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The use of participatory modeling to promote social learning and facilitate community disaster planning

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ABSTRACT

Coastal island communities face significant risks associated with increased natural hazards and other impacts associated with climate change. Further, deeply rooted social issues, lack of awareness or information, and inadequate infrastructure and planning may exacerbate risks to island socio-ecological systems. Understanding these relationships is often difficult, given the lack of methods available for communities to explicitly explore anticipated risks and potential adaptation strategies, in relation to the characteristics of their community socio-ecological system. Social learning has also been shown to foster adaptation to environmental changes, build social trust and empower diverse stakeholders, by offering opportunities for groups of individuals to challenge, negotiate and propose new norms, policies or programs. We present a three-phase social learning framework to facilitate stakeholder-driven scenario-based modeling, in order to inform community disaster planning in relation to the potential impacts of a tsunami. The participatory research was conducted in conjunction with a community disaster committee, representing the communities of the North Shore of O'ahu, Hawai'i. Through a series of iterative participatory modeling workshops using fuzzy-logic cognitive mapping, the community committee represented, explored and actively questioned their beliefs about the natural hazards that their community faces. Further, the modeling process allowed the committee to represent the communities' dynamic nature, run tsunami hazard scenarios to quantify potential direct and indirect effects, and explicitly compare trade-offs of competing adaptation strategies. Changes in the committee's model representations that took place over time demonstrate a progression through single-, double- and triple-loop learning, indicating that social learning occurred across individual to institutional levels, and over short- to long-term time scales.

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1. Introduction

The Hawaiian Islands are vulnerable to natural hazards and the impacts of climate change, due to their geographic remoteness and large dependency upon imported food and energy (Kaly et al., 2002). Historically, communities comprised of native Hawaiians and long-term residents have utilized place-based strategies to maintain their resilience, however community members now report that fragmentation, tourism and globalization have weakened the collective social memory and legacy effects of past disasters (Vaughan and Ardoin, 2013). As a result, these communities are more prone to rely on aid after a disaster occurs, which does not improve long-term adaptive capacity (Birkmann, 2006). A comprehensive multi-sector approach is needed to improve disaster planning and build more resilient communities (Folke et al., 2002; Walker et al., 2002). Analysis of key physical, social, economic and environmental system factors is critical in order to reduce vulnerability and enhance coastal resilience to long and short term "shocks" to these communities (Birkmann, 2006). This includes developing methods for communities to collaboratively articulate the potential impacts of hazards and climate change, in order to define the anticipated outcomes of various adaptation strategies.

Community-based resilience planning will have a higher probability of success if stakeholder-driven community descriptions, community resources and the issues of concern (Abarquez and Murshed, 2004; Adger, 2003; TRIAMS, 2006; USAID, 2007) can be formalized into a set of scenarios that capture the major uncertainties in the system's future dynamics (Walker et al., 2002). This paper outlines a methodology that standardizes diverse stakeholder knowledge and management strategies in a form that maintains the integrity of complex human understanding and is useful for analyzing a community's dynamics in relation to natural hazards. Additionally, we present data that measure changes in the community's model over time as evidence of conceptual change among community members. This research draws from several distinct yet related bodies of literature on: (1) representing individually held beliefs (e.g. mental models) in the planning process; (2) allowing agreement or inconsistencies in beliefs to be discussed as a way to facilitate structured social learning; and (3) understanding how learning occurs as a result of engaging in scenario analysis to improve the adaptive capacity of communities in relation to environmental change.

To adapt to change, communities must be able to anticipate a problem, collect and share knowledge about it, reflect, and together develop a shared vision for action (Tschakert and Dietrich, 2010). However, tools and processes that promote such interaction in an organized and participatory manner in real time are somewhat limited (Walker et al., 2002; Gray et al., 2013) although significant advances have occurred in recent years (Voinov and Bosquet, 2010). Here, we suggest that actively representing individual and group beliefs through a mental modeling exercise, facilitated by the development of fuzzy-logic cognitive mapping (FCM) supports structured deliberation around coastal hazards and provide a way for diverse community members to construct and revise their knowledge over time.

Mental models are individually and internally held cognitions of external reality that are used to code, filter, and interpret the external world, allowing individuals to reason, explain and interact with their surroundings (Jones et al., 2011). Mental model representations enable individuals to reason and make decisions, similar to a computer simulation, allowing different scenarios to be examined (Johnson-Laird, 1983). Sharing mental models is a conduit to improve stakeholder communication and reduce collaboration barriers, by (1) utilizing visual participatory processes contributing to clear and open communication; (2) overcoming obstacles to incorporating multiple sources of knowledge (Rodela, 2011; Reed et al., 2010); (3) enabling shared ownership of a conservation plan (van der Wal et al., 2014); and (4) improving social assessments (Biggs et al., 2011).

Change in mental models is considered to be a type of learning (Chi, 2008). Mental models can be changed through interactions between stakeholders of a given social network (Reed et al., 2010) by sharing ideas through a deliberative process that facilitates social learning. Promoting learning through guided interaction has been found to foster understanding of socio-ecological systems (Walters and Holling, 1990; Walters, 1986; Reed et al., 2010; Holling, 1978). Social learning has also been shown to foster adaptation to environmental changes (Pahl-Wostl et al., 2007; Folke et al., 2003), build social trust and empower diverse stakeholders (Reed et al., 2010), by offering opportunities for groups of individuals to challenge, negotiate and propose new norms, policies or programs (Reed et al., 2010; Rist et al., 2007).

A social network's characteristics also play a significant role in the type of learning that occurs (Pahl-Wostl and Hare, 2004; Wildemeersch, 2007). These networks are not uniform and vary across space and time scales. Some networks, such as governmental hierarchies, may be inflexible and limit the degree of learning that takes place, while others, such as friendships, may be more flexible and democratic and facilitate more rapid change in personal understanding (Reed et al., 2010; Keen et al., 2005). The speed at which learning and information sharing occurs within a network (Pahl-Wostl et al., 2007; Tompkins and Adger, 2004) influences the ability of individuals to reorganize after a hazard event and therefore influences adaptive capacity. Fazey et al. (2007) state four learning-related requirements for adaptation, including: (1) the willingness to challenge and transform epistemological and cultural ways of thinking, knowledge and behaviors toward socio-ecological resilience from the individual to societal level; (2) a thorough understanding of how current practices and behaviors influence socio-ecological resilience and re-directing them toward more sustainable goals; which will support (3) the willingness to engage in proactive, continuous assessment of current behavioral impacts on sustainability, in order to inform decision-making amidst uncertainty; and (4) the ability to change their behavior based upon these requirements (Fazey et al., 2007).

Anticipatory learning that addresses adaptation is expected to increase community understanding and the ability to respond to system crises and shocks (Tschakert and Dietrich, 2010). Community disaster planning should provide opportunities for stakeholders to communicate iteratively (Osbahr, 2007), evaluate risks and adaptation