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Participatory scenario planning for developing innovation in community adaptation responses: three contrasting examples from Latin America

Abstract: Environmental change requires adaptive responses that are innovative, forward-looking and anticipatory, in order to meet goals for sustainability in socio-ecological systems. This implies transformative shifts in understanding as conceptualised by the idea of 'double'- or 'triple-loop learning'. Achieving this can be difficult as communities often rely on shorter-term coping mechanisms that purport to maintain the status quo. The use of participatory scenario planning to stimulate forward-looking social learning for adaptation was investigated through three contrasting community case studies on natural resource management in Latin America (in Mexico, Argentina and Colombia). Exploratory scenario narratives that synthesized local knowledge and future perceptions were used iteratively to define response options considered robust across multiple futures. Despite its intensive format, participants in each case agreed that scenario planning enabled a more systematic appraisal of the future. Scenarios facilitated innovation by providing scope to propose new types of responses and associated actions. Differences in local context meant that learning about future change developed in diverse ways, showing a need for a reflexive process. Reframing of key issues characteristic of double-loop learning did occur, albeit through different forms of interaction in each location. However, a shift towards transformative actions characteristic of triple-loop learning was less evident. Achieving this would appear to require ongoing use of scenarios to challenge social norms in light of changing drivers. Use of learning loops as a diagnostic to evaluate adaptive responses provided a useful reference framework although in practice both innovation and consolidative approaches can develop concurrently for responses to different issues.

Keywords: socio-ecological systems, community-based adaptation, scenarios, triple-loop learning, social learning, Latin America

1. Introduction

The process of adaptation involves both managing actual change in the present whilst also preparing for expected future changes in order to minimise negative outcomes and maximise opportunities. The ability to both manage and prepare for change through design and implementation of adaptive responses can be characterised as adaptive capacity, for which knowledge and learning processes represent a major enabling influence (Williams et al., 2015). Learning represents an exploratory, stepwise search process where participants experiment with innovation and knowledge development until they meet constraints and new boundaries (Pahl-Wostl, 2009). With regard to natural resource management in integrated socio-ecological systems, local knowledge can provide an important catalyst for scoping and delivering community-level actions in response to larger-scale drivers of change (Folke et al., 2003). However, when learning about future change, the scale of the adaptation challenge is often perceived as particularly hard to interpret based upon difficulties in reconciling available information and personal or collective experience (Dovers, 2009). Furthermore, inter-relationships between a community, its environment and the wider world are constantly being modified, often in new ways by drivers such as climate change and globalisation (Bridges, 2002; Young et al., 2006; Berkes, 2007). These difficulties may then provide a boundary to knowledge development and innovation for anticipatory adaptation, perpetuating a reliance on shorter-term responses conditioned by the past (Rodima-Taylor et al., 2011). Participatory scenario-planning is one technique thought to aid learning and use of local knowledge for adaptation (Bohunovsky et al., 2011) although evidence on its use as a learning facilitator has often been conjectural and lacking a diagnostic framework.

The objective of the present study was to test the concept of 'learning loops' as a diagnostic tool for referencing the role of learning in making adaptation decisions with evidence provided from the use of participatory scenario planning in three focal areas. Learning loops (Argyris and Schön, 1978) provide a structured approach to help understand the dynamics of learning in organisations or other collective groups (Table 1). Single-loop learning can be characterised as a consolidative process that is primarily structured around reactive or incremental actions without changes in existing mental models: these actions tend to be governed by a rigid system of policies, procedures or 'rules'. By contrast, double-loop learning requires actors to change their reference frame and guiding assumptions (e.g. cause-effect relations) to identify new ways to achieve strategies or goals: this requires challenging and possibly changing existing 'rules'. Triple-loop learning takes actors beyond pre-existing structures by challenging existing decision paradigms and the contexts which frame the decision-making process, including underlying principles and norms (Maarleveld and Dabgbégnon, 1999; Pahl-Wostl, 2009). Full triple-loop learning may therefore be conceptualised as learning about the learning process itself and how this process can be further enhanced to tackle new challenges and opportunities.

Despite the considerable research into learning loops to support intra-organisational learning, there has been less application in settings related to managing environmental change. Although the potential insights it can provide as a conceptual framework for adaptation and knowledge innovation processes have been highlighted, it has also been noted that there is a need for more empirical evidence to test and substantiate the concepts (Nelson et al., 2007; Tabara and Ilhan, 2008; Pahl-Wostl, 2009). The present study tests learning loops in the context of community-based adaptation which aims to empower communities to use their own shared knowledge and place-based decision-making processes to manage change (Aalst et al., 2009). A key pillar of such empowerment is provided by participatory social learning to enhance capacity for knowledge exchange, adaptive management and local leadership, together with recognition of informal or tacit knowledge systems that extend beyond conventional scientific knowledge (Nazarea, 2006). Pluralistic approaches to knowledge development can provide an important enabler for engagement of civil society in sustainability planning if they can incorporate longer time horizons, adaptability and feedbacks, integrated approaches, and systems thinking (Burch et al., 2014). However, barriers to adaptive innovation may occur in terms of understanding of issues, selection of response options, or implementation of required actions (Moser and Ekstrom, 2010).

1.1 Short-term versus long-term responses

To respond to adverse conditions, communities typically employ short-term coping mechanisms that draw upon available skills and resources to help manage antagonistic situations whilst maintaining or restoring basic community functions (Berman et al., 2012). Rural populations are particularly likely to rely on coping mechanisms due to a frequent direct dependence on productivity of natural resources that are sensitive to changing conditions (e.g. Mengistu, 2011; Gebresenbet and Kefale, 2012; Mavhura et al., 2013). Knowledge associated with coping processes can be valuable by retaining a social or cultural 'memory' of the viability of different responses (Nazarea, 1998; Olick and Robbins, 1998; Climo and Cattel, 2002).

Coping mechanisms may be progressive if they can facilitate ongoing transitional adjustment to change but improved community preparedness, including planning and implementation actions, ultimately require some reframing of key issues in order that the changing context for decisions is recognised (Pahl-Wostl, 2009). As coping mechanisms involve short-term responses, typically in an ad hoc reactive mode during or after events, and usually with an emphasis on previously successful tactics (Bankoff, 2004) they are primarily characterised by single-loop learning that limits the ability to adapt. Post-event recovery to a pre-existing status quo may therefore perpetuate existing vulnerabilities that predispose communities towards adverse impacts. In a changing world, coping mechanisms may not therefore be sufficiently forward-looking to anticipate and respond to future changes, thereby exacerbating existing vulnerabilities and constraining opportunities to improve future well-being (Ellis, 2000). Instead, more substantive long-term transformation processes are likely to be required to maintain or enhance community functions as external circumstances change, requiring a shift in emphasis towards proactive strategies that can anticipate, adjust to, and manage future conditions (Kates et al., 2012).

1.2 Participatory scenarios as learning tools

Despite a vigorous theoretical debate, there is as yet limited empirical evidence on the processes that can transform coping mechanisms into more forward-looking and proactive adaptation responses (Berman et al., 2012). However, knowledge or skills developed through learning activities associated with monitoring and evaluation have been identified as important stimuli in the transition from coping to transformation (Park et al., 2012). Similarly, the benefits for learning through 'hands-on' experience (i.e. 'learning-by-doing') have been emphasised, particularly in a shared setting (Bos et al., 2013). Hence, the present study investigated participatory scenario planning as a learning tool to enable innovation in community-based adaptation, including the linking of short-term and longer-term responses.

Scenarios are strategic tools that can provide alternative descriptions of an uncertain future, in both qualitative and quantitative formats, thereby facilitating anticipatory planning beyond the limitations of prediction or forecasting. Using multiple scenarios can help define the diversity of possible future changes, especially associated with key macro-scale drivers, thereby challenging existing mental models of change (Börjeson et al., 2006). Participatory scenarios are commonly developed with expert groups but their use in a community setting offers potential to combine scientific knowledge with local knowledge, including potential access to social or cultural memory (Bohunovsky et al., 2011; Mistry et al., 2014). By convention, scenarios can be distinguished according to two types of approach: exploratory (i.e. 'what could happen?') or normative ('what should happen?) (Börjesen et al., 2006; Robinson et al., 2011). The intention in the case studies was to develop community-based exploratory scenarios to learn more about anticipating and managing the future from different perspectives.

2. Case Studies

Case studies in Mexico, Colombia and Argentina (Figure 1) were used to apply the generic scenario planning method: each differed in terms of environmental settings, cultural contexts, community structure, governance, and priorities. Latin America faces a unique combination of challenges and opportunities from global change. Despite being well integrated into the global economy, it has economies heavily dependent on natural resources and pervasive poverty and inequality (Hoffman and Centeno, 2003). Populations are highly mobile, livelihoods and economies are rapidly changing, and the political and institutional context is often volatile, all indicating high potential for unprecedented change (Eakin and Lemos, 2010). Each case study used civic society-scientific partnerships (herein 'local partners') to identify local solutions for sustainable management of natural resources. The Argentinian study focused on coastal management of the Bahia Blanca estuary, where development pressures, climate change, and overfishing are perceived to impact on the livelihoods of artisanal fishermen. The Colombian study considered the management of water and other resources in a highly biodiverse region on the Pacific coast with environmental conflicts related to timber extraction, mining, infrastructure development, water use, and illicit crops. The Mexican study, located in Oaxaca's Sierra Juarez (south Mexico), focused on forest management and the need to improve socio-economic benefits to help slow down emigration rates.

The Colombian and Mexican studies share a tradition of collective ownership of land and co-management of natural resources. The Mexican study established a strong community management system after indigenous people regained control over their land in the 1970s with a well-preserved forest area that has resisted the agricultural expansion occurring elsewhere. The Colombian study features two community councils formalizing the autonomy of indigenous peoples and those of African descent including consultation processes for governmental and private interventions. The Argentina study has an industrialized setting and a strong influence of private ownership and large corporations in decision making rather than through community structures.

Scenario planning had only previously taken place in the Colombian study through a future visioning exercise carried out in 2011. Levels of participation varied in the case studies. In Mexico, not all participants were engaged in all stages and it was sometimes dominated by community leaders with low active participation from women. In Argentina, representatives of all relevant sectors participated, although a dispute regarding fisheries resources meant that some fishermen did not fully engage with the forward-planning activities, and large multinational companies were absent. In Colombia, the engagement of the community was very strong but external stakeholders were only infrequently engaged (partly because of a violent uprising in Buenaventura).

3. Methods

The methodology was devised as a series of four sequential steps (Figure 2 drawing upon both informal and scientific knowledge of local socio-ecological systems and changing drivers as a primer to consider viability of different response options. Scenario planning builds on previous engagement in which local partners characterised key relationships in their social-ecological systems in the context of community-based natural resource management (Waylen et al., in press). Implementation was adapted to the context of each case study using a combination of preparatory work by the local partners and a series of workshops that involved mainly local community participants but also some external stakeholders (Table 2). In Mexico and Colombia, participants were identified through previous contacts based upon the outreach activities of community councils. However, in Argentina no equivalent community forum existed, so participants were identified through stakeholder analysis. Workshop outputs were complemented by interviews with local partners at each stage to review progress and interpretation of outputs with regard to key issues (section 3.5).

3.1 Drivers and system variables

The aim of this stage was to consider how key external drivers may influence local variables with emphasis on understanding sensitivities of the local socio-ecological system. To encourage consideration of a broad range of

drivers, their selection was guided by the STEEP template (Social, Technological, Environmental, Economic and Political), which provides a taxonomy of driver categories used for futures' research (Fowles, 1978). For each driver, two contrasting states were identified to allow relative influence to be summarised in different pathways of change. To help guide a representative selection of local variables based upon a common socio-ecological systems classification, the schema of Ostrom (2009) was used: this provides a common series of key variables grouped according to the following sub-systems: resource systems; resource units; governance systems; resource users; related ecosystems; actions (interactions and outcomes). Both the STEEP template and Ostrom framework were intended as aide memoire to facilitate consideration of a wide range of systems interactions rather than to be prescriptively applied, therefore communities could vary in selecting the more important drivers and variables. The relationship between selected drivers and local variables was then systematically explored by the communities to identify key sensitivities and dependencies.

3.2 **Constructing alternative future scenarios**

Exploratory scenarios should aim to be: plausible; distinctive; relevant; challenging; and internally consistent across multiple variables of change (van der Heijden, 2011; Amer et al., 2013). Multiple scenarios are important to explore how the future can unfold in different directions. The present study adopted a commonly-used expedient to incorporate these criteria into scenario development by using generic global scenario archetypes to guide the process (cf. Rothman, 2008; Bezold, 2010). Archetypes were derived from a meta-analysis by Hunt et al. (2012) that had used commonality in drivers from several global scenario exercises to encapsulate a wide range of potential futures. Futures therefore differ between those similar to present but shaped by dominant drivers ('Policy Reform' or 'Market Forces') compared to those in which a 'great transition' towards new human values or attitudes to development emerges ('Eco-Communalism' or 'New Sustainability Paradigm') or alternatively where fragmentation or crisis ('barbarization') occurs ('Fortress World' or 'Breakdown' type scenarios). Participants were at liberty to diverge from the archetypes in developing community-level storylines of change as guided by the sensitivity analysis in the previous exercise (section 3.1) and the number of multiple scenarios was not pre-defined. For logistical reasons, sample narratives were initially developed by the scientific partners but then refined or validated by the communities in a workshop setting in conjunction with the use of informal drawings and graphical metaphors as tools to help visualise the future. For reference, the future was defined as being over the next 20 years (or 'one human generation').

3.3 **Identifying robust response options**

Scenario narratives were each used to iteratively stimulate an elicitation process for the recognition of 'response options', these representing interventions or initiatives that could help achieve community goals whilst also managing changes described by the scenarios. Response options could be nominated based upon change occurring now or in the future and they could include existing activities as well as completely new options. A broad distinction was made between responses at community level and those which involved dependencies on others to identify implications of change. Elicitiation produced a 'long list' of response options which were then each evaluated against all of the scenarios to assess their prospective relevance and viability in delivering sustainable outcomes. Responses considered as robust were shortlisted meaning that they could continue to deliver outcomes across multiple alternative scenarios rather than just one future pathway. Shortlisting could include combining multiple responses together into a strategy if that was considered to enhance overall robustness. Finally, in this stage, further evaluation of shortlisted response options was provided by considering different types of 'shocks' (i.e. low frequency, high magnitude events) of high relevance to local systems. Shocks introduce the concept of abrupt discontinuities rather than incremental change, which may further challenge existing community responses (van Notten et al., 2005).

3.4 **Implementation of response options**

The aim of this stage was to consider how response options identified as robust would be implemented in practice, including key responsibilities and support mechanisms, or existing barriers. 'Anchor points' were identified to show how existing plans and programmes could be modified to implement new measures. Workshop participants were asked to systematically address the shortlisted response options to identify the following: (i) what would need to be done (specifically) to implement this response option? (ii) who would need to do it (for each specific component)? (iii) how would this need to be done?

3.5 Evaluation of the process

To assess the utility of the process, semi-structured interviews were conducted with facilitators after each workshop to gather feedback including any unexpected outcomes (Waylen et al., in press). In addition to reflecting on the method, including the reasons for any divergence from the general approach, interviewees were asked to identify if that particular workshop had generated new knowledge in the context of adaptive management, and whether consensus or divergence in opinions occurred. Recorded data from the interviews was coded and analysed using the NVivo10 software package. After the final workshop in each a cross-case study workshop involving team members from each location was convened to collectively summarise key findings. Together with the outputs produced by scenario-planning, this information was then used to contextualise each case against the learning loops framework.

4. Results

Findings are described for each step with regard to their role in facilitating social learning and adaptive innovation, including recognition of key inter-dependencies, implications of future change, and the development of response options. More detailed descriptions of the scenario process for case study are also available (Escalante Semerena et al.,2014; Farah et al., 2014; Rojas et al., 2014).

4.1 Scenario development

Selection of variables and drivers therefore provided some initial information on the existing concerns of each of the communities and also implicitly identified some of the power issues associated with local decision making (further discussed in section 5.3), either within the community, or through the role of external stakeholders. Table 3 presents the drivers selected in case studies referenced against STEEP categories with variations mainly due to specific local interests. Regarding selected internal variables, in Mexico these were mainly associated with local governance; in Argentina most emphasis was placed on the role of resource users; by contrast, Colombia used a more equal division of variables across the Ostrom (2009) sub-sytems (section 3.1).

Several driver states were perceived as having potential to cause significant internal change and potential system instability. In Mexico, the community wished to maintain the current system of collective governance therefore this stage highlighted its dependencies and vulnerability to change. In particular, it showed that modifications to the legal framework were not the only driver potentially threatening the governance system, because of a pivotal dependence on external subsidies (from government and emigrants) which, if reduced, was perceived as the first step in privatization of land and losing territorial management rights (as elsewhere in Mexico). Loss of key skills and knowledge through emigration was also highlighted. Drivers were often interpreted as linked: for example, climate change and the increased risk of large forest fires was linked to emigration: if emigration increased there would be less people for fire-fighting, and forest damage resulting from more fires might also lead to more emigration.

In Argentina, the role of collective community action as a key variable was linked to changes in several drivers, including contrasting states of the same driver but for different reasons. For example, increased harbour development was seen as reason for protest, whereas reduced development provided a reason to exert greater community involvement in the use of the harbour. In Colombia, the process served to make more apparent the key existing differences between the two administrative sub-units as the same driver showed differing sensitivities for local variables, improving shared awareness of these differences.

Scenario narratives as elaborated and validated by the communities from the initial archetypes are summarised in Table 4, contrasting futures similar to the present against those with greater sustainability or potential breakdown of current societal structures ('barbarization'). The Colombia case study further embellished the two alternatives to a conventional world view as 'desirable' and 'undesirable' scenarios, reflecting their underlying normative goals with regard to sustainability. In Argentina, the conflict on fishing rights that occurred during the process meant that participants actually envisaged their current circumstances as equivalent to a 'barbarization' world view, strongly influencing their perceptions of both short-term and long-term change.

Reactions to the notion of future thinking varied between the case studies. In Mexico, future planning was unfamiliar to the community as their primary focus was on the routine of 'daily activities' rather than long-term issues, indicative of a reliance on coping mechanisms (Eriksen et al., 2005). However, during the process participants expressed satisfaction at 'having been given the opportunity to think about the future'. Similarly, in Argentina, a very positive reaction to futures thinking was expressed and they acknowledged a previous focus 'only on the short term': this stimulated a realisation of their own role and responsibility in managing natural resources (notably fisheries) for the future. In Colombia, previous community involvement with future scenarios meant that there was less of a step change in thinking about the future than in the other two countries. However, the systematic exploration of drivers and variables was suggested by participants to have provided new insights into future change by challenging existing perceptions.

4.2 Identifying robust response options

In Mexico, proposed response options were initially quite generic but through deliberation this was refined to include activities associated with training, capacity building and diversification of income sources. External stakeholders suggested that individual or family agricultural activities could be supported with communal funds and they advocated more emphasis on accountability, efficiency and productivity. Three individual response options were identified as robust: training and advice, strengthening of links between the community and the local institutions, and further development of forest management plans through community participation. Deliberation then produced a combined strategy to integrate response options: (i) creation of local financial institutions; (ii) new sustainable investment projects based on individual and collective schemes; (iii) diversification of economic activities; (iv) strengthening of customary practices and collective memory. This strategy anticipated a sequential process for sustainable development: in order to diversify economic activities, new investment was required, and this in turn requires that a financial institution would act as a cheap credit supplier. However, the strategy also identified that sustainable development could not be achieved without the benefits of customary practices and mechanisms to reinvigorate collective memory. A balance was sought between the need to modernize the governance system and the desire to keep core community-based values. A particularly innovative dialogue in Mexico revolved around the issue of cargos (mandatory unpaid work for managing the governance of the community). Payment for cargos was not initially considered as an option and its subsequent inclusion potentially represents a major change in the community governance system. As discussed later (section 5.1), this shift in thinking may not have been completely attributable to the scenario planning process only, but it was felt by participants that the process opened up an arena to raise issues that were previously considered as 'unthinkable'.

In Colombia, participants focused on response options developed around key themes: (i) strengthening and evolution of the internal organization of the community; (ii) use and management of the territory including declaration of protected areas; (iii) consultation between community councils and external organizations; (iv) natural resources co-management as a collaboration with relevant national organizations. The traditional oral transmission of community history and rules to be passed on to the younger generations was seen as a pivotal issue to be captured in written form, together with the transfer of knowledge and leadership skills. The response identified as most robust was the strengthening of the internal organization as this was perceived to underpin other response options. Educational development, particularly ethno-education to recognise cultural values, was also identified as a robust response. Implementation was strongly associated with a need for a 'school of governance', to induct community members into local arrangements and use of traditional knowledge, and therefore improve community capacity to respond to change by building greater empowerment to take actions through leadership, enhanced inclusion, and defence of community interests. A specific action to enable this was to request the Ministry of Education to include these developments in the formal school curriculum. A further proposed action was design of a monitoring system to review progress on implementation of response options. Although existing municipal plans can currently act as anchoring points for the new response options, there was a perception that these plans do not meet community needs. The 'school of governance' would be designed to enhance formal and informal institutional arrangements by clarifying the roles played by different actors in the decision-making process.

In Argentina, response options initially proposed were also quite broad, but specific responses were refined when linked to responsibilities, notably for community engagement in a local coastal management plan and for the government to provide improved legal frameworks for protecting fisheries. There was consensus that collective action was key to a more resilient and sustainable future; achieving this was particularly focussed on social protest, probably influenced by the current fishing conflict and Argentina's tradition of protest. Deliberation of the response options identified the local coastal management plan as a primary mechanism for delivering robust coordinated actions and to help reconcile local, regional and national policy goals. In this case study, the actual process of discussing robustness may have been more useful than the identification of robust responses due to lack of experience and capacity for local-level decision making on natural resource management. The most direct outcome from the process was the recognition of a collective identity and the need for co-ordinated actions rather than to identify specific actions; the notion of 'us' in terms of responsibilities was novel and the process helped confirm and develop a new sense of community. Improved coordination of actions was also linked with improved knowledge exchange and communication with external organizations.

Shocks chosen for each case study are summarised in Table 4. In Mexico, the community decided that the robust measures already identified would also remain relevant in the event of a massive forest fire. However, discussion identified more specific actions to enhance resilience such as improvement of forest infrastructure and a co-ordinated firewall strategy. In Argentina, discussion of shocks was affected by the perception that the community was already in a real-world shock situation due to the current fisheries conflict, therefore it offered no new insights. For Colombia, this part of the process resulted in the community broadening their outlook from mainly internal-level responses to also define the role of external stakeholders. For example, it was realised that a pandemic would require larger-scale government intervention to occur in co-ordination with the community, rather than the community acting alone. Nevertheless, the strengthening of internal organization was still recognised as the key response particularly if national government acted to repeal legal frameworks for community ownership and control of the land (law 70/1993).

5. **Discussion**

5.1 Innovation in response options and application of learning cycles

Table 6 presents the shortlisted set of robust response options categorized against the triple-loop learning framework. The following common themes emerged across the three cases:

(i) the role of education, particularly in capturing and communicating local knowledge, together with systems of governance and decision making;
(ii) capacity building, so that skills and knowledge to manage change were more available;
(iii) strengthening the sense of community and its ability to deliver collective actions;
(iv) improving communication between the community and external institutions.

These themes are broadly consistent with those found from the local level of the scenario analysis conducted by Mistry et al. (2014) in Guyana. However, in the case studies presented here, the diversity of socio-ecological contexts also identified important context-specific responses. The emergence of new response options is exemplified in Mexico by 'paying the cargos' which represents a paradigm shift with regard to the traditional governance system, recognising a need for reforms to deliver social and economic sustainability as complements to environmental sustainability. This need had previously been recognised by some participants but scenario planning highlighted the long-term implications and provide scope to 'think the unthinkable'. Reframing of objectives and reappraisal of governance rules then acted to meld differing perspectives on individual performance-based management compared to collective traditional practices in order to find a workable local solution. Further innovative proposals included diversification of economic activities and establishing local financial institutions to provide capital for investment. The following extract from the evaluation interviews summarised progress:

"They know what they want for their future, even if they don't have enough time for thinking about it. They do not have forums for discussion due to their everyday duties, so they appreciated the opportunity to do this"

In Argentina, the role of scenarios in stimulating learning and innovative thinking was more difficult to assess because traditional coping mechanisms were already being disrupted by the current fishing conflict and its implications for their social-ecological system. Radical thinking was particularly expressed through emergence of a higher priority for collective action, as a reaction to the current top-down governance regime for natural resource management, the need for a local management plan to coordinate responses to multiple drivers, and a new role for social media in improving communication channels. The evaluation interviews identified that:

"The discussion on the actions proposed … was very interesting, and the discussion following the brainstorming *of actions helped in constructing consensus as to specific actions"*

By comparison, the process in Colombia was more consolidative rather than innovative but also with a shift towards more detailed actions and broadening participation, following on from a previous planning exercise. Specific responsibility for actions was identified within the community but also the role of external organisations became more clearly defined through the process. These mainly consolidative actions were to be brought together through the proposed 'school of governance'. A key outcome from this case study is therefore recognition for scenario planning to be an ongoing dynamic process between the community and external partners and that planning needs to be linked to concrete actions. A local team member during the evaluation interviews identified that:

*"It helped them [the community] to reflect on the future, to see that there are ot*her truths that must be taken into account because it allows them to evolve. Without the project, we would not call upon what we will do when adversity comes."

The scenario process also identified the role of power issues in decision making. This was most obvious at the final workshops when agreeing implementation actions for robust response options. In the Mexico case study, pre-existing social norms meant that those engaged in the workshops tended to be older men linked to the existing community governing body but by the end of the process a woman spoke publicly for the first time showing some broadening of community participation. More conspicuous efforts to broaden participation occurred in Colombia through the co-opting of new community members to further that specific goal. However, whereas in Mexico external relations were linked to the formal safeguards provided by legal autonomy, the Colombia case study concluded that their actions required both improved co-ordination with other community councils and to be better incorporated in regional and national-scale planning processes. In Argentina, the case study saw for the first time the emergence of group of local people with diverse interests acting to consider collective action, despite the conflict related to fishing interests. Some protection for artisanal fisherman has since been provided by provincial law (Ley de Pesca Artesanal de la Provincia de Buenos Aires: May 2015) and attributed to collective lobbying that was at least partly facilitated by the communal actions from the participatory workshops (Eduardo Flores, local fisherman – pers.comm).

In each area, existing plans were identified as 'anchoring points' through which new innovations could be trialled. These actions may facilitate reframing of issues characteristic of double-learning by breaking the cycle of incremental decision making, providing institutional arrangements are supportive. However, full triple-loop learning requires reform of formal and informal institutions and networks to transform decision-making protocols and accommodate proactive adaptation (Preston and Stafford-Smith, 2009). As yet each case study shows no fundamental transformative shift in approaches that would be consistent with full triple-loop learning, though the Mexico case study was associated with one radical change in outlook ('paying for cargos': discussed below). The change in social norms represented by the triple-loop would appear to require more emphasis on explicating, appraising and challenging these norms (Armitage et al., 2008). In scenario planning this could be accommodated by integrating both exploratory and normative scenario procedures, thereby identifying the degree of overlap between desirable and plausible futures, to challenge visions for the future and explore how they could be made more resilient to external changes (Milestad et al., 2014). This would inevitably require a longer engagement process to link reappraisal of norms to community and institutional re-organisation, and would undoubtedly be best enabled by encouraging communities themselves to take greater ownership of the scenario planning process (Vervoort et al., 2014).

Arguably, the biggest step towards transformation was found in the Argentina case study, but this was forced by existing instability leading to a priority to take more direct collective action, rather than the scenario planning process: here, maintaining the status quo was not deemed viable as this involved loss of livelihoods. In Mexico, a shift from the status quo through changed governance arrangements was actively promoted by improved awareness of dependencies and the need to innovate; this at least partly led to the community finally approving remuneration of cargos conditional on performance criteria to acquire new projects (and funding). Therefore the seed may have been planted here for a transformative shift but the community still remains rather conservative with regards to other aspects of change. In Colombia the level of progress is more indicative of consolidation within a double-learning loop, as particularly expressed through the proposed 'school of governance' incorporating traditional knowledge and self-organized decision making. The focal issues also remain in Colombia which may act against the definition of issue-specific networks that characterise triple-loop learning (Pahl-Wostl, 2009).

Each community may therefore be suggested to have moved further into double-loop learning as deliberations increased awareness of the challenges of future change compared to the past, with recognition that new response options may be needed achieve community goals in the face of this change (Waylen et al. in press). Nevertheless the case studies suggest full reframing of issues can only occur within the wider context of reform of institutional and governance structures, supporting the assertion that full double-loop learning actually requires elements of triple-loop learning, notably the challenging of some existing norms (Pahl-Wostl, 2009).

Although elements of double-loop learning were identified, full double-loop learning and triple-loop learning apparently require ongoing reflexion, experimentation and monitoring of progress, which may be challenged due to higher transactions costs as networks and institutions are restructured.

5.2 Implications for adaptation theory

The case studies suggest adaptive transformation proceeds both by periods of new insight and also by consolidation of knowledge (as particularly exemplified in Colombia). This would challenge a simple linear stepwise interpretation of learning cycles and also appears more consistent with the conceptual framework of 'adaptation action cycles' which highlight oscillation between incremental and transformative modes of action, with each mode differing in terms of their information needs and requirements for policy support (Park et al., 2012). In this context, policy support for adaptive governance may be required to improve cross-scale linkages to higher levels of decision making and external stakeholders (Olsson et al., 2004; Mistry et al., 2014). The case studies also suggest a smooth transition from coping towards adaptation is complicated by the association of social learning with place and identity which can encourage elements of both incremental and transformational processes depending on the local context (Marshall et al., 2012). Identity and social memory can also potentially reinforce internalised notions of resilience that enhance vulnerability by underestimating the magnitude of change of external drivers (Shaw et al., 2014).

The role of social memory in facilitating learning cycles and community-based adaptation therefore deserves further research to refine existing theory (e.g. Mitztal, 2003). Although social memory may sometimes be inert or even encourage maladaptation (Scheffer and Westley, 2007), case studies from established communities in Colombia and Mexico provide further positive support for the notion of social memory as a dynamic construct, especially as it becomes recombined with new knowledge (Nazarea, 2006). Using a participatory scenario process to help enhance such evolving knowledge can potentially further extend concepts of time-depth and memory based upon traditional practises (Ballard and Huntsinger, 2003) but in a forward-looking perspective to facilitate robust adaptation planning (Table 7).

5.3 Lessons for community scenario planning

Each case study found that the scenario process was considered rather intensive by participants. The steep learning curve and resource-intensive nature of participatory scenario exercises has been noted in previous studies (e.g. Vervoort et al 2014). This difficulty particularly applies to the challenge of maintaining stakeholder interest whilst also enabling a comprehensive assessment of future change (Brown et al., 2015), which may be particularly pronounced with lay people rather than organisations in which scenario exercises have been normally developed (e.g. in business or government) Engagement may therefore require some flexibility and divergence from a 'pure' scenario process in order to maintain interest.

Interviews with local partners suggested that use of intuitive actor-based scenarios rather than more formal scenarios (e.g. quantitative model outputs) reportedly engendered a greater sense of ownership of the process because participants could modify and customise narratives that incorporated local knowledge. The development of scenario 'storyline' narratives therefore provided a crucial step in linking drivers to local variable relationships in a coherent format enhanced by consensus building, supporting previous findings on the role of narratives as bridging mechanisms across epistemological or cultural divides (Brown and Castellazzi, 2014). Further vicarious enhancement of the scenario process was achieved by use of drawings and pictures as visual supports (section 3.2), either for presentation (Mexico and Argentina) or as a device to help construct narratives from the original scenario archetypes (Colombia). Images can therefore help to elaborate futures thinking (Nicholson-Cole, 2005) and to act as stimuli to activate social memory (Mistry et al., 2013).

Participants asserted that that they could 'see' the differences between the scenarios and that they represented plausible futures, even if some seemed more 'distant' than others.

The opportunity for iterative refinement of response options based on the local context was considered by participants to be particularly effective in translating the results into implementation actions, supporting the findings of Mistry et al. (2014) that scenarios at a local level can become more action-focussed than at higher levels of scale. Iteration was believed to improve communication channels between the community, external stakeholders and scientists, gradually bringing together disparate perspectives. Assessment of robustness ultimately required explicit statements on community goals and development pathways for the future. Therefore, it seems that a continuing scenario approach will ultimately raise normative issues that are consistent with further exposition of the learning cycle framework and that this will challenge community goals that are only based upon maintaining the status quo.

6. Conclusions

Using a 'learning loops' framework to analyse experiences of scenario-planning with three communities in Latin America indicates that scenario planning can encourage innovation in forward-looking adaptation responses by envisaging the future in new ways and by challenging existing reference frames.. In each case, the process acted to enable increased awareness of changing future interdependencies and hence the need to develop anticipatory responses that may be different from past tactics and traditional practices. The role of local knowledge and social memory in this process may be very important but was also recognised as complex and dynamic relative to the local context. The use of intuitive scenarios was found to be important for incorporating local knowledge Common themes for building adaptive capacity were found to be focussed on strengthening local governance arrangements, emphasising the sense of community, education (particularly based on the distinctive local context), and the need for improved relations with external institutions to co-ordinate change management. In the context of learning cycles, it was concluded that each case study developed thinking on response options that showed exemplars of double-loop learning through reframing of key issues. However, a concerted shift towards the transformation agenda that characterises triple-loop learning was less evident and would require an ongoing community scenario process or other forms of engagement to further challenge existing social norms in the context of sustainability objectives.

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