TOWARDS A FRAMEWORK FOR THE OBSERVATION, UNDERSTANDING, AND MANAGEMENT OF SOCIO-ECOLOGICAL SYSTEMS: INSIGHTS FROM SOCIO-ECOLOGICAL, INSTITUTIONAL, AND COMPLEXITY THEORY

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ABSTRACT

Studies about human vulnerabilities to global socio-ecological changes abound; there is precise information on the risks that need to be urgently addressed to prevent major crises. In Latin America, the Andean region has been signaled as one with major risks. Nevertheless, current methodologies for observation, understanding, and management of socio-ecological systems are incomplete and insufficient, since these are developed without exchange and conversation between various relevant theoretical fields. Based upon a multi-paradigmatic approach, the aim of the paper is to set up the basis for an integral methodology for supporting self-management of socio-ecological systems by its key actors, mostly inspired in contributions from socio-ecological, institutional, and complexity theories. The article: 1) integrates the fields in discussion building a framework to observe and understand the phenomenon; 2) discuss the bases for a methodology to support communities from vulnerable SES to self–organise and agree on strategic actions and responsibilities; 3) develops a preliminary empirical analysis from a Colombian case study, highlighting the questions derived from this analysis. It happens in the context of the Fuquene Lake socio-ecological system, placed on Colombian Andean Eco-region.

APPROACH

Our research aim is to build a framework for explaining how institutions and socio-ecologic systems adapt (or not) to global environmental changes triggered by climatic disruption: in particular we aim to observe and act upon internal vulnerabilities of socioeconomic and governance structures at the national, regional, and local levels. We aim to investigate how some innovative concepts and tools suggested by researchers in the field could help people and institutions to move towards a scenario of climate change adaptation, such as: viability and resilience in socio-ecological systems; Complex Adaptive Systems; Adaptive and Multi-Level Governance; Institutional Diversity; and Institutional Isomorphism.

Three theoretical approaches have inspired and focused this research. The first approach comes from institutional theory of change (Powell, 1991; Di Maggio & Powell, 1983; Scott, 1995; Fligstein, 2008). We propose that a jolt due to a major event such as climate change destabilize established meanings, rules and practices (Greenwood, Suddaby, Hinings, 2002) at the local levels. Jolts such as social upheavals (Togler & Zucker, 1996) or environmental major events (Meyer, Brooks,

Goes, 1990) have been studied in previous institutional theory. This jolt, for instance a major flooding or drought, may precipitate as a response, the entrance of new players and actors, such as governmental agencies or NGOs, and the ascendance of new local entrepreneurs and organizations (Greenwood, et al, 2002) who introduce new ideas and practices for collective actions. New actors bring about necessarily new perceptions, and usually during this processes problems are reframed, and new questions arise. The social perception of environmental risks undergoes a significant change. In this process of change, new actors and organizations innovate seeking new viable solutions to the global threat and the institutional misfits it creates. As a response, new practices and innovations in governance and organizational forms are tried. For these new practices to become widely adopted in the local community as new rules, norms and meanings, it is necessary the involvement of stakeholders in a previous stage of sense-making (Weick, 1992) or "theorization" (Greenwood et al, 2002; Tolbert & Zucker, 1996) to understand what the implications of global change to local socio-ecological systems are.

In this "theorization" phase, actors and stakeholders who are affected by an external threat, propose and specify new categories, and elaborate new meanings and chains of cause and effects about what is occurring (Suddaby, Greenwodd, Hinings, 2002). Theorising is not a momentary act but one which requires sustained repetition to generate a shared understanding of the problem and the new proposal for solution, especially when local responses are implemented. These new accounts of the changing reality by a process of collective sense-making will simplify the "properties" of the new practices. Thus, this stage of "theorization" and negotiation requires a process of discussion and construction of new meanings by which localized deviations from prevailing rules and conventions are simplified and understood. At this stage, actors specify the institutional and organizational failures and propose a local response to overcome their vulnerabilities and strengthen their resilience. If the local community sees such new ideas and practices as more appropriate than previously existing ones, they may be re-institutionalized.

According to Greenwood et al (2002) the proposed models must make "a transition from formulation to become a social movement at the local level to further develop an institutional imperative" (Strang & Meyer, 1993: 495). This re-institutionalization process requires a new legitimacy support by stakeholders, not only the local community but also local and national governmental agencies, new NGOs that get involved, and traditional producers among others. The new legitimacy base can be pragmatic (Suchman, 1995) due to the economic results or moral, in the sense that it is the "right thing to do" in relation to environmental and social issues. If these new practices and organizations are successful they will diffuse in time and space to other local scenarios creating an isomorphic effect. Full institutionalization at the national level will occur as the density of adoption of the new practices becomes cognitively institutionalized, that is to say that the new practices become taken for granted by the relevant actors and decision- makers.

The second approach comes from socio-ecological management theories, especially those focusing on the resilience-thinking paradigm (Walker and Salt, 2006, Chapter 1). This approach offers tools to reveal social and ecological interdependences, and to identify misfits between theory and practice: they can be for example, biophysical, in the social systems and governance, or of spatial / time scale misfits (Cumming et al.,

2006). Misfits are often institutional: exists inadequacy between the problems as identified or addressed at the policy – decision making level, and the response perceived or implemented by local actors. Moreover, the type of responses will depend not only on the magnitude of the climate threat, but also on the socio-ecological system own vulnerability, which may be intrinsic -determined by biophysical, institutional and social variables- or added -as a result of previous human intervention in the landscapes- (Walker and Salt 2006). In particular, responses may be affected by the socioeconomic and governance structures at the local level, and the innovative or proactive abilities of the societies to transform the crisis. These ideas or new practices may be related to new organizational forms or new rules to manage resources, to respond to the new contextual change. We state that this process of change occurs mainly at the local level, although influenced or triggered by up-scaled forces.

The third approach comes from complexity and soft OR approaches. There has been an increased interest in holistic and complexity approaches to sustainability; in particular the interest has focused in ideas from Complex Adaptive Systems and Viable Systems to better explain issues of organisational transformations in socio-ecological systems (Paucar Caceres & Espinosa, 2010). We have presented elsewhere our understanding on how complexity theory will support self-organisation and self-governance in communities, industries and governments within a socio ecological system; we described analytical tools to support social transformations oriented towards achieving more sustainable governance in a SES, and offered multiple examples of applications of this approach to environmental management and sustainable development (Espinosa & Walker, 2011).

By using such models and tools we can map the network of interacting agents, the rules of interaction and the different roles they take regarding sustainability of the SES, and learn about ways to more effectively make decisions and act upon them. We consider that by using this approach in an action research mode, we can raise the agents' level of knowledge and awareness about misfits between theory and practice, and offer them criteria to jointly design more focused and effective responses to mitigate climate risks. We also explained how by using a multi-methodological approach based on action learning, we can support communities, industries and networks of people dealing with issues of sustainability (Espinosa & Porter, 2010), and in particular on issues of global climate change (Espinosa & Walker, 2010, Ch 6).

We suggest that by redrawing organisational boundaries to enable institutions to respond to the main challenges in our socio-ecological systems, and by enabling clusters of self-organising units to work together as a coherent whole, with interactions based upon dynamic, co-evolving, rapid-response control loops (i.e. around critical global climate change risks responses), we can contribute to create a more sustainable governance structure. In this research project, the action learning focuses in improving knowledge and information management, as well as group decision-making, by distributing information, promoting self-organisation and offering meta-systemic management tools for improved multi-level self-governance.

METHODOLOGICAL BASES FOR A UNIFIED FRAMEWORK.

Von Foerster (1979) addresses the problem of the relation between observer and observed systems. The second order cybernetics approach states how this artificial separation between observer and objects in reality brings out second order problems; this occur when the observer system is contained in the observed system. Given this contention of the observer in the observed system, an objective observation of this kind of phenomenon is not possible and the modification of the observed system by the observer is an inevitable outcome. As von Foerster (1979) proposes, our point of departure considers that the second order problems can only be addressed when the observer makes explicit his/her intentions about the system he is observing.

Since in the managerial context this relation of involvement between observer and observed system is explicit; and having into account that the researchers of this project are cognitively and emotionally involved with the observed phenomenon, these considerations open the space for the development of a research project based on an intended action. As Mingers (2006) proposes, action and knowledge have an inseparable relationship, given that knowledge takes form in action and is derived from action. In this research context an action takes place in human systems as a purposeful activity guided by a particular set of objectives (Checkland, 1981).

Systemic action research approaches are especially relevant in this socio-ecological context because they allow participants to build and rebuild contextualized and autonomous solutions for their local problems, in comparison with the approaches looking for the adaptation and implementation of foreign solutions (Ison, 2008).

Following Mingers (2006), we chose a multi-methodological and multi-paradigmatic action research approach because of three key arguments. In first place, the phenomenon we are studying has a multidimensional nature and involves different actors in different levels; we are attempting to understand the socio-ecological system from its ecological, economic, social, institutional, and managerial dynamics analyzed at the individual, group, organizational and regional levels. Second, we understand that a solution for the regulation of the socio-ecological system cannot be implemented as a discrete event; the transformation of the current dynamics and practices requires a gradual process of implementation. Third, the use of institutional, socio-ecological, and complexity approaches allows us to triangulate our findings, improving de reliability and validity of our investigation.

The question asked by several theorists is how is it possible to make a methodological integration without violating paradigmatic restrictions (Zhu, 2011). Mingers (2006) addresses this problem understanding the paradigm as a set of fundamental philosophical assumptions in which the vision of the world, more explicitly, the scope of research and intervention is based. Therefore, integration of different methodologies derived from different theoretical bodies should be elaborated with rationality and a scientific approach: the solution proposed by Mingers (2006) consists in the use of a new paradigm that is able to articulate, instead of simply adding, the methodologies involved. Our point of departure, in line with Mingers (2006) proposal, considers that each paradigm focus its attention on different aspects of the socio-ecological system; hence, the paradigms incorporated in this methodology interact more as complements than as rivals.

Towards a framework for the observation, understanding, and management of socio-ecological systems

As Zhu (2011) states, mixing-methodology theorising has failed because is dominated by an essentialist foundation that assumes paradigms as incommensurable: "this has over time brought contemporary theorising into stagnation, stifled innovation and failed to make a practical difference" (p. 784). According to the author, the paradigms are not completely delineated or defined, and work more as structures that scientists tend to recognize in some cases or pass trough in some others. In consequence, our approach is more pragmatist than paradigmatic; we give more relevance to the ontological nature of the phenomenon in observation: instead of integrating the theoretical bodies based on their paradigmatic assumptions, we integrate them based on the dimensions of the socio-ecological system, yet keeping in mind the theoretical bodies roots.

As mentioned above, von Foerster (1979), Mingers (2006), Checkland, (1981), and Ison (2008) lead us to adopt an action research approach. Action research derived solutions should be implemented as processes; Mingers (2006, p. 202) conceptualize the action research process as one in which researchers find answers to four central questions: "What is happening? Why is it happening? How could the situation or explanation be different? And, what shall we do?" These questions need to be answered from each perspective we are using.

The theoretical approaches involved in this research participate equally in four phases, giving answer to the above mentioned questions. The four phases proposed by Mingers (2006) are appreciation, analysis, assessment, and action. In the appreciation phase we describe the situation as experienced by the different actors involved. In the analysis phase we look for the understanding and explanation of the current situation; these two first phases are coherent, for example, with the theorization phase proposed by the institutional approach. The assessment phase is intended to evaluate the accuracy of the proposed explanations and to evaluate alternative explanations of the phenomenon. Finally, the purpose of the action phase is to implement necessary or desired changes in terms of the equilibrium in the socio-ecological system.

Building on the strengths of these combined theories and analytical tools, we introduce here an interpretative framework, to assess the vulnerability and resilience of socio-ecological systems as well as the capability for adaptive responses from local, regional and national agents. The institutional approach to change helps us to explain the dynamics of interaction of social agents responding (or not) to climate risks; the socio ecological approach explains the misfits between theory and practice and misconceptions in the practice that many times explain lack of effective social action. The complexity approach explains how social agents and institutions get organised to address the core risks and manage to more effectively and timely act together. Based on the theoretical perspectives inspiring us, our working hypothesis is that by strengthening cooperation and self-management alternative schemes to help self-organization of community actors they'll be better equipped to deal with their socio-ecological system risks in a more effective and holistic way.

The new framework combining these insights will help us to accomplish a better comprehension and management of socio-ecological systems in high-risk areas. The precise objective is to contribute to the design of both, targeted interventions to reduce vulnerability to climate change, as well as regional and national policies for risks mitigation related to global climate change.

Towards a framework for the observation, understanding, and management of socio-ecological systems

The suggested methodology includes the following stages and analyses:

- Modelling the socio-ecological system.
- Description of the socio-ecological system: attributes, identity, and key variables.
- Inventory of the socio-ecological services provided: current states, trends, and main actors.
- Informal networks pioneering climate change related projects to improve local resilience and long term viability.
- Considerations about management for resilience and adaptation.
- Institutional analysis within the socio-ecological system.
- Description of the current regulatory framework concerning land use, water use, and property rights in the socio-ecological system.
- Description of the cultural-cognitive mental frameworks shared by the different actors within the socio-ecological system about the services desired/provided.
- Description of the current normative practices related with resource use, considering stakeholder characteristics for the comprehension of power relationships between the actors.
- Analysis of the regulatory, cultural-cognitive, and normative institutional mainstays of the system for the design of an intended intervention: Institutional change towards sustainability and adaptation.
- Institutional change.
- Diagnosis/redesign of community/ regional organisation (CoR):
- Rich picture of the CoR key networks.
- Identifying the System in focus: Identity of the CoR.
- Mapping the levels of complexity of the system in focus.
- Desired identity/tasks of the CoR.
- VSM Diagnosis of existing CoR.
- Recommended CoR changes.
- Learning and self-assessment – (Self Regulatory Systems).

- Existent control management mechanisms (decision making systems, environmental management control systems, information systems about socio-ecological vulnerability, among others).

Towards implementation of changes:

- Participation, dialogue, and negotiation spaces between different stakeholders and environmental authorities.

- Creation of a learning context for the study and appropriation of vulnerability and adaptation knowledge.

Having agreed on the elements of organizational diagnosis and jointly identified possible action courses, we will reflect from these new perspectives about the core situations of risk and vulnerability in Colombia and the required institutional and policy adjustments. We are aiming to test such framework at different scales (local, regional, national) and produce recommendations for policy and institutional adaptation to encourage resilience at all levels.

In order to test our hypothesis and progress towards development of a full application, we have started reflecting on a particular high risk SES in Colombia, in the Andean Eco-region. Lake Fuquene is one of the most relevant regions for the diary industry in Colombia: its SES has suffered important changes due to global climate change and its survival is in clear danger. We'll reflect below on the first analysis and findings about this SES from our theoretical perspective as well as about the nature of the misfits and required changes. We shall address the analysis at two spatial scales within the country, one national in which the public policy responses occur, and at the local level, focusing on this specific SES -as a start-. On the basis of this preliminary experience we aim to validate our analytical framework and experiment it later in other SESs (i.e. regional) in order to test innovative ways of dealing with major global climate change's risks at different levels and scales.

FINDINGS

Studies about environmental risk in socio-ecological systems at global and local scales abound, and usually offer information on climate threat. Threat is usually assessed through modelling and projection of climate data (Gitay et al., 2001). As mentioned above, in Latin America, the Andean region is been signalled as one with major risks. Climate change risks have been established for Colombia (Van der Hammen et al 2002), through downscaled climate projection models (IDEAM 2010; Pabón et al, 2010); Mulligan (2000) explains its impacts on hydrological process. We consider however, that risk studies should be complemented by the assessment of specific vulnerabilities (intrinsic and added) of socio-ecological systems. Nevertheless, methodologies to assess local vulnerabilities (social and institutional) are quite scarce and are currently under construction, especially on the relationships

between social and ecological resilience. Following the suggestions of Adger (2000) on this respect, a model applied to Fúquene Lake is currently being constructed[1] [2].

Our first approach to the phenomenon suggests that foreign proposed solutions for the management of Fuquene Lake socio-ecological system ignore several socio-ecological services, because these solutions are in favor of the most lucrative service (an irrigation district for the dairy industry). The most concerning consideration in this respect is that foreign solutions instead of diminishing vulnerability in the system contribute for an increase in the risk of imbalance (flooding, temporal or permanent drought) in the lake.

The preliminary analysis suggests that existing institutional arrangements and policies to prevent increase of such risks are either inadequate or not operating as effectively and timely as they should. The case study analysis highlights the limitations in current management practice in the region (i.e. top down approaches to deal with climate change risks' management; dislocated views of ecological and social processes; inadequate understanding of the need for adaptation, etc). In this first stage, the model is been used to explain the misfits that occur between the current institutional and governance arrangements at the local level to respond to the global threat of climate change, stressing the need for development of innovative bottom up approaches to cross-scale environmental management issues.

Especial focus is being given to the use of the best of resources, knowledge and understanding available as well as the identification of formal and informal networks of people and institutions (rules, norms and shared meanings) at each level. In a second stage the model will be used to explain how new local governance structures, organizations and practices emerge (or not) as new practices for collective actions as a response to the external threat.

At this preliminary stage, we have identified some institutional misfits in policy implementation when countries and regions are aiming to prevent major risks of global climate change, and decisions does not fit harmonically with local response processes. This reinforces our hypothesis that a new approach to support institutional change is needed, although some limitations of the use of the concept of adaptation have been encountered (see Walker et al., 2004). These ongoing reflexions confirm that more effective responses to climate change risks are urgently required in the context of our country (Colombia), and also that a change of approach is urgently needed. We have identified potential contributions from the institutional, socio-ecological, and complexity approaches, especially to face up to encountered misfits and inadequacies.

A trans-disciplinary approach using the above mentioned theories has a clear potential to understand and analyse the process of institutional change and the network

[1] Franco, C L, Andrade, G I. (2010 – paper in progress). Linking biophysical variables and resilience proxies to address vulnerability to global environmental change in Lake Fúquene socio-ecological system.

[2] A joint project is being carried out between Los Andes University – School of Management and the Wetlands Foundation in the Fúquene Lake and other high Andean wetlands, which supports an important dairy industry.

characteristics of contemporary social organisations dealing with global climate change risks and by doing so, improve their possibilities of success in overcoming current implementation misfits. Finally, a multi-level (multi-scale) adaptive – transformative management scheme is in the process of been defined, that will help to integrate the reciprocal interactions between the national policy and sub national environmental planning responses and local actions.

RESEARCH LIMITATIONS/IMPLICATIONS

This paper sets up the theoretical and methodological basis for designing a complex long-term research project that combines the power of institutional theory, complexity and cybernetic theory, and ecosystem management approaches. While institutional Theory offers a clear way to address the dynamics of social interactions within key agents in a particular region, an eco-systemic management approach guides us to identify the misfits between theory and practice, and the complexity approach offers criteria to support the existing networks to improve their cohesiveness, synergies and self-governance for sustainability. A trans-disciplinary analytical framework is being constructed, and practical tools developed, aiming to intervene in the current local management processes and the national policy - making climate change scenarios. The paper doesn't yet explain or detail the practical implications of using these ideas, -as the research project is still ongoing- but clarifies the implications of moving into such an alternative framework for analysis and its usefulness for designing action research projects in the field.

Keywords: Socio-Ecological Systems, Resilience – thinking, Global Environmental Change, Adaptive Management, Implementation Misfits, Viable Systems, Social Networks, Institutional Theory.

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