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## Editorial

# Tipping Points in Adaptive Capacity and Adaptation Processes

Matthias Garschagen*,‡ and William Solecki†

*Head of Vulnerability Assessment,
Risk Management and Adaptive Planning (VARMAP)
Institute for Environment and Human Security
United Nations University, UN Campus
Platz der Vereinten Nationen 1
D-53113 Bonn, Germany

†Department of Geography
Hunter College
City University of New York
695 Park Avenue, Rm 1006 HN
New York, NY 10065, USA

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Tipping points have become phenomena of great interest within the science of global environmental and climatic change as well as and extreme events (Scheffer 2009). Engaging with tipping points conceptually and empirically can help to decipher the dynamics and complexity of systems undergoing change. Tipping points are typically characterized as being reached when the system in question surpasses a critical threshold at which a rather small additional perturbation can cause a comparatively abrupt and significant shift in the system configuration, moving it from one state or regime to another (Lenton *et al.* 2009; Renaud *et al.* 2010). The current interest in tipping points has largely been fueled

‡Corresponding author's email: garschagen@ehs.unu.edu

by attention to the potential for abrupt, non-linear and climate change-triggered shifts in the elements of the Earth system, e.g., the melt-down of the Greenland Ice Sheet or the disruption of the Atlantic thermohaline circulation (Lenton *et al.* 2008; Kriegler *et al.* 2009). Efforts have therefore been directed towards characterizing such tipping points and finding possible early warning signals (Scheffer *et al.* 2009); the identification of which remains to be one of the most prominent analytical challenges. Apart from the long-term risks such as sea level rise, these shifts in the Earth system can have direct effects of the frequency, magnitude and geographical patterns of extreme events. Recent data suggests for instance, that changes in the jet stream contributed to the Russian heat wave and Pakistani floods in 2010 (Schellnhuber and Martin 2014). Along with the tipping points in environmental systems and natural hazard patterns, there can be sudden surges in the impacts on human systems (Lenton and Ciscar 2013). In fact, these tipping points in impacts are one of the main triggers for the increased attention to Earth system tipping points in the first place. For example, the question arises whether tipped regional climate systems can cause widespread and rather abrupt changes in agricultural yield potentials.

Yet, despite the increasing engagement with tipping points in the *hazards* and expected *impacts* of environmental change, there has been little empirical or theoretical engagement with tipping points in *adaptive capacity* and in the *adaptation processes* of actors or entire social systems. More often than not, adaptation and the build-up of adaptive capacity is considered as a smooth and rather linear process, driven by the continuous accumulation of experience, knowledge, capabilities and political support. Yet, there are increasing empirical signals which demonstrate that considering adaptation as such a steady process disregards the reality of much more erratic trajectories often observed in adaptation and the development of adaptive capacity. First steps towards a concept of adaption turning points have been suggested in the literature (Werners *et al.* 2013). The aim therein is to analyze when and where climatic change exceeds socio-technical thresholds (e.g., the capacity of an existing flood protection system) and leads to turns in adaptation (e.g., the implementing of a new dyke system), thereby guiding adaptive development pathways (Haasnoot *et al.* (2013). Yet, even in this concept the agency and trigger are clearly considered to sit with the environmental change, while the cultural, political and social adaptation responses are mainly considered to react.

We are argue in this special issue that such an understanding of tipping points falls short of acknowledging other important dimensions of adaptation dynamics and the potential for tipping points in adaptive capacity and adaptation processes irrespective of the environmental changes. Rather, we ask whether adaptive capacity and determination to adaptation may not be influenced equally — or even

more strongly — by shifts in social, economic and political conditions that are not related to climate or environmental change in the first place. In low and moderate income countries, for instance, shifts in adaptive capacity often can be strongly linked to non-environmental trends or changes such as rising price levels, growing disparity or creeping corruption. While such trends typically behave in linear ways, they have the potential to trigger abrupt and non-linear changes in adaptive capacity, e.g., when a state-bureaucracy rapidly loses its functionality after exceeding a certain level of corruption or when disparity erupts into social conflict after trespassing a certain limit. At the same time, tipping points towards a rapid increase in adaptive capacity can also exist, e.g., upon major political shifts, such as recently in Myanmar, or access to a new technology such as a vaccine.

These heuristic examples point to a number of questions that inspired the discussion at two academic geography conferences (in Berlin and Chicago in 2015) that are behind the topics examined in this special issue: Which different types of tipping points in adaptive capacity and adaptation processes can be observed? How do they relate to technical, financial, cultural, political, cognitive and other aspects of change? What is the role of limits versus opportunities in triggering abrupt adaptation changes? How are tipping points influenced by creeping changes versus extreme events? What is the role and importance of adaptation turning points that are directly linked to environmental changes and their impacts versus tipping points that might not be linked to environmental changes (Figure 1)? If there is a duality in adaptation tipping points, how can those that shift adaptation pathways in "positive" directions be fostered and those that cause "negative" trajectories be avoided? Which tipping points in adaptive capacity and adaptation processes are reversible and which are not? When, how and why do adaptation regimes shift from one paradigm (such as resistance or resilience) to another (e.g., to more fundamental transformation) (Solecki *et al.* 2017)?

The papers of this issue address these questions in one way or the other. Together, the special issue aims to collect and discuss empirical as well as theoretical researches on tipping points related to adaptive capacity and adaptation processes. The goal is to contribute to the refinement and advancement of

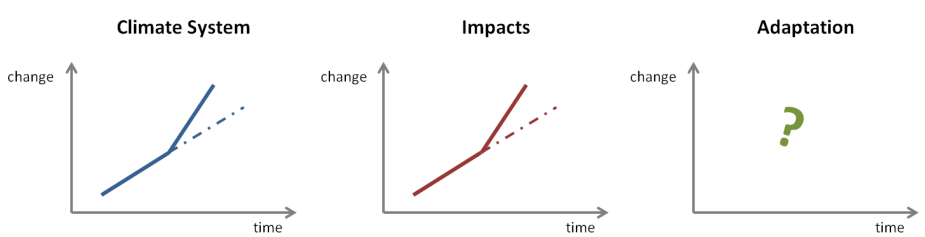


**Figure 1.** Tipping Points in the Climate System and their Impacts versus Adaptation

adaptation scholarship by: (a) Addressing current gaps in the empirical knowledge and conceptual representation of adaptation dynamics, (b) Providing heuristic insight into adaptation-related tipping points and (c) Inspiring a future research agenda.

The paper by Hartmut Fünfgeld combines conceptual thoughts with two case studies from Australia to analyze "Institutional Tipping Points in Organizational Climate Change Adaptation Processes." It asks how institutional dynamics that enable or hinder climate change adaptation in social groups and organizations can be better understood. It specifically seeks to explain why some social groups adapt to climate change while others with similar structures, mandates and resources do not. The paper draws on institutional theory to develop a multi-scale framework for detecting and encouraging positive institutional tipping points, labeled "virtuous." Through his case studies, Fünfgeld offers insight on organizational tipping points at which organizations shift from one dominant regime of dealing with climate change (skepticism and foot-dragging) to another (embracing proactive adaptation action), triggered by the inclusion of adaptation goals into the strategic planning directions. Whilst the momentum for this change of regimes had slowly built up informally, it could only unfold its full impact on adaptation action upon formal enactment — but then with brisk force. The paper concludes with naming five future research needs, including the need for coherent analytical framework for tipping points in the social realm and tools for deciphering early signs for institutional emergence and change.

The paper by Sarah Burch *et al.* looks into "Tipping for Transformation: Progress, Patterns and Potential for Climate Change Adaptation in the Global South." It takes issue with the fact that despite the surge in climate change research in the global South and the plethora of case study projects, rather little is known about the broader trends and shifts across cases. The paper is particularly interested in analyzing whether and to what extent the sum of single projects leads to adaptation actions that push larger social–ecological systems over tipping points and towards a more desirable and sustainable state, especially with regards to transformative change that is necessary for fundamentally redirecting current development models towards sustainability. In order to shed light onto these issues, Burch *et al.* assess 54 adaptation research projects, sponsored by three key donors of adaptation research in the global South. They find that, overall, the reviewed projects can be characterized as incremental rather than transformative, most notably by addressing symptoms of vulnerability rather than the systemic root causes of unsustainable development pathways. This is because the projects typically are too short, not capturing the full spectrum of relevant actors, too narrowly focused on behavioral changes rather than system-wide governance shifts, too compartmentalized into different thematic clusters, not well coordinated

with each other and focused too vaguely on the actual transition towards transformative action, rather than the preparation for it. The paper closes with developing key questions for future research, most notably addressing a required reorientation of donor-funded adaptation research projects towards making effective contributions to long-term and fundamental transformation.

The paper by David Eisenhauer deals with "Tipping Points in the Anthropocene: Crafting a Just and Sustainable Earth." It supposes that the arrival of the Anthroposcene entails an evolutionary tipping point which challenges the basic precepts of the political theory and modern science. The purpose of the paper therefore is to assess how political theory, critical social science and humanity chart culturally relevant and politically motivated pathways for responding to an increasingly non-linear and unpredictable world within the Anthropocene, full of tipping point crossings. Drawing on its review, the paper argues that the Anthropocene and its tipping points are not challenges to be overcome through already existing, but rather new political practices. It uses the four concepts of possibility, irreversibility, entanglement and novelty to specify this argument.

The paper by Sven Fuchs and Thomas Thaler assesses "Tipping Points in Natural Hazard Risk Management: How Societal Transformation can Provoke Policy Strategies in Mitigation." It asks how different groups of society act to complement conventional risk management policies and initiate societal transformations — occurring rather abruptly — to which established institutions of risk management in turn have to adapt. Fuchs and Thaler draw on empirical findings from three case studies in Austria, comprising data from interviews, scenario techniques and policy analysis, to assess the potential tipping points in the implementation of innovative risk management systems. The find that tipping points are shaped by a complex mix of top-down and bottom-up factors where thresholds in a few key respects are most important: legislation, demand for new solutions, land-use pressure, risk acceptance, technical options and policy entrepreneurship.

The paper by Brian Peterson and Diana Stuart focuses on "Navigating Critical Thresholds in Natural Resource Management: A Case Study of Olympic National Park." Using the example of anadromous fish species in this national park in the United States, it empirically analyses the challenges that park managers face in the management of wildlife populations in ecosystems approaching critical thresholds, e.g., with respect to habitat loss. The analysis finds that park managers face numerous challenges to identify and avoid tipping points or to adapt ecosystems if critical thresholds have been passed. Management strategies, policies and budgets are tailored towards current conditions and do not offer much flexibility to engage with or plan for shifts in the future. The analysis suggests that critical thresholds might play an even bigger role under climate change conditions in the future,

potentially causing ecological tipping points of such severity that also larger socio-economic thresholds will be passed. The paper therefore calls for a stronger integration of ecological and social thresholds in the conception and management of future system dynamics.

In total, the papers clearly show two things: First, they underscore the important role of non-linear trends and multi-dimensional tipping points in adaptation processes and in the build-up as well as the loss of adaptive capacity. This conceptual and empirical insight is important as it contributes to revealing and refining the still predominant approach which views adaptation as a gradual process that can be nicely managed if only the right knowledge, technologies and institutions are developed and put to use. Second, the papers show how much we do not yet know about the precise characteristics of these tipping points and the factors that are responsible for driving and shaping them. Yet, an improved understanding will not only be desirable intellectually but also practically necessary if we want to avoid negative adaptation tipping points and foster positive ones, helping us to shift adaptation trajectories towards sustainable directions. The special issue therefore provides relevant directions for the future research agenda.



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