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Factors influencing local decisions to use habitats to protect coastal communities from hazards

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ABSTRACT

Coastal hazard mitigation policy in the US has historically focused on construction of hardened, or gray, infrastructure. Recently, there is increased public interest and policy supporting the use of habitats, or natural infrastructure (NI), following decades of increasingly supportive ecological, engineering, and economic evidence. This trend suggests that behavioral and institutional factors may also be important for mainstreaming NI. To understand what factors affected decisions to use NI, we conducted semi-structured interviews with a total of 16 individuals associated with three NI cases: Ferry Point Park Living Shoreline, Maryland (MD); Surfer's Point Managed Retreat, California (CA); and Durant's Point Living Shoreline, North Carolina (NC). Our grounded theory analysis of the interview transcripts revealed four common themes across the decisions: 1) perception of benefits (N = 45) and costs (N = 31), 2) diffusion of innovation led by innovators (N = 34), 3) local champions (N = 46), and 4) social networks and norms (N = 30). This grounded theory suggests that the decisions to use NI were driven by innovators (citizens, local non-governmental organization (NGO) staff, and/or state government resource managers) who were influenced by seeing NI successes implemented by trusted experts and perceived NI benefits beyond protecting coastlines (e.g., maintaining coastal heritage and sense of place). Innovators also acted as local champions, getting others "comfortable" with NI and connecting to local interests. In addition, our analysis shows the role of regulatory permitting requirements in perpetuating or controlling biases against innovations like NI. In 2008, MD passed a policy that helped address biases against NI by changing NI from a preferred option to the required option except in places where scientific analysis suggested that gray infrastructure would be needed, while in CA and NC gray infrastructure remains only a preferred option. These results suggest an opportunity to harness heuristics, such as visual demonstrations and messaging from trusted persons, in addition to policy tools to mainstream NI in places where there is evidence that it would be effective. These results also suggest that heuristics could result in biases that not only lead to underuse but also to inappropriate use of NI; and, policies, similar to the policy in Maryland, are needed to control these biases.

1. Introduction

Coastal flood hazards are among the costliest natural disasters in the US (Gall et al., 2011). The losses from Hurricanes Katrina (2005) and Sandy (2012) make up two of the top 10 costliest natural disasters worldwide since 1980 (Munich Re, 2014). US hazard mitigation policy at the federal, state, and local level has historically focused investment on construction of hardened, or gray, infrastructure for shoreline protection, resulting in a patchwork of aging shoreline infrastructure covering 9% of the nation's coastline (Hiller, 2003; NOAA, 2014). In addition to the costs of repairing and maintaining these coastal defenses, structures such as bulkheads, riprap revetments, seawalls, jetties and groins have been shown to have an adverse impact on the ecology, coastal processes, and aesthetics of shoreline ecosystems (Schlacher et al., 2007; Griggs, 2010). At the same time, there is a growing body of research on the hazard protection provided by natural coastal habitats such as

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dunes, wetlands, oyster reefs, coral reefs, and mangroves. These habitats have been shown to mitigate erosion and floods by buffering wave energy and absorbing and storing water from high tides and storm surges (Costanza et al., 2008; Das and Vincent, 2009; Gedan et al., 2010; Shepard et al., 2011; Arkema et al., 2013; Barbier et al., 2013; Ferrario et al., 2014). Conservation groups have been generating and using ecological, engineering, and economic evidence to argue for incorporating habitat restoration and protection, or natural infrastructure, into the coastal resilience plans of communities, governments, and businesses (e.g., Downing, 2013; Reddy et al., 2015). Internationally, "managed realignment," setting back or repositioning the coastal or riverine flood defense line to improve sustainability of the defense, is gaining momentum especially in the UK, where a strong legal basis supports removal or realignment of hardened infrastructure to create new or restored intertidal habitat (DEFRA, 2004, Esteves, 2014).

Here, we define natural infrastructure (NI) as natural areas, or a combination of natural areas and hardened structures, that provide the same types of services that gray infrastructure provides (e.g., marshes and bulkheads can both reduce erosion caused by waves (Gedan et al., 2010; Bridges et al., 2015)). Studies have shown that differences in coastal hazard, geomorphological, ecological, and economic conditions may influence what methods of adaptation and type of NI may be suitable for a given location and the potential protection it provides (Inman and Nordstrom, 1971; Fairbridge, 2004; Arkema et al., 2013; Bridges et al., 2015). However, little attention has been paid to how institutional or behavioral differences influence decisions to choose whether to invest in NI or gray infrastructure.

In the US, private and public responses to coastal erosion are governed by a complex framework of legislation and court decisions, with national policies and practices interacting with state and local policies (Ricketts, 1986). Although there has been a general trend in the US of expanding coastal hazard management beyond gray infrastructure to include flood insurance, land use regulations, and beach nourishment (Platt, 1994), differences in state and local policies have the potential to influence the adoption of NI. The influence of these different state and local institutional contexts may be increasing because of the central role that state and local governments are now playing in climate change policy, including policies on adaptation (Wood et al., 2014).

Within these institutional contexts, decisions to use NI may be determined or influenced by the behavior of individuals, including private landowners, engineers, environmental non-governmental organization (NGO) staff, government staff, and elected officials. The field of environmental psychology has produced multiple hypotheses and analytical frameworks that could help explain the connection between an individual's awareness and knowledge about the environment and their conservation behavior (Kollmuss and Agyeman, 2002; Vining and Ebreo, 2002). Social psychology studies have also shown that the majority of human decisions are shaped by heuristics, or mental shortcuts, that link to subconscious or automatic responses (Smith DeCoster, 2000; Aronson and Aronson, 2008; Cialdini, 2009). Individuals have been shown to rely on heuristics to make decisions about unknown or unfamiliar subjects (Aronson and Aronson, 2008), suggesting that technical information does not play a key role in many decisions. An individual's neighborhood or community also influences his or her decisions via social structures and processes (Sampson et al., 2002). This includes the role of social networks that facilitate the spread of behaviors and emergence of social norms (i.e., cultural phenomena that determine context-specific behavior) (Hechter and Opp, 2005). The term social network refers to both the metaphor describing the interconnections between people and the formal definition of these connections by the number of people involved, the distance between people, and the character of the connections between people (Scott, 2002). For instance, perceptions of authority and likeability of the 'messenger' has been shown to influence how much weight we give to information (Aronson and Aronson, 2008; Dolan et al., 2012). A study of HIV-prevention techniques showed that people were more likely to listen to messages from people who were similar to them (Durantini et al., 2006).

The "diffusion of innovation theory" specifically describes how new innovations, such as technology, spread between people (Rogers, 1983; Aronson and Aronson, 2008). The new technology, idea, or practice flows from a source through five categories of adopters: innovators, early adopters, early majority, late majority, and laggards (Rogers, 1983). Innovators are the first to try an innovation; they are risk takers and naturally interested in new technology. Early adopters are opinion leaders that are comfortable adopting a new innovation because they recognize a need for a change. The early majority needs to see evidence that an innovation is successful before they adopt. In contrast, the late majority is more skeptical and needs to see that many others have successfully adopted an innovation before they adopt it. Lastly, laggards are entrenched in tradition and skeptical of change. These social-psychological and context models of human decision-making are in stark contrast to the "information deficit" model that motivates much of current conservation science and practice. The "information deficit" model assumes conscious cognitive processes dominate and posits that the supply of objective information, in this case on the physical or economic performance of a technology, will result in changes in behavior (Sturgis and Allum, 2004).

Environmental behavior can be influenced by working around the conscious cognitive processes and tapping directly into automatic behavior responses or unconscious cognitive processes (Cialdini, 2009; Dolan et al., 2012). A growing body of studies on energy efficiency supports the idea that this sort of behavioral nudge (involving positive and indirect reinforcement) (Thaler and Sunstein, 2008) may be more effective and efficient than traditional information campaigns or enforcement. For example, solar panels in a neighborhood increase the likelihood that other neighbors get solar panels (Bollinger and Gillingham 2012). Providing reports that compare neighbors' home energy use reduces a person's own energy use (Allcott and Rogers, 2014). In contrast, there has been little empirical research on how behavioral processes affect decisions involving nature conservation (Scarlett et al., 2013; Cowling, 2014; except see Chen et al., 2009; Frank et al., 2011; Asah et al., 2012; Lubell et al., 2013; Reddy et al., 2014). This may be because studying human behavior and conservation poses additional challenges not faced when studying individual consumer behavior —namely, smaller sample sizes, group decision making, externalities, and no systematic record of decisions (e.g., in contrast to records of consumer purchases, etc.).

We advance this research by using a grounded theory approach (Strauss and Corbin, 1990) to examine the decision processes for three coastal NI cases. Grounded theory is a qualitative analysis method that enables researchers to develop a new understanding of social processes that is grounded in observation (Glaser and Holton, 2005). Grounded theory analyses can help generate hypotheses for future quantitative analysis, which makes it especially appropriate for emerging research on human decisions and nature conservation (Marincola, 2007). The qualitative analysis involves coding and categorizing text from interviews or other sources into common themes (Strauss and Corbin, 1990). We used semi-structured interviews with individuals who were involved in each NI case to identify the common themes in the decision processes. The results from this research advanced our understanding of coastal hazard management, with specific implications for conservation practice, policy, and communications. It also