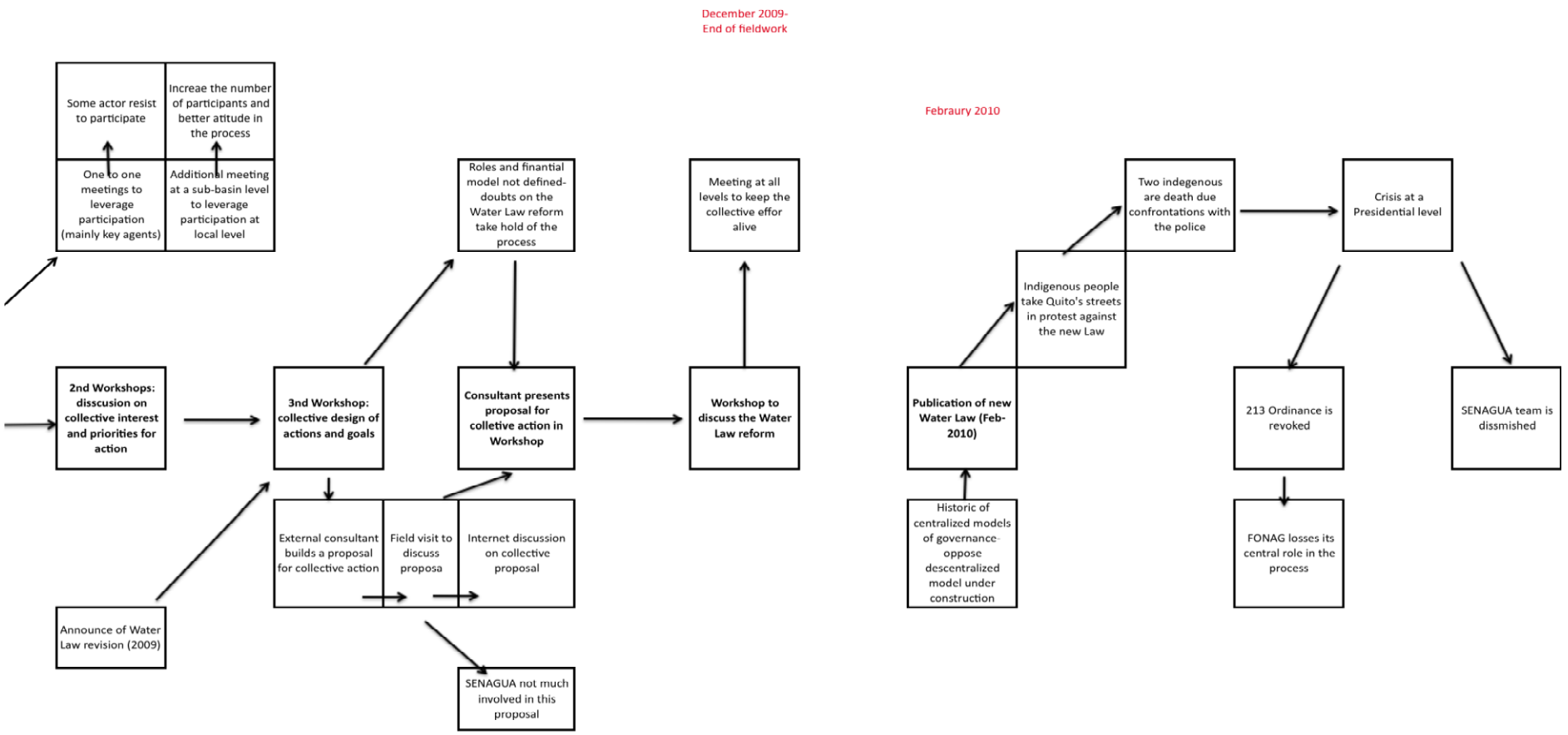
December 2009-
End of fieldwork
Some actor resist to participate
Increae the number of participants and better atitude in the process
One to one meetings to leverage participation (mainly key agents)
Additional meeting at a sub-basin level to leverage participation at local level
Roles and finantial model not defined- doubts on the Water Law reform take hold of the process
Meeting at all levels to keep the collective effor alive
2nd Workshops: disscusion on collective interest and priorities for action
3nd Workshop: collective design of actions and goals
Consultant presents proposal for colletive action in Workshop
Workshop to discuss the Water Law reform
External consultant builds a proposal for collective action
Field visit to discuss proposa
Internet discussion on collective proposal
Announce of Water Law revision (2009)
SENAGUA not much involved in this proposal
Febraury 2010
Two indegenous are death due confrontations with the police
Crisis at a Presidential level
Indigenous people take Quito's streets in protest against the new Law
Publication of new Water Law (Feb-2010)
213 Ordinance is revoked
SENAGUA team is dissmished
Historic of centralized models of governance- oppose descentralized model under construction
FONAG losses its central role in the process

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Appendix 5 - Interviews Agenda and Methods from Fieldwork

Case Study- The Mandú Alliance (Brazil)

Research Assistant- Ramiro (Mandú Alliance)

Names of Interviewees	*Number of Interviewees*	*Number of Interviews*	*Interview Method*
Instituto Floravida	2	1	Group Interview (participatory method)
Embrapa	2	1	Group Interview (participatory method)
CARE Brazil	2	1	Group Interview (participatory method)
UFPI- Piauí Federal University	3	1	Group Interview (participatory method)
SEMAR- Environment and Hydrological Resources Se	1	1	Semi-structure interview
EcoAdventure	1	1	Semi-structure interview
PPSJ- Susana Jácobs Chilcare Post	1	1	Semi-structure interview
Aliança Mandú staff members	3	3	Semi-structure interview
Project beneficiaries- Sweets Cooperative	2	1	Semi-Structure Group Interview
Local communities- Bairro Vermelho Community	2	1	Semi-Structure Group Interview
Local communities- Barra Grande Community	4	1	Semi-Structure Group Interview
NGO Peixe Boi	1	1	Semi-structure interview
Inter-sector Workshop	6	1	Group Interview (participatory method)

Total Number of interviewees- 24	**Group Interviews (Participatory Method)- 5**	
Total Number of Interviews- 16	**Semi- Structure Interviews- 7**	
	Semi-Structure Group Interviews- 3	

Appendix 6 - Interviews Agenda and Methods from Fieldwork

Case Study- An Integrated Water Management Plan for Quito

Research Assistant- Celsio (FONAG)

Names of Interviewees	*Number of Interviewees*	*Number of Interviews*	*Interview Method*
FONAG (Fund for the Preservation of Water Resources)	6	1	Group Interview (participatory method)
Corporation Randi Group	2	1	Semi-Structure Group Interview
Universidad Politécnica Salesiana (Cayambe).	1	1	Semi-structure interview
El Pisque' Irrigation Council	1	1	Semi-structure interview
FFLA (Foundation for the Future of Latin America)- Technical Assistant to process	1	1	Semi-structure interview
FFLA (Foundation for the Future of Latin America)- Responsible for process	1	2	Individual Participatory interview
Ayora Drinking Water Council	1	1	Semi-structure interview
Mejía Municipality- Environmental Sanitation Director	1	1	Semi-structure interview
Secretariat for the Environment	2	1	Semi-structure interview
MIDUVI- Ministry of Urban Development and Habitation	1	1	Semi-structure interview
SENAGUA (Water Secretariat)- Quito Municipal District Unit	1	1	Semi-structure interview
EMAAP-Q (Quito Public Enterprise for Water Supply)- Environmental Sanitation Programme Director	1	1	Semi-structure interview
Tambillo Drinking Water Council	0	No-shown	NA
SENAGUA (Water Secretariat)	0	Flight delayed- meeting canceled	NA
Floral and Bottling companies	0	Invitation refused	NA
Inter-sector Workshop	5	1	Group Interview (participatory method)

Total Number of interviewees- 19	**Group Interviews (Participatory Method)- 2**	**Semi-Structure Group Interviews- 1**
Total Number of Interviews- 14	**Semi- Structure Interviews- 9**	**Individual Participatory interview- 1**

Appendix 7

Pictures from Field Work

Picture 1: CARE Brazil members also participants of the Mandú Alliance.

Picture 2: Piauí Federal University members also participants of the Mandú Alliance.

Picture 3: EMBRAPA members also participants of the Mandú Alliance.

Picture 4: Inter-Sector Workshop with participants from CARE Brazil, Federal University, Floravida Institute and EMBRAPA.

Picture 5: Visit to Sweet Cooperative- one the Projects supported by the Mandú Alliance.

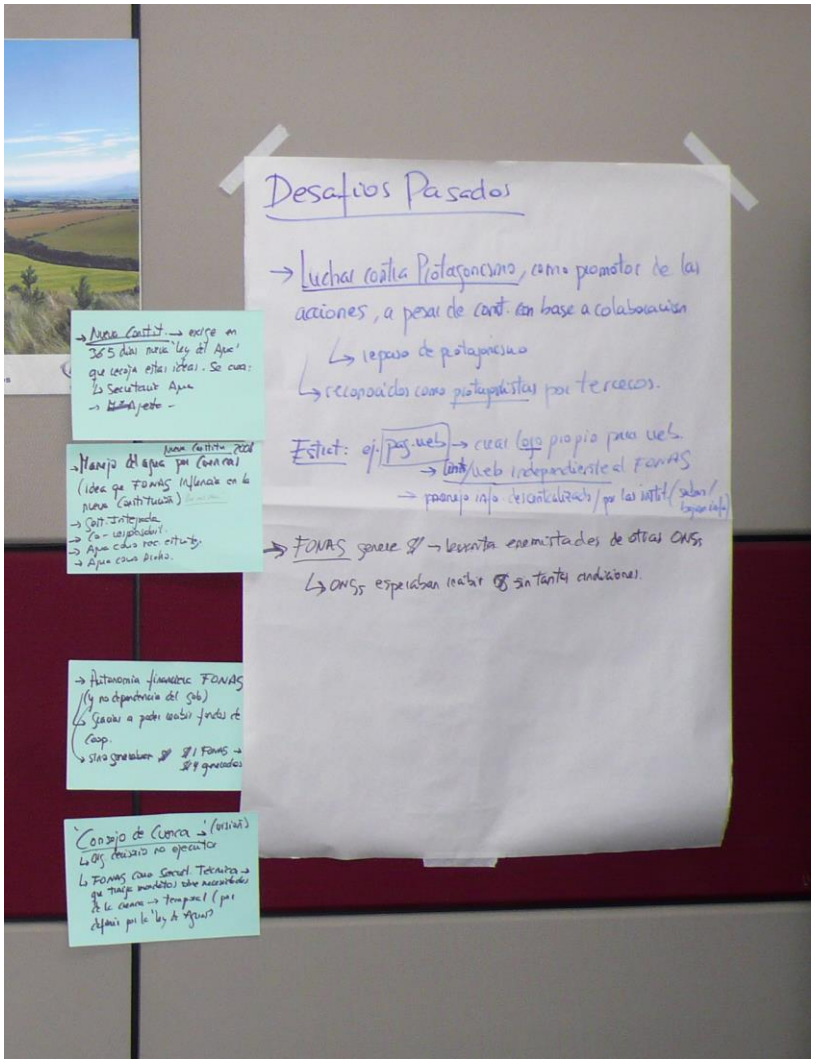
Picture 6: Research Assistance presentation during Inter-Sector Workshop.

Picture 7: Researcher facilitation during Inter-Sector Workshop.

Picture 8: Coastal ecosystem around the communities visited.

Picture 8: A Mandú Alliance logo and communication panel

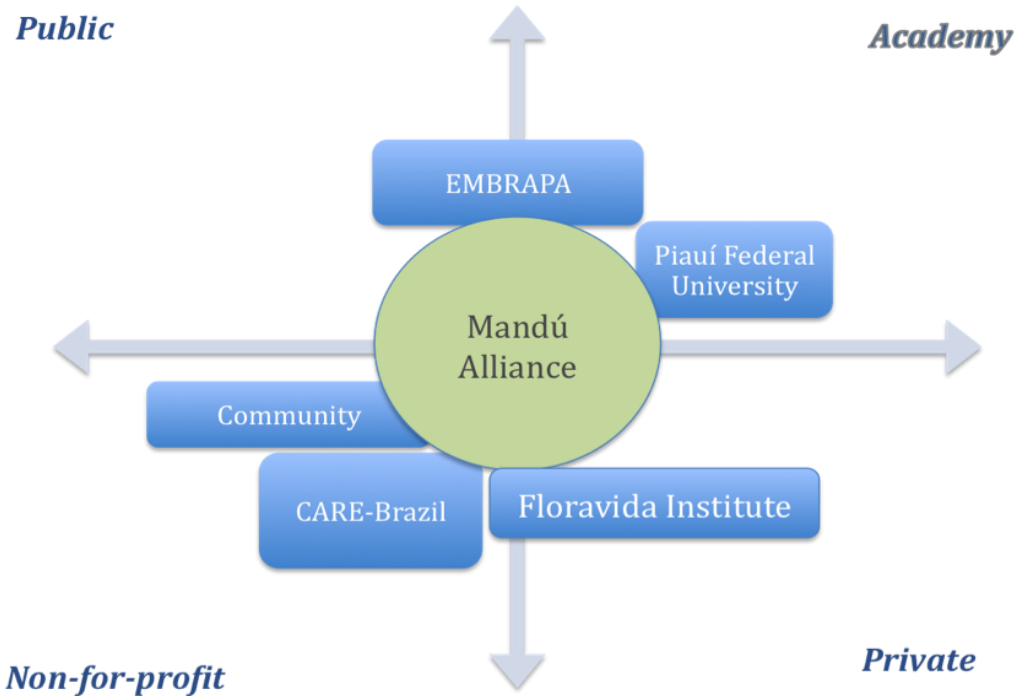
Picture 9: Outcome from FONAG's Sectoral Workshop



Picture 10: FONAG's challenges in the multi-stakeholder process

Appendix 8

Organizational Chart of the agents involved in the Mandú Alliance Case Study



EMBRAPA Brazilian Public Research Enterprise for Agriculture and Livestock

Flora Vida Institute Local branch of the chemical company, Vege Flora Group.

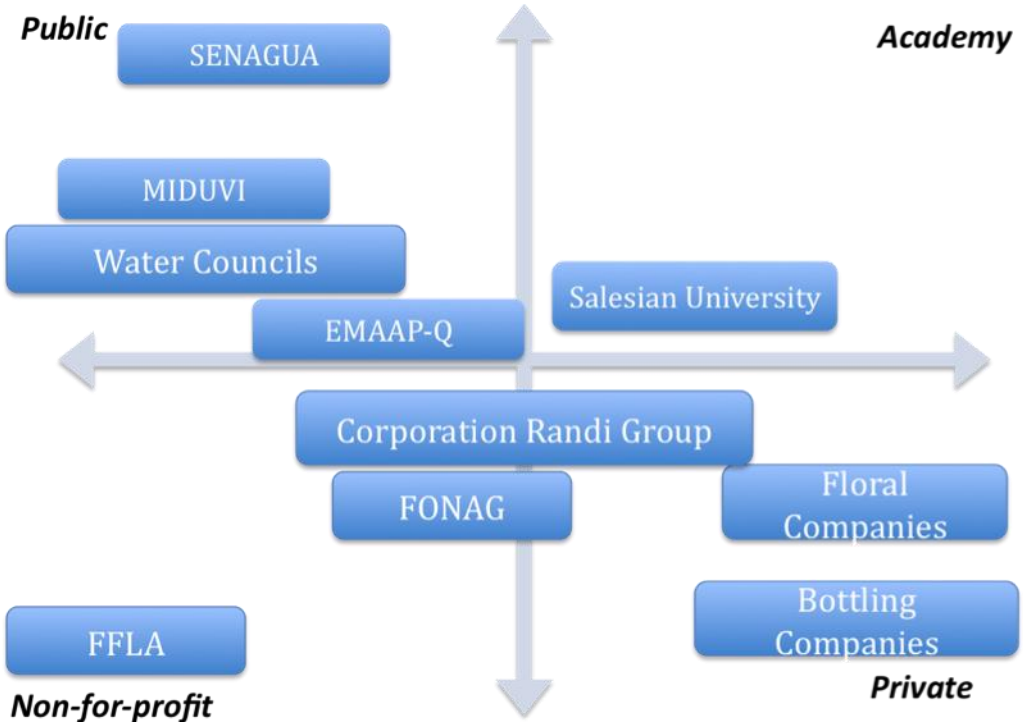
CARE Brazil Regional branch of the International non-for-profit organization, CARE International.

UFPI Piauí Federal University

Communities 10 coastal communities: four in the Parnaiba region; three in Ilha Grande (on the coast); one in Luis Correia; and two in Cajueira de Praia

Appendix 9

Organizational chart of the main actors involved in the Quito case study.



EMAAP-Q Quito Public Enterprise for Water Supply

FFLA Foundation for the Future of Latin America

FONAG Fund for the Preservation of Water Resources

MIDUVI Ministry of Urban Development and Habitation

SENAGUA Water Secretariat

Appendix 10

The Indigenous Movement in Ecuador

This appendix provides complementary information for understanding the events presented and analysed in the Quito case study (Chapters 6 and 7).

The seeds of the modern indigenous movement were planted with the application of national laws that authorised the formation of community organisations, which can receive funds from the state for various development projects (Kenneth & Scott, 1998).

From 1974 to 1990, the number of registered indigenous communities, associations, cooperatives and centres almost doubled. It was usual with the assistance of other organisations, especially NGOs, for groupings of these communities and cooperatives to be formed into federations, usually within provinces. In some cases, these community organisations and federations were indigenous-specific, while in other cases they were representing peasants or agricultural families.

In the 1960s and 1970s, the indigenous movement was very similar to, and in fact tied to class-based leftist movements (Simbaña, 2007). The 'new' aspect, coming into focus by the early 1980s, was the ethnic agenda of reviving, and in some respects creating a positive indigenous identity. A major demand by indigenous organisations dating from the 1970s was for bilingual literacy. The battles for bilingual literacy came to a climax successfully in 1989, with the establishment of bilingual education programs throughout the country.

The contemporary indigenous movement in Ecuador, especially since the creation of the pan-Ecuadorian Indigenous Nations Confederation (CONAIE) in 1986, pursued a political strategy of popular mobilisation and direct negotiations with government leaders to achieve its goals. Their demands of the state were for the recuperation of lands, recognition of specific cultural identities, and the institution of specific laws and policies.

In Ecuador, especially between 1996 and 2004, successive governments handed over more than six million hectares (or 15 million acres) of territory, mainly encompassing native forests and moorland, as mining, oil, water and hydroelectric concessions, as well as for 'biodiversity management', to national private companies and NGOs, and above all to transnational corporations. These concessions affected private, community and publicly-owned property, directly and indirectly impacting

indigenous and peasant peoples and communities (Fresco, 2003). On top of this, the intention to sign the Free Trade Agreement (FTA) with the US, led the rural sector to rise up again in another direct confrontation with capital (now openly at the international level) and the state.

The present period is marked by a setback in *Neoliberalism*, the current government of Rafael Correa and a new period for the indigenous movement, indicating that we are facing a historical *process of transition*, according to Simbaña (2007)**,** former leader of the indigenous movement.

This new process is characterised by a renewed relationship between the indigenous movement and Correa's government. The indigenous movement is consolidating its new political direction and strengthening its unity with the popular sectors to confront this process of change. The outcomes of this transition will greatly depend on how the current constituent process is addressed and, above all, on the efforts made to dismantle *Neoliberalism* in the rural areas. This is particularly relevant with regard to private land concessions, as under this political approach constructing a democratic country based on fairness and equality is just not possible.

Indigenous groups are powerful lobbyist actors, both in the region and in the country. According to the Salesian University Director, "they need to keep this attitude to safeguard their interests and hegemony".

Appendix 11

Quito Case Study

Summary of the system of study multiple dimensions and specific conditions at the beginning of the multi-stakeholder process

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Socio-Economic Conditions-

- Increase in water demand by a growing population and industry users.
- Higher diversity of water consumers: drinking water, industrial users (flower companies and bottling companies), agriculture, ecological flow, etc.
- Dissimilar socio-economic activities between urban and rural areas.

Political Conditions-

- Inefficient legal framework on water issues- Water law.
- Politicians open to pro-environmental issues.
- Centralized governance model- decision taken and structure.
- Lack of regulatory framework for water quality treatment.
- Inefficient water authority (Water Secretariat- SENAGUA).
- Neo-liberal political view as oppose to traditional structures and indigenous worldview on water issues.
- Inefficient Hydrological Model – water volume allocation.
- Sub-Basin structures are not legally recognized in the Water Law
- Basin Councils are an official stage in water management but it is not part of the decision-making in water issues.
- Lack of a Hydrological Scheme has allowed industrial users to be located above irrigation areas and communities.

Environmental- Geographic Conditions-

- Limited natural capacity in water resources due to geographical conditions- particularly in the urban area.
- Water demand > natural supply
- Dependence on surrounding areas and other hydrological basins- i.e. West basins (Amazon)

Technological Conditions-

- Technology for water storage and supply inadequate to adapt to fast changes in demand both quantity and quality terms.
- Decision making for infrastructure construction has not considered all kinds of water users but mainly drinking water.
- Traditional water infrastructures and governance models persists in rural areas (Mingas), where government's neo-liberal policies has not reached yet.

Cultural and Social Conditions-

- Differences in agents' background: urban vs. rural origin (mostly peasants with an indigenous background).
- Diversity of knowledge: technical vs. traditional.
- Partial view on water origin and dynamics, mostly in rural areas.

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