Farming Systems Dynamics: The quest for a methodology to measure social-ecological resilience in subsistence agriculture

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Abstract: *Researchers aiming to identify factors and scales of vulnerability, adaptability and social-ecological resilience in farming systems are faced with the dilemma to find appropriate and holistic methodologies. This workshop aims at contributing to the understanding of vulnerability, adaptability and resilience in a subsistence farmers' context by presenting research on the farmers' attitudes to risk and uncertainty, on factors that determine vulnerability and adaptability, as well as by identifying threats to ecosystems and farming systems in which subsistence agriculture is embedded. Key terms and current scientific debates are shortly introduced.*

Keywords: *Social-ecological resilience, subsistence agriculture, farming systems dynamics, adaptability*

Setting the scene

Resilience is a desirable system property but since resilience is a conceptual theoretical foundation, direct measurement of resilience proves difficult in practice (Carpenter et al., 2005). Researchers extract and combine theories, tools and methods from several disciplines in order to present a holistic approach to measure resilience, often combined with the aim to provide a framework with which useful and sustainable development policies can be created and implemented.

Methodological frameworks are based on complex systems theories bridging social and physical sciences to understand and identify possible ecosystem management options (Nelson et al., 2007). Research on social-ecological resilience includes analyses of adaptation processes e.g. based on the adaptive cycle concept (Holling, 2001). It may also be based on the sustainable livelihoods or vulnerability and poverty frameworks, examining variables such as capabilities, assets and activities required for a means of living, e.g. individual skills and abilities (human capital), land, savings and equipment (natural, financial and physical capital respectively), and formal support groups or informal networks that assist in the activities being undertaken (social capital). To be able to assess resilience as well as to find a way of quantifying resilience, surrogates of resilience are used (Bennett et al., 2005). Surrogates are 'variables through which the persistence of social-ecological systems (SES) emerging through change can be assessed' (Berkes & Seixas, 2005:967). The difference of surrogates to indicators is that they are forward-looking instead of being measures of current or past states (Carpenter et al., 2005).

This workshop aims at contributing to the understanding of vulnerability, adaptability and resilience in a subsistence farmers' context by presenting research on the farmers' attitudes to risk and uncertainty, on factors that determine vulnerability and adaptability, as well as by identifying threats to ecosystems and farming systems in which subsistence agriculture is embedded. Key terms and current scientific debates are shortly introduced below.

Resilience

In the context of social-ecological systems, the study of resilience investigates how a society deals with change and how the capacity of renewal and innovation is provided within a social-ecological system (Berkes et al., 2003). The resilience approach is 'founded on the understanding that the

natural state of a system is one of change rather than equilibrium' (Nelson et al., 2007). It is understood that the greater a society's resilience 'the greater is their ability to absorb shocks and perturbations and adapt to change' (Berkes et al., 2003:14) and that 'resilient social-ecological systems incorporate diverse mechanisms for living with, and learning from, change and unexpected shocks' (Adger et al., 2005a:1036).

Resilience is mostly used to describe the capacity for adaptation despite adversity (Manyena, 2006; Tompkins & Adger, 2004) and is widely seen as a desirable system property and a key to sustainability in ecosystem management. O'Brien et al. (2006:71) argue that 'resilience does not focus on what is missing in a crisis (needs and vulnerabilities) but on what is already in place (resources and adaptive capacities[1])'. Folke et al. (2003) highlight four categories of factors for building resilience: (1) learning to live with change and uncertainty; (2) nurturing diversity for reorganisation and renewal; (3) combining different kinds of knowledge, and (4) creating opportunity for self organisation. Howard et al (2006:11) summarise that 'characteristics of resilient systems may include a highly diverse (and hence redundant) resource base, a flexible set of subsistence strategies, well-developed coping strategies, a flexible set of institutions that organises people and creates clear rules for the management of resources and social relations, a sufficiently deep social memory[2] that has accumulated knowledge and experiences over a long period, as well as spaces for individual creativity and innovation, that can be drawn on to face current crises'.

Resilience and Vulnerability

Reduced resilience increases vulnerability, and thus, susceptibility to the impact of hazards. When considered with climate change, vulnerability is defined as the extent to which a natural or social system is susceptible to sustaining damage from climate change (IPCC, 2001). Vulnerability depends on many variables including exposure, physical susceptibility, socio-economic fragility as well as on the characteristics of a person or group and their situation that reduce their capacity to anticipate, cope with, resist and recover from the impact of natural hazard and other shocks (O'Brien, 2006; Manyena, 2006). A vulnerability analysis takes into account household livelihoods, food access, consumption and utilisation through different seasons or cycles to elucidate levels of food security, the type and magnitude of shocks faced by households in specific contexts, and the factors that constrain their ability to cope with those shocks (WFP, 2004 in Canali & Slaviero, 2010).

Resilience and Adaptive Capacity

Resilience is closely linked to the concept of adaptive capacity. Adaptive capacity confers resilience to perturbation, and increases the ability of ecological and human social systems to reconfigure themselves with minimum loss of function (Gunderson & Holling, 2002). Adaptive capacity has been defined as 'the ability to plan, prepare for, facilitate and implement adaptation options' (Klein et al., 2003:38). It depends on the available social, human, natural manufactured and financial capital as well as the system of institutions and governance (Walker et al., 2006 in Darnhofer et al., 2008).

Adaptive management

In order to cope with unexpected sudden impact of hazards, as well as to create long-term resilience to adverse conditions, humans continuously have to adapt their lifestyles and practices (Adger et al., 2005b; Oliver-Smith, 1996). A way to build resilience is 'to avoid being tied to specific response paths

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[2] Social memory refers to the 'diversity of individuals and institutions that draw on reservoirs of practices, knowledge, values and worldviews and is crucial for preparing the system for change, building resilience and for coping with surprises' (Adger et al., 2005a:1037).

by implementing flexible learning-based management' (Tompkins & Adger, 2004:10), which is key in adaptive management. Successful local adaptation activities to hazards are often based on long-term experience and build upon proven local knowledge (Berkes et al., 2000; Ellen, 2007; WB, 2003; Oliver-Smith, 1996 Sillitoe, 1998; Buchmann, 2009).

Local agricultural systems reflect various adaptations and learning cycles on how best to manage natural resources and to ensure sustainable production and reliable returns (Prance, 1995; Sillitoe, 1998). Such management is based on the ecological understanding, gained through social learning, trial and error experimentation, and repeated experience of adaptive cycles of disturbance-response-transformation (Howard et al., 2006). Local farmers may be well aware of the constant possibility of perturbations and there is 'growing evidence that the acknowledgement and confrontation of uncertainty adds to resilience' (Gunderson, 2003:38). They often have 'mechanisms specifically to deal with crisis, which they might periodically expect, and even in times of unanticipated disaster always utilise local knowledge as part of a strategy "to cope" ' (Ellen, 2007:22). Adaptation is not only reactive, in the sense that it is triggered by past or current events, but it is also anticipatory as it is based on some assessment of conditions in the future (Adger et al., 2005b).

However, although local 'knowledge and experience fashioned by adversity can be found in every community' (UN/ISDR, 2004:4), the increase of vulnerability to hazards continues 'largely because of the undermining of indigenous adaptations through direct government policies or political economic forces creating production systems inappropriate to local culture and environmental conditions' (Oliver-Smith, 1996:315).

Subsistence societies

Subsistence agriculture is one of few possible ways for rural people to survive under and adapt to extremely difficult conditions involving risks and uncertainties (Kostov & Lingard, 2004). The Food and Agriculture Organization of the United Nations stated that 1.4 billion people worldwide depend directly upon low-input, subsistence farming systems (FAO, 1996). Highly dependent on local resources these people usually have a good understanding of the sustainable use and conservation of biodiversity.

Traditional Ecological Knowledge

Traditional ecological knowledge (TEK) or indigenous knowledge[3] is embedded in the local culture and environment (Raedeke and Rikoon, 1997); it is dynamic, constantly adjusted, tried and adapted to new circumstances (Berkes et al., 2003; Ellen & Harris, 2000; Tengö & Hammer, 2003; Warren et al., 1995). TEK is described as 'a cumulative body of knowledge, practice and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment' (Berkes et al., 2000:1252).

There has been considerable interest in understanding local knowledge and how this might be incorporated into research, conservation and development discourses (Alcorn, 1995; Altieri, 1990; Prance, 1995). Studying agro-ecological systems, including management practices based on TEK, as well as understanding social mechanisms and social memory behind them, will assist in the process of designing alternative resource management and farming systems (Altieri, 2004; Berkes et al., 2000, Tengö & Hammer, 2003). Farms need to be 'interpreted as learning systems whose survival and growth strongly depends on the successful generation and absorption of new knowledge' (Darnhofer et al., 2008:345).

[3] Indigenous knowledge: 'local, orally transmitted, a consequence of practical engagement reinforced by experience, empirical rather than theoretical, repetitive, fluid and negotiable, shared but asymmetrically distributed, largely functional, and embedded in a more encompassing cultural matrix' (Ellen, 1998: 238)

Workshop objectives and research contributions to the workshop

This workshop provides a discourse on theories and methods aiming to identify and measure factors that build resilience within subsistence agriculture's different aspects. The emphasis of the research presented lies on how these aspects (e.g. cultural institutions, social mechanisms, agrobiodiversity, traditional knowledge) are interconnected and relate to the ability of the farmers to adapt to change. A range of interdisciplinary papers are presented in this workshop to analyse farming systems dynamics and the theories of adaptation and risk aversion. The workshop will not only help to identify common risk coping strategies to the challenges and problems that farmers face across the continents, it will also reveal adaptive risk management strategies and learning cycles that point towards theories, methods and solutions that may be applied elsewhere. Therefore risk management and the adaptation of traditional activities are portrayed using case studies from Africa, Asia, Latin America and Europe.

Canali and Slaviero (2010), for example, present research on food insecurity and risk management of smallholder farming systems in Ethiopia, based on methods that incorporate livelihoods into vulnerability and match economic and social dimensions with environmental and spatial analyses. Fischer and Buchenrieder (2010) analysed risks and risk management of vulnerable rural households in Northern Vietnam, highlighting the theoretical links between poverty, vulnerability and risk. Tibério, Torres Manso, Marta-Costa, Fonseca and Monzon (2010) emphasise that the development of traditional subsistence agriculture, agroforestry and food processing activities can be essential for the preservation of protected areas with the example of the "Serra de Montemuro" in Portugal. Cialdella and Dedieu (2010) investigated the underlying action logics with which family livestock farmers maintain their activity over the long term, despite internal and external disturbance. Results from case studies in France, Uruguay and Argentina are drawn together to identify patterns of adaptive paths that are taken by family livestock farmers. These patterns include optimization, diversification, enlargement, autonomy and flexibility. Cialdella and Dedieu (2010) discuss how the identification and analysis of such patterns can improve resilience assessments of family livestock systems. Coquil, Dedieu and Béguin (2010) provide a review on the dynamics of farming systems. They describe a double co-evolution: the co-evolution of the farming system and its environment, and of the farmer and his biotechnical system. Coquil et al. (2010) highlight the need to include an analysis of 'learning' in addition to the analysis of 'farmer activities' in farming systems that are facing increasing uncertainty in their environment.

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