



## Research article

# Catching sea cucumber fever in coastal communities: Conceptualizing the impacts of shocks versus trends on social-ecological systems



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## ABSTRACT

Research on vulnerability and adaptation in social-ecological systems (SES) has largely centered on climate change and associated biophysical stressors. Key implications of this are twofold. First, there has been limited engagement with the impacts of social drivers of change on communities and linked SES. Second, the focus on climate effects often assumes slower drivers of change and fails to differentiate the implications of change occurring at different timescales. This has resulted in a body of SES scholarship that is under-theorized in terms of how communities experience and respond to fast versus slow change. Yet, social and economic processes at global scales increasingly emerge as ‘shocks’ for local systems, driving rapid and often surprising forms of change distinct from and yet interacting with the impacts of slow, ongoing ‘trends’. This research seeks to understand the nature and impacts of social shocks as opposed to or in concert with trends through the lens of a qualitative case study of a coastal community in Mexico, where demand from international seafood markets has spurred rapid development of a sea cucumber fishery. Specifically, we examined what different social-ecological changes are being experienced by the community, how the impacts of the sea cucumber fishery are distinct from and interacting with slower ongoing trends and how these processes are affecting system vulnerability, adaptations and adaptive capacity. We begin by proposing a novel framework for conceptualizing impacts on social systems, as comprised of structures, functions, and feedbacks. Our results illustrate how the rapid-onset of this fishery has ecological changes are being experienced by the community, how the impacts of the sea cucumber fishery are distinct from and interacting with slower ongoing trends and in poaching and armed violence have emerged, exacerbating pressures from ongoing trends in immigration, overfishing and tourism development. We argue that there is a need to better understand and differentiate the social and ecological implications of shocks, which present novel challenges for the vulnerability and adaptive capacity of communities and the sustainability of marine ecosystems.

## 1. Introduction

The impacts of contemporary social and environmental change are particularly glaring for coastal communities, exposed to and engaged in the dynamics of both marine and terrestrial systems (Bunce et al., 2010; Ommer, 2007; Bennett et al., 2015). Coastal zones face some of the greatest biophysical impacts of climate change, including myriad consequences of rising sea levels (e.g., coastal erosion and sea water inundation) and increased variability of storms, drought, and other extreme weather events (Bunce et al., 2010). A combination of stressors such as ocean acidification and unsustainable global fishing practices has meant that coastal communities increasingly confront challenges related to gradually declining marine ecosystems, from decreased

livelihood sustainability to food insecurity (Pauly and Maclean, 2003; Bennett et al., 2016). For many smaller and more remote coastal communities, declines in coastal and marine livelihoods are resulting in aging populations, as younger generations leave to pursue employment and education opportunities in urban centers (Ommer, 2007). Conversely, more populated coastal zones are often sites of demographic, economic, and land-use change, driven by processes such as tourism development and urbanization (Bunce et al., 2010). As a result of such processes, understanding the consequences of multi-scale, interacting social and environmental change presents an enduring challenge for researchers and decision makers engaged in researching vulnerability and adaptation in coastal communities (Bunce et al., 2010). While SES scholarship in this area has tended to focus on climate change (e.g.,

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Cinner et al., 2015; Bunce et al., 2010; Julca and Paddison, 2010; Prno et al., 2011; Bardsley and Wiseman, 2013; Wise et al., 2014; O'Brien and Wolf, 2010) less attention has been given to understanding non-climatic anthropogenic drivers of change, such as broad demographic, socio-political, economic, cultural, or technological processes of change and their cross-scale impacts (Breslow, 2015; Bennett et al., 2016). In addition, there has been little differentiation between the drivers and impacts of fast versus slower forms of change among SES scholars. This is less the case in other non-SES fields, such as the psychology and sociology of risk and natural disasters (e.g., Bromet et al., 2011; Freudenburg et al., 2008) and coastal management (e.g., Mee, 2012). Given the importance of temporal characteristics (rate of onset, duration, and frequency) in research on hazards and risk (Tobin and Montz, 1997), for instance, the lack of distinction between fast and slow drivers in scholarship on community vulnerability is striking. Indeed, social drivers of rapid change play an increasing role in the opportunities and challenges being experienced by communities (Hicks et al., 2016; Breslow, 2015), with distinct consequences for their ability to respond or adapt.

Expansion of the global sea cucumber trade, triggered largely by growing demand in Asian luxury seafood markets, exemplifies such a rapid social driver of change. Sea cucumbers are slow-moving, tubular-shaped invertebrates that inhabit ocean floors worldwide (Eriksson et al., 2015). Over the past few decades, the increasing international value of sea cucumber products has sparked fishery booms, often in communities where commercial sea cucumber harvesting had not previously occurred (Eriksson et al., 2015). Moreover, Anderson et al. (2010) have shown that despite a trend of increasing global sea cucumber catches, the catch of individual fisheries has followed a boom-and-bust pattern, “declining nearly as quickly as they expanded” (p.1). While ‘boom-bust’ marine resource industries have occurred throughout history, the current speed with which markets for species of this and other echinoderms are emerging is unprecedented, supported in part by the accelerated mobility of information, technology, labour, and capital (Adger et al., 2009; Berkes et al., 2006; Eriksson et al., 2015).

While there is a growing body of research on sea cucumber fisheries, there is a dearth of studies that give specific consideration to the social dimensions of these fisheries. The limited research in this area reveals themes of social impacts and conflict reflective of terrestrial resource booms (Bremner and Perez, 2002; Christensen, 2011) and limited capacity for management resulting in overexploitation of stocks (Anderson et al., 2010; Eriksson et al., 2015). Rapid-onset sea cucumber fisheries thus represent an important but understudied driver of fast change in coastal communities, with heretofore-limited research into the associated social impacts and feedbacks and how these changes combine with ongoing social-ecological change.

To better understand the social implications of fast and slow drivers of change for social-ecological systems, the research presented here investigates how a rapidly developed sea cucumber fishery has driven change in a local community through a qualitative case study of Río Lagartos, a fishing community on Mexico's Yucatán Peninsula. Specifically, we examined: a) what different social-ecological changes are being experienced by the community, b) how the impacts of the sea cucumber fishery are distinct from and interacting with slower ongoing trends and c) how these processes are affecting system vulnerability, adaptations and adaptive capacity. Below, we situate this research within the literature on social-ecological resilience, vulnerability, and adaptation in the face of multiple stressors. In so doing, we clarify the need to differentiate between the impacts of slow trends and rapid shocks and propose a framework for conceptualizing impacts to social systems in SES research.

## 2. Understanding impacts and responses to change in SES

The concept of a social-ecological system (SES) reflects an under-

standing that the human and biophysical components of a given landscape are inextricably linked, continuously influencing and responding to each other in a complex adaptive system (Adger, 2006; Berkes et al., 2006; Renaud et al., 2010). ‘Resilience’, ‘vulnerability’ and ‘adaptive capacity’ make up three of the dominant theoretical lenses through which research has examined how these linked systems experience and respond to change (Gallopín, 2006). While specific definitions of these terms vary across scholarly traditions, a broadly accepted characterization of a resilient SES is “one with the capacity to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks” (Walker et al., 2006). Alternatively, vulnerability has been described as the “degree to which a system is susceptible to and is unable to cope with adverse effects” which is itself a function of “the stress to which a system is exposed, its sensitivity, and its adaptive capacity” (Adger, 2006 p.269). Through this theoretical lens, adaptive capacity represents the latent characteristics or attributes of a given system that enable it to respond adaptively in the face of stress, threats or perturbations (Engle, 2011; Smit and Wandel, 2006; Birk, 2014). Adaptive capacity is ‘realized’ through adaptive response (adaptation), as a system reacts to change or stress either by preparing in advance or else by adjusting, compensating and responding to effects as they unfold (Engle, 2011; Adger, 2006; Bennett et al., 2016).

An area of growing interest in particular is how multiple drivers of social-ecological change interact at varying spatial and temporal scales to influence the vulnerability of individuals, communities, and ecosystems at the local level (Bunce et al., 2010; Bennett et al., 2016; Leichenko and O'Brien, 2008). This scholarship on community vulnerability to “multiple stressors” or “multiple exposures” has centered on climate change, for example, trying to understand how climate stress interacts with economic globalization (O'Brien et al., 2004), disease epidemiology (Reid and Vogel, 2006), livelihood risks (Belliveau et al., 2006) or resource management policies (Bunce et al., 2010).

Preoccupied with global climate and environmental change (e.g., O'Brien et al., 2004; Reid and Vogel, 2006; Birk, 2014; Bunce et al., 2010; Tschakert, 2007; McCubbin et al., 2015), SES scholarship has paid less attention to social drivers of change. Notable exceptions include recent work by Breslow (2015) and Hicks et al. (2016), who demonstrate how social drivers play an ever-greater role in shaping social vulnerability in fishing communities and can be linked to local ecological changes, which push marine ecosystems towards regime shifts.

SES scholarship also often assumes slow variables, seldom differentiating between faster and slower drivers or impacts. Despite frequent reference to the varying temporal scales at which drivers exert pressure on local systems (Bennett et al., 2016; Adger et al., 2012; Bunce et al., 2010), there has been little empirical research demonstrating how the timescales of different interacting stressors relate to community vulnerability. The role of temporal variation has often been masked by a dependence on different terms, each used to characterize or represent sources of SES change. Consider, for example, stressors (O'Brien et al., 2004; Bunce et al., 2010), exposures (O'Brien and Leichenko, 2000), shocks (Schwarz et al., 2011), trends (Bennett et al., 2016), and perturbations (Gallopín, 2006). However, while some of these terms (e.g., shocks or trends) imply differing timescales or magnitudes of pressure, the terms are often used interchangeably and applied to both slower and faster forms of change. Yet, as globalization and technology produce growing interconnectedness between SES across geographic scales, our ability to differentiate the nature, scale, speed, and implications of change is key (Berkes et al., 2006). This is particularly true for fast change as social processes at global scales increasingly emerge as ‘shocks’ for local systems, driving rapid and often surprising forms of change, distinct from and yet interacting with the impacts of slower drivers (Armitage and Johnson, 2006).

Furthermore, while social and ecological systems are interdependent, they also have inherent differences that carry implications for

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