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Adaptation as innovation, innovation as adaptation: An institutional approach to climate change

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Global climate change and growing environmental instability affect local communities in many parts of the world. Institutions at multiple scales mediate responses to climate change while rapidly changing and adapting to new demands. The papers in this collection build on the insight that effective responses to climate change require innovation – technological as well as institutional and relational. Innovations are human adaptations to changing needs and socio-economic conditions, and are therefore embedded in social processes. The concept of social innovation draws attention to the broader, collective dimensions of these adaptive practices. This special section focuses on analyzing social innovation in the context of adaptation to climate change and associated variability, investigating the emerging institutional spaces, networks and coalitions.

We aim to contribute to the ongoing conversation about the applied and interdisciplinary dimensions of climate adaptation research. The articles published in the 2010 special issues of the *Annals of the Association of American Geographers* and the *Journal of Applied Geography* on climate change demonstrated the importance of a place-based approach in understanding the severity of the impacts of climate change. While celebrating the breadth of contributions that geographers have made to a very important topic of the 21st century, the papers also call for integrating variations between physical and human systems in future research (Yarnal, 2010). They outline a need for "practice-relevant" and locality-based research on vulnerability and adaptation that particularly draws on social science perspectives on climate action in response to climate change (Moser, 2010: pp. 466–467). This means expanding the landscape of climate change research to consider broader sets of issues, including institutional, social and cultural matters. The papers in this issue aim to illuminate the still poorly researched human dimension of local climate adaptation, concentrating on local institutions and their multiscale embeddedness. They highlight the collective and collaborative dimensions of innovation, expanding the notion of adaptation that is crucial to enabling appropriate policy responses. While contributing to an interdisciplinary integration of climate change research, the collection explores climate adaptation and innovation through multiple disciplinary lenses and across diverse geographies. The articles are the outcome of two collaborative workshops organized by the Initiative on Climate Adaptation Research and Understanding through the Social Sciences (ICARUS).

Social dimensions of climate adaptation: institutions, community, and social innovation

The effects of climate change are most pronounced among poor and marginal populations whose livelihoods are primarily natural resource based, and where climate change has a potential to cause long-term transformations in local social–ecological systems. As

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recent research on climate action suggests, concentrating on short-term strategies of hazard mitigation and risk management does often not allow for an in-depth analysis of local vulnerabilities (Adger, 2006; Ribot, 2010). There is a growing emphasis on preparing for climate variations by encouraging adaptation: "a process whereby societies improve their ability to manage climate risks and climate fluctuations" (Heltberg, Siegel, & Jorgensen, 2010, p. 260). Viewing local adaptation as contributing to a long-term ability of local populations to cope with climate risk calls attention to wider social and economic drivers of vulnerability. The focus in climate adaptation research has therefore shifted to examining the interaction of different variables, highlighting the effects of "multiple stressors on people's well-being and livelihoods" (O'Brien et al., 2009, p. 24). Climate action is increasingly viewed as an integral part of sustainable development, contributing to "both equity and environmental integrity in the long term" (Eriksen & Brown, 2011, p. 3). Sustainable climate adaptation strategies therefore draw not only on local practices and knowledge, but also take account of local power differences and divergent interests in the community (Eriksen et al., 2011). Questions have furthermore arisen concerning the best ways to study the social and political-economic dimensions of local vulnerability, as "climate events … are transformed into differentiated outcomes via social structure" (Ribot 2010, p. 49).

Structural patterns of poverty and marginalization contribute directly to climate vulnerability and shape local responses to climate stress. Much recent climate action has concentrated on building local resilience through participatory techniques and community empowerment. As climate change affects most harshly the poorest populations and social groups, special attention has been directed to local structural inequalities, and the voice and representation in decision-making of these groups. Effective claim-making on local resources as well as support from public institutions have become essential for enhancing the climate resilience of the poor. Adger (1999, 2003) has suggested that the effectiveness of local collective action is the major determinant of the ability of societies to adapt to climate change. He argues that in resource-dependent livelihoods with multiple property-use regimes, environmental management and climate adaptation are strongly dependent on "networks and flows of information between individuals and groups" (Adger 2003, p. 389). Local networks and associations, and the relationships and patterns of reciprocity and exchange, are therefore paramount to building adaptive capacity.

In order to investigate climate vulnerability in the context of a "wider political economy of resources use", Ribot (1995, 2010) suggests examining the "multiscale causal structure" of local vulnerabilities and the practices of their management (Ribot, 2010: pp. 50–51). This enables one to look for the reasons for stress as well as for the mechanisms of change within the social system without an excessive focus on external interventions, and illuminates how environmental management is socially and spatially differentiated. Resource entitlements and the capacities they create are at the center of the social obligations and debt networks affecting local environmental action. An investigation of local adaptation practices with a focus on historical experience and traditional environmental knowledge helps to trace these social dynamics and uncover important loci of innovation. Because the concept of social innovation draws attention to the ideas, patterns and strategies pertaining to social issues, civic institutions and collective action, it shows a great potential for analyzing climate action in the complex and multiscale institutional environments of the developing world.

Attention to social actors with their diverse interests and purposes helps to contextualize the notions of community and participation. A focus on the ways social action and innovation can build local resilience has a potential to facilitate analytical frameworks as well as policy applications that encourage sustainable climate adaptation. The papers in this collection explore the relationships between social innovation and climate adaptation in complex vulnerability environments. They draw attention to local micro-politics and the interface between the formal and informal in local climate action. The importance of social innovation as occurring within the embedded scales of the adaptive system and encouraging collective action and learning is explored in Rodima-Taylor's paper, "Social Innovation and Climate Adaptation: Local Collective Action in Diversifying Tanzania". The informal mutual help groups among Kuria people involved both customary patterns as well as important innovations, and their flexible and participatory format enabled local farmers innovative approaches to managing their livelihoods. Building upon micro-level, relational dynamics, the mutual help associations encouraged experimentation and creative innovation as well as non-hierarchical connections between the scales of the adaptive system. The local associations provided viable adaptation mechanisms in the contexts of environmental instability and economic diversification. Eriksen and Selboe's paper, "Local Adaptation to Climate Variability and Global Change in Norway: The Case of a Mountain Farming Community", similarly demonstrates the continued dependence of the farmers on informal social relations to manage the increasing formalization of rural agricultural production. The article draws attention to the potential limits of innovation and adaptation under increasing pressures to formalize local relations of production, and emphasizes the need for a policy framework that accommodates existing informal structures and local collective action. The importance of viewing local adaptation strategies as a product of multi-level discourses and institutional practices is emphasized in Olwig's paper, "Multi-Sited Resilience: The Mutual Construction of 'Local' and 'Global' Understandings and Practices of Adaptation and Innovation". Through local groups, local and global discourses on participation and climate change are shaped and re-interpreted, with a potential to both limit as well as encourage new spaces for local agency.

The issue of institutional articulation is revealed as being primary in shaping the effects of social and institutional innovation on climate adaptation. Upton's study of institutional innovation in post-socialist Mongolian rural communities, "Adaptive Capacity and Institutional Evolution in Contemporary Pastoral Societies", shows that the donor-initiated herders' groups (*nukhurlul*) have not achieved their full potential, partly because of weak institutional linkages and partnerships. In their paper "Migration as a contribution to resilience and innovation in climate adaptation: Social networks and co-development in Northwest Africa", Scheffran, Marmer and Sow argue that creating an enabling environment for local innovation may turn migration into a successful adaptation strategy. Migrant social networks can build the climate resilience of the communities of their origin by increasing local diversity and creativity through various joint environmental initiatives, opening up new pathways for co-development. The impacts of institutional connectivity to adaptation are also examined in the contribution by DiGiano and Racelis, "Robustness, Adaptation and Innovation: Forest Communities in the Wake of Hurricane Dean". Strong local governance systems and multi-directional communication between institutional levels are seen as important contributors to social learning and creative climate adaptation. The paper by Chhetri, Chaudhary, Tiwari and Yadaw, "Technological and institutional innovation in agriculture: understanding agricultural adaptation to climate change" investigates the success of the collaboration of farmers and their supporting institutions in co-producing climate-sensitive technologies in the rural communities of Nepal. Attention is on novel institutional partnerships that

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facilitate the involvement of plural knowledge systems and multiple sources of innovation in local adaptation thus illustrating how climate insecurity can become a powerful driver of technological and institutional innovation.

Technological and institutional innovation in climate adaptation

While there is an increasing recognition that many adaptation actions are local and build off experience of managing past climatic risks (Christoplos et al., 2009), there can be barriers and limitations to adaptation. These can come from several fronts including inadequate climate information (Deressa, Hassan, Ringler, Alemu, &, Yesuf, 2009), partial understanding of climate impacts and uncertainty about benefits of adaptation (Hammill & Tanner, 2011), institutional inertia and lock-in (path dependency) (Chhetri, Easterling, Terando, & Mearns, 2010), disconnect between climate science and policy leading to a lack of use-inspired research (Moser, 2010), insufficient credit access (Bryan, Deressa, Gbetibouo, &, Ringler, 2009), and weak market systems (Kabubo-Mariara 2009). By using the conceptual infrastructure of the hypothesis of induced innovation, such as done by Chhetri et al., in this issue, researchers can extend the boundaries of climate change research to take into consideration the role of institutions in the innovation and delivery of technologies to enhance the adaptive capacity of a society. The hypothesis of induced innovation refers to the process by which societies develop technologies that facilitate the substitution of relatively abundant (hence, cheap) factors of production for relatively scarce (hence, expensive) factors in the economy (Hayami & Ruttan, 1985). The concept has earned recognition in climate adaptation and has been used to explain the complex process of institutional and technological change (Koppel, 1995). While the role of climate as a stimulant for institutional and technological innovation is a difficult assumption to test (Abler, Shortle, Rose, & Oladosu, 2000), scholars have drawn on this hypothesis in explaining the possible relationships between change in resource endowment and the development of new institutional and technological arrangements (Easterling, 1996; Gitay, Brown, Easterling, & Jallow, 2001). Insights about the role of climate as a stimulus to innovation are therefore crucial to improving our understanding of adaptation to climate change.

One of the most important insights of this hypothesis is that the innovation of technologies that are needed to respond to the emerging threat of climate is the function of change (or difference) in resource endowment and the ability of institutions to deliver technologies on demand (Chhetri & Easterling, 2010). Technological change is treated as being induced by institutional change (Koppel, 1995). Institutionalized research is therefore crucial for producing innovations leading to advanced technologies capable of making society resilient and adaptable. Institutional change, in turn, is treated as induced by changes in factor supplies (e.g., land, water) and product demand (e.g., food, health) and affected by technological change (e.g., high yielding varieties, better medicine) (Hayami & Ruttan, 1985). Institutions that lack the mandate and knowledge to implement climate-sensitive measures can diminish the adaptive capacity of the social–ecological system (Moser, 2009). The innovation of appropriate technologies therefore depends on the sensitivity of institutions to progressively respond to climate change.

As climate changes there may be a more pronounced focus on wider partnerships between all stakeholders and on the co-production of knowledge. Nepal's evolving experience in dealing with the nation's dwindling food security has shown a demand for a broad participation of farmers and their supporting institutions in innovation of technologies. The research establishment in Nepal has developed novel multi-level institutional partnerships, including collaboration with farmers and non-governmental organizations at the critical stages of technological innovation (Chhetri et al., in this issue). In their paper Chhetri et al. also show that existing centralized top-down institutions are increasingly being complemented and sometimes challenged by new forms of collaboration, including public–private partnerships and demand led collaboration. Yet, notwithstanding this recognition, there is a dearth of research that unravels the role of climate as a stimulus for the innovation of appropriate technologies (Ruttan, 1996; Smithers & Blay-Palmer, 2001).

As the transition to a new and highly variable climate does not occur in an institutional vacuum (Agrawal, 2008, 2010), efforts to generate appropriate adaptation response require institutional arrangements that empower the stakeholders to co-produce the technologies needed to address the new challenges. The induced innovation framework enables the researchers to extend the boundaries of climate change research by taking into consideration the role of institutions in the innovation and delivery of technologies to enhance the adaptive capacity of the society. The impacts of climate change are already being observed, and because of a lag in natural systems, more and severe challenges are inevitable (Burton, Huq, Lim, Pilifosova, &, Schipper, 2002). At the heart of climate response strategies lies the issue of how smallholder farmers in developing countries cope with variable and unpredictable climate (Christoplos et al., 2009). Local communities and NGOs are demanding an increasingly active role of public institutions in the delivery of technological options to cope with emerging climate challenges (Prowse & Scott, 2008). Despite the importance accorded to the role of institutions in fostering adaptation, few researchers have investigated how the challenges of managing natural resources may induce new forms of institutional arrangement that can facilitate adaptation to climate change. Much of the attention on the effects of climate change in developing countries has focused on its impact on natural systems, producing little insights on the present and future adaptability of whole systems. However, the effect of climate variability on innovation is a crucial factor in the calculus of understanding the adaptive potentials of social–ecological systems.

The local and the global: multi-level institutional linkages and climate adaptation

Globalization has increased the mobility of not only people, information and resources, but also new ideas and discourses that can facilitate innovation and adaptation. Local innovations and adaptations are thus increasingly interlinked with global policy and intervention indicative of a profound global interconnectedness between institutions and actors. Indeed, the global is embedded in the local and vice versa. The very notion of the local and the global constituting a dichotomy is, in fact, problematic because it is based on the idea of "society as a bounded object or closed social system analogous to an organism", which it is not (Leach, Mearns, &, Scoones, 1999: pp. 229–230). Rather, as Liep (2001: p. 169) explains: "the modern or global is not something advancing at the boundary of the local but present and active in the midst of it. […] Regarding creativity, we have thus seen that its viability is not only dependent on the resonance of a local social environment, but subject to the stark realities of a much wider context".

Individuals adapt and are innovative through complex interactions between institutions and actors at multiple scale levels. These processes are multi-directional and not – as would be proposed by a structuralist approach – only the result of larger scale institutions, such as those of donors and national government, providing a structure within which local actors must navigate. As Leach et al.

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(1999: p. 235) point out: "the interrelationships between scale levels are far from deterministic. Land claims at the local level may spill over into national, state or provincial-level politics, for example, and influence the direction of future policy and the scope of legally enforceable rights". Scale is a social construction, not a force of nature. Furthermore, institutions are dynamic (Agrawal, 2010: p. 174) and some institutions, as discussed by Yarrow, even alternate between global and local identities depending on the circumstances. Thus, in his study Yarrow (2008: p. 438) found that "the opposition between local and global was employed relationally to make a variety of contextual distinctions and to perform a range of shifting identities". Local and global understandings and practices of innovation and creativity in face of climate change are therefore entangled and cannot be analyzed as distinct.

Research on the interrelationships between local and global processes shaping adaptation is still in its infancy. Although "cross-scale linkages (crossing boundaries from local to global levels) are commonly asserted to be important in social processes", Adger et al. (2005: p. 80) noted in 2005, "in examining adaptation, the dynamic nature of linkages between levels of governance is not well-understood, and the politics of the construction of scale are often ignored". Six years later, in 2011, the situation is only just beginning to change according to Pelling (2011: p. 163): "Perhaps most important are the interactions between different levels of social actor (individuals and organizations) and of the institutions that give shape to social systems. Research and policy on adaptation to climate change is just beginning to recognize the full contribution of values and governance to behavior and action". Recent work on the importance of the social aspects of climate change (see for example Mearns & Norton, 2010; Pelling, 2011), has thus particularly highlighted the interaction between institutions and actors across multiple levels (e.g., Agrawal, 2010; Ribot, 2010).

The articles in this special section contribute to the new focus in research on the social dimensions of climate change by illuminating the important vertical and horizontal interconnections between institutions that constrain as well as open up for new spaces of local and global adaptation and innovation. In the context of a developed country, Norway, Eriksen and Selboe explore how farmers adapt to a changing climate through informal and formal collaboration at different levels. They find that these collaborative relations are interdependent involving both formal economic exchanges and informal social ties that depend on personal trust. In the contrasting context of a developing country Upton examines the complex processes whereby endogenous and externally initiated institutions enable as well as limit local strategies and capacities for adaptation in Mongolia's Gobi region. Interestingly, novel donor-initiated herders' groups led to innovative adaptation, but when faced with difficulties, there was a reversion to traditional informal institutions. In a different setting, among the Kuria in Tanzania, Rodima-Taylor similarly found that informal civic institutions, in the form of informal work groups and community associations, were of crucial importance. The success of the government-initiated decentralization program and its impacts on resource management and climate resilience depended on the partnerships of the new formal administrative institutions with local customary authorities and informal community groups.

Acknowledging the importance of local values, organizational forms and abilities, the donor organizations in Olwig's study seek to engage local people in donor-initiated participatory groups. Through this method global donor organizations aim to involve local populations in the construction and implementation of projects that build resilience in the context of disasters and climate change. Olwig argues, however, that due to the strong presence of globally funded organizations in areas such as northern Ghana global donor organizations' notions of local capacity in the context of climate change affects how the local populations believe projects are best implemented. Through this process, local and global understandings and practices of resilience building become mutually constructed. It is therefore inadequate to focus on only one kind of institution; the interrelation between the formal and the informal, the traditional and the modern, is crucial.

In the context of the impacts of Hurricane Dean on forest communities in Mexico, DiGiano and Racelis point to the possibilities for adaptation facilitated by "connectivity". They identify horizontal and vertical connectivity as one of five factors that shapes the adaptive capacity of social–ecological systems; the better connected, the greater adaptive capacity. Not just any kind of connectivity is beneficial, however. DiGiano and Racelis stress that unidirectional connectivity (e.g., high dependence on external actors) is problematic, for example because it often leads to poor information flow. The question of power relations between different institutions and actors is an important topic that cuts across the articles in this special section. In her discussion of the dominant role of donor organizations in northern Ghana Olwig points to the risk that the current global concern with building on local capacities through participatory groups creates a discourse founded upon a donor imaginary of what could be called the "appropriate recipient". This means that only someone who displays the appropriate mix of resourcefulness and need will be regarded as suitable to become a member of a group benefitting from development projects. In the end, the donor imaginary may create new victim categories – those that do not fit this image and therefore are not able to join groups.

While the articles in the special section underscore that skewed power dynamics between global and local actors are important, they also stress the significance of dimensions of power within nations, communities and households. Eriksen and Selboe discuss how, in Norway, power dimensions are pertinent as it is assumed that planned policy interventions – formal institutions – automatically will lead to adaptation. For this reason, local values and perceptions – informal institutions – risk being ignored thus disempowering the local farmers causing local inaction instead of innovation and adaptation. A discussion of power thus leads back to the theoretical discussion of structural-functionalist versus actor-oriented analysis. As Leach et al. (1999: p. 238) state: "To understand how different actors' practices are embedded in – and help to shape – such a range of formal and informal institutions necessitates an actor-oriented approach to understanding institutions […] one which takes an analysis of difference and an appreciation of power relations seriously". Upton's article underscores the problems that can arise when donors do not fully appreciate local differences and power relations. Upton examines institutions that are donor initiated, but because the donors have a poor understanding of local mechanisms of institutional access, both the wealthiest and poorest tend to be excluded.

In their contribution to this volume, Chhetri et al. offer a positive case of institutions cooperating across levels in a way that overcomes certain power issues. Their article thus feeds into arguments being made in the literature stressing the importance of "institutional partnerships across the civic-public-private domains in the context of climate adaptation" (Agrawal, 2010: p. 179). Examining technological innovation in the context of agricultural adaptation to climate change in Nepal, they find that the multi-level institutional partnerships that have been created and which involve collaboration with farmers and NGOs, have enabled the government to efficiently transfer agricultural technologies to farmers. Farmers have been taken seriously not only as end users, but also as active participants in the innovation of new technologies. Scheffran, Marmer and Sow provide another example of successful interconnectedness between institutions at different levels in their

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discussion of co-development projects in the Western Sahel. Providing an alternative to the idea of migration as merely leading to brain drain they relate how migrants have provided important links between their home communities and host regions through collective development projects. Migration can thus lead to the strengthening of social networks across regions and the generating of opportunities for innovation and adaptation through the exchange of knowledge and resources.

The articles in this special section thus point to several key elements of the multi-level institutional linkages that shape adaptation and innovation in the context of climate change. They demonstrate that informal, formal, endogenous and externally initiated institutions are interdependent and equally important in processes of adaptation and innovation. They also show that increased connectivity and interaction between these many different kinds of institutions can be beneficial, yet highly influenced by power dynamics. By focusing on partnerships and by acknowledging the mutual construction of adaptation and innovation across global and local levels, it is possible to avoid losing sight of the agency of actors. It is after all individuals who get novel ideas, not the structures within which they navigate.

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