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Caribbean island states in a social-ecological panarchy? Complexity theory, adaptability and environmental knowledge systems

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ABSTRACT

Many social-ecologically sensitive Small Island Developing States (SIDS) increasingly face global (climate) change risks to sustainable development. However, the validity of factors said to contribute toward vulnerability is disputed in light of the differing economic success, enormous heterogeneity, divergent paths of development, and varying potential for adaptability displayed by small islands. Research on uncertainty, vulnerability and resilience of coupled social-ecological systems (SES) can provide a valuable contribution to the sustainability debate. Based on the fundamentals of complexity theory, the notions of social-ecological adaptability, and panarchy, this article highlights the role of context-based, hybrid, and limited environmental knowledge and risk knowledge systems and cultures. The modes of organization of disaster management in Grenada (Eastern Caribbean) and environmental governance in The Bahamas (Western Caribbean) on various spatio-temporal scales serve as case studies. The production and communication of knowledge, the difficult (cross-scale) integration of diverse knowledge systems, the role of experience and memory, as well as social/institutional learning and inertia appear as significant factors as regards the strengthening of social adaptability. The findings further demonstrate that significant challenges remain for Caribbean SIDS. These include long-term, socially, locally, and sectorally differentiated vulnerabilities; deficits in governance and communication; and the diverging and spatially-temporally bounded nature of knowledge systems.

1. Introduction

Twenty years after the first international conference on small island states was held in Barbados, the problems of small islands have reached center stage and attracted international attention. Diverse global change processes increasingly threaten the sustainable development of Small Island Developing States (SIDS), as sensitive social-ecological spatial systems (Hay, 2013; IPCC, 2014). Research on the scientific and technological uncertainty, vulnerability, and resilience of coupled human-environment systems can make a valuable contribution to the sustainability debate concerning small islands. Yet the further development of integrating concepts for the analysis of social-ecological systems (SES) remains a challenge. The resilience perspective, developed largely within the discipline of system ecology (Holling, 1973), considers the dynamically adaptive ability of a system to withstand and recover from stressors and further develop. Despite criticism for undertheorizing political, social and cultural dynamics, this approach to analyzing human-environment relations has become increasingly important in risk and sustainability research (Brown, 2014; Xu et al., 2015). It is embedded in theories of complex systems that focus on dynamic systems, conceived of as nonlinear, unpredictable, and multiscale interdependent due to interactions between "agents". Various system process phases and speeds, as well as significant types of interaction and feedbacks may be described, as, for instance, in the heuristic models "adaptive renewal cycle" and "panarchy" (Gunderson and Holling, 2002; Allen et al., 2014). Research on social-ecological resilience and adaptability emphasizes the importance of knowledge systems and processes of learning (e.g., Berkes, 2009; Krasny et al., 2011; Wilson, 2015), a standpoint that conceptually informs this article. Such SES concepts, however, require further refinement as regard to the role of social specifications for constructive transformation, such as mental models and knowledge systems of risk and environment as well as social network formation (see Luthe and Wyss, 2015; Xu et al., 2015).

It appears crucial for SIDS to integrate and link sectoral social and economic policy and planning on the national, island and

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municipal levels with environmental and natural hazard policies. Strengthening social-ecological resilience is commonly understood as an important element of sustainable development strategies. So far, few resilience related investigations have used small-island case studies to examine adaptive cycles and panarchical relations (e.g., Bunce et al., 2009; Holdschlag and Ratter, 2013). Small and in particular flat islands are generally seen and represented as being especially vulnerable to external stressors and environmental changes, thus global "canaries in the coalmine". Numerous SIDS are threatened by rapid extreme events such as volcanic eruptions, earthquakes, tsunamis, storms, and flooding, as well as by increasing air and sea surface temperatures, climate variability, rising sea levels, coastal erosion, saltwater intrusion, ocean acidification and changing currents (Pelling and Uitto, 2001; IPCC, 2014). Characteristics that indicate increased vulnerability toward stressors include limited natural, financial and human capital, (post-) colonialism, (post-) conflict and peripheralization, exposed economies with little diversification, cost-intensive infrastructures, insufficient planning capacities, and the dominant influence of financially strong governments and firms.

Although economic, political, and technological globalization is not a new phenomenon for small islands and there are many examples of resilient island societies, the recent dynamics of globalization have created new, widely recognized challenges, especially for local coping and adaptability capacities (Hay, 2013). Moreover, SIDS are strategic actors at the heart of political debates on local effects of global climate change (e.g. Alliance of Small Island States, AOSIS). However, major research deficits concerning SIDS remain. There has, for example, been insufficient investigation of the indirect and long-term effects of natural hazards on states and especially on local communities. In particular, the significance of local contextual ties and historicity has often been neglected, resulting in a corresponding emphasis on the necessity of local and historical research approaches and of long-term data analyses (see, e.g., Gough et al., 2010; Forbes et al., 2013; Kelman, 2014). Concurrently, the general validity of factors said to contribute toward vulnerability is disputed in light of the differing economic success, enormous heterogeneity, divergent paths of development, and varying potential for adaptability displayed by small islands (Connell, 2013). In the Caribbean, topics of valuable research include the fields of tension between global change, natural hazards, resource exploitation, and vulnerability, as well as issues of environmental perception and the production and integration of knowledge (Ratter and Rettberg, 2009; Mercer et al., 2012; Rhiney, 2015).

This article aims to contribute toward a deeper integrative understanding of how, in the global context of uncertainty and

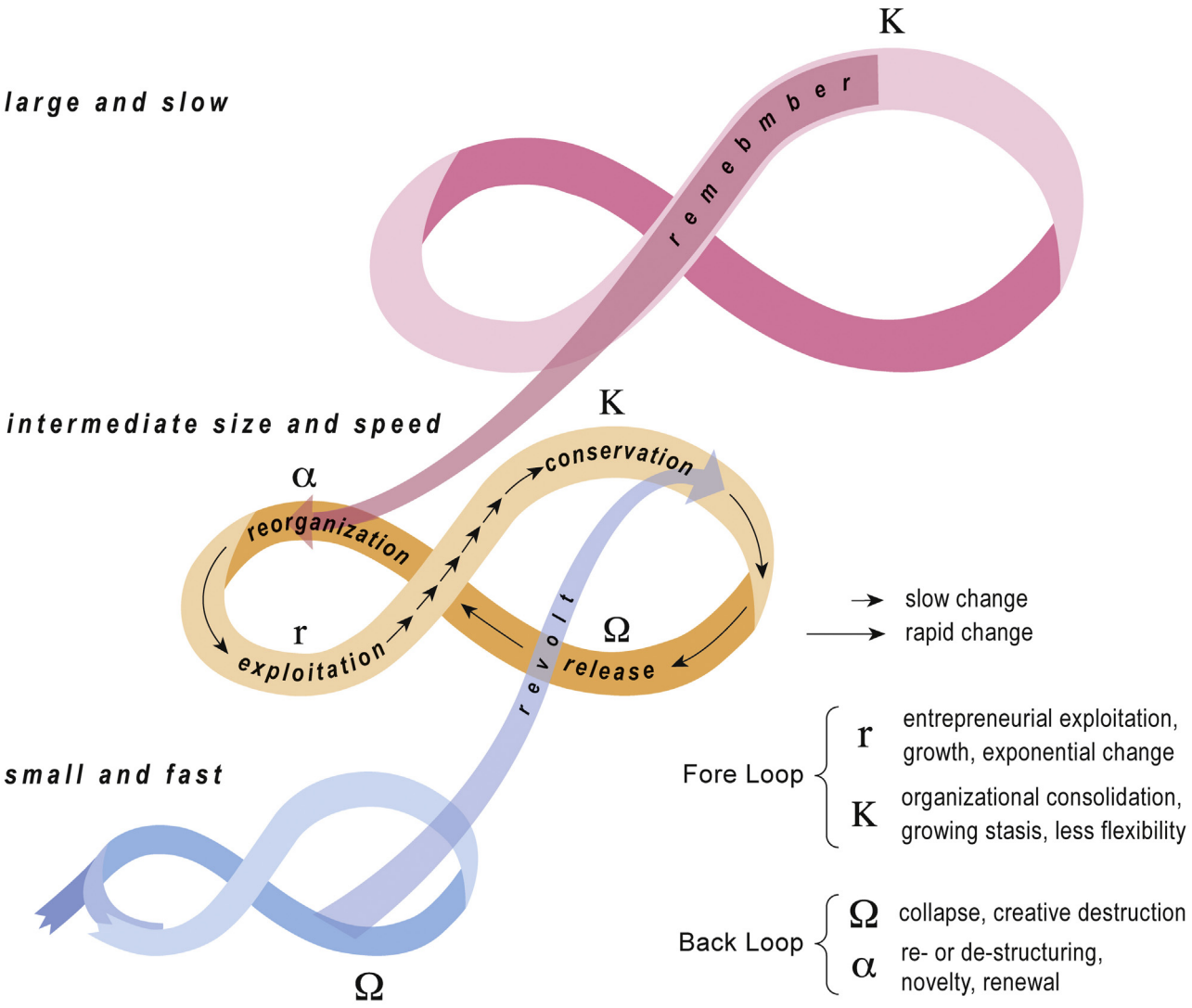

Fig. 1. Heuristic models of the "adaptive renewal cycle" and "panarchy" (source: modified from Gunderson and Holling, 2002).