Climate change vulnerability and adaptation assessments

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The fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) confirmed the warming of the climate system. The report also highlighted the various impacts that social, economic and ecological systems are currently facing and will have to anticipate in the coming decades and centuries, including changed frequency and magnitude of extreme weather as well as sea level rise (IPCC 2007a). Given the inertia generated by the various chemical and physical processes in the atmosphere, and the difficult political negotiations related to mitigation and adaptation as exemplified by the limited outcomes of COP15 in Copenhagen in December 2009, there is an urgent need for assessing our vulnerabilities linked to the effects of climate change and to start adapting to its foreseeable consequences.

In the past few decades, much research has been devoted to vulnerability assessment in the context of both disaster risk reduction (DRR) and climate change. Despite the fact that the DRR and climate change adaptation (CCA) communities both address the negative impacts of hazards on society, they have worked mostly independently from each other and have given different definitions and conceptualisations to vulnerability, risk and adaptation. For example

the definition of vulnerability by the DRR community¹ (UN/ISDR 2004) is different in terms of elements and processes considered when compared to that given by the IPCC (2007b)² whereby the latter, in contrast to the former, puts an emphasis on the characteristics of the hazard. As another example, the DRR community uses the term “coping” to characterise how people face-up to hazards whereas the CCA community uses the term “adaptation”, which can be anticipatory, autonomous or planned. Reasons for these differences are manifold and have been reviewed by Birkmann et al. (2009) and Thomalla et al. (2006).

Increased integration of disaster risk management and risk reduction strategies with CCA is required to reduce future climate-related risks (Hyogo Framework for Action 2005; Bali Action Plan 2007) and the two approaches should be included in policies linked to development planning in order to contribute to achieving the goals of sustainable development (McBean and Ajibade 2009). Synergies between the two communities do exist and need to be built upon and developed further in order contribute to reducing the vulnerability of communities and systems that are increasingly exposed to environmental hazards.

This special feature comprises papers that contribute, through review, theory and practical applications, to bridging the gaps between the disaster risk and climate change communities around a shared vision to prepare

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¹ Vulnerability is the condition determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards.

² Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity.

societies and help them adapt to extreme events. The first two papers were selected because they present the theoretical arguments for integrating the sometimes disjointed views on vulnerability from the various schools of thought working on the topic. The last three papers provide practical analysis and modeling of how communities as diverse as coastal villages of the Coral Triangle countries, urbanites in Asia's biggest cities, and resource-limited towns in the Middle East are impacted and build resilience to the cascading effects of a changing climate. The message article by Carl Folke sets the scene in terms of systems that need to be considered in the context of sustainable development, DRR and CCA: the artificial separation of nature and society that has prevailed in the past is being replaced by the notion of social–ecological systems whereby people and nature are interdependent. In this context, vulnerability assessment needs to account for multiple social and ecological systems and the feedback mechanisms that characterise their interactions at various spatial and temporal scales. These dynamic systems are reflected in the papers included in this special feature.

The concepts of vulnerability and the methods developed for its assessment have been investigated on two separate tracks by the natural hazard and climate change communities. Emmanuel Romieu and his co-authors analyse the reasons for the initial divergence, and recommend ways to bridge the two communities in order to show optimal adaptation pathways and contribute to DRR. The task is not trivial, as temporal and spatial scales for assessments vary greatly (planning for 2050 or 2100 in the case of CCA vs planning for now in the case of DRR). Romieu et al. highlight the fact that adaptation strategies focus on existing risks (which might be aggravated by climate change), and that DRR also constitutes an adaptation strategy. Potential areas for synergies exist, including more integrative cross sectoral, multi-scale approaches and putting communities at the centre of analysis.

In the second paper, Birkmann and von Teichman note that the majority of environmental hazards are hydro-meteorological in nature, and have the potential to become more frequent or more extreme as a consequence of climate change. The authors conduct a thorough literature review and present the results of 38 expert interviews to make recommendations and to propose quality criteria for the development of cross-sectoral and multi-scale approaches; the development of coherent norms and assessment tools; and, for the improvement of information and to expand the knowledge base. Finally, Birkmann and von Teichman show how CCA concepts can be incorporated concretely into the various phases of the disaster cycle.

Rural farmers are very well aware that variations in climate directly affect their livelihoods; but Birkmann and co-authors remind us that it is in the cities of the

world—many of them located in low-lying coastal areas with informal settlements—that we find constraints to adaptation. Yet the consideration of CCA strategies in urban areas lags far behind the actions that are taking place or being envisaged in rural areas. This is so despite the fact that urban centres are where populations and critical infrastructure are concentrated, and that they play major economic roles at the national level. The authors appraise the CCA strategies of nine cities worldwide and combine this approach with more empirical research in two cities in Vietnam where they derive key questions for a more in-depth analysis. The need to link adaptation strategies over time and space are again visible in the detailed analyses of Ho Chi Min and Can Tho cities. The paper builds on the knowledge presented by Birkmann and von Teichman and provides new directions for adaptive urban governance.

More than extreme weather events, sea-level rise is the largest concern for small island nations in the decades to come. This threat was the impetus for a collective negotiating strategy at COP 15 in Copenhagen in December by small island developing states for adaptation assistance. McLeod and co-authors used the dynamic interactive vulnerability assessment (DIVA) model to estimate the effects of sea level-rise in the countries of the Coral Triangle, and to assess the expected coastal changes in terms of impacts on ecological, social and economic systems. Results show significant, if inconsistent, impacts. Within the 2100 time horizon, Indonesia could see 5.9 million people affected by flooding, and the Philippines may see the highest economic impacts at US \$6.5 billion per year when no adaptation initiatives are taken. The largest ecological impacts would occur in the numerous coastal wetland areas in the region. Model simulations demonstrate that consideration of adaptation measures drastically reduced the negative impacts of sea-level rise. The authors provide useful suggestions to improve the reliability of modelling in the future, thus meeting some of the concerns highlighted by Romieu and co-authors in the first paper.

Lastly, Shahbazbegian and Bagheri compare long term impacts of drought on two cities in Iran—one abundant in water resources and the other under constant water stress. Their results indicate that water-limited communities are less vulnerable to droughts as they have adapted their economic activities to conditions of water scarcity as opposed to communities that do not perceive water as a potentially limiting resource. The authors use the concept of viability loops to model secondary drought impacts such as loss in income and out-migration. An improved approach to gauging vulnerability is proposed through monitoring and indices of agricultural performance, water utilisation, and diversity.

While recognising that the world is moving towards a future with changing climate averages, it is the increasing

impacts due to large percentage change in extremes that is worrisome. The IPCC recognises this fact, which is leading to its preparation for a special report assessing factors that make human and non-human systems vulnerable to extreme events; how present and future patterns of extremes relate with climate change; and, ways of managing the risks of disasters over a wide range of scales in time and space (Field and Barros 2009). Thus, this special issue of *Sustainability Science* is expected to provide additional sources of information to the on-going IPCC special assessment as well as contribute to the continuing discussions of risk management and risk reduction strategies started by the Bali Plan of Action at the UNFCCC.

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