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Perception of change in freshwater in remote resource-dependent Arctic communities

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Abstract

This paper provides empirical evidence to support existing anecdotal studies regarding the mechanisms by which human communities become vulnerable to rapid changes in freshwater resources on the Seward Peninsula, Alaska. We interviewed adults, stratified by age, sex, and extended family, in Inupiat communities on the Seward Peninsula. Using categorical indices as part of a semi-structured interview we elicited a respondent's perception of the availability and quality of freshwater resources in their community as well as their perception of change in the availability and quality of freshwater during the period of their lifetime in that community. Significant relationships were observed between age groups for the perception of change in the availability of the local water source and the perception of change in its quality—older generations perceiving more change than younger age groups. These perceptions of change were examined with respect to recent historic changes in precipitation and temperature on the Seward Peninsula. These findings suggest that individual perceptions are instrumental in determining whether or not change merits response. The findings also provide evidence that oral traditional knowledge systems have shifted from continuous to discontinuous transmission, distancing the users from traditional resources. We discuss the role of collective knowledge, through the transmission of knowledge from elders to subsequent generations, in aiding the development of a community's ability to note and respond to changes in critical natural resources.

Keywords: Resilience; Environmental perception; Freshwater; Environmental change; Human response; Traditional ecological knowledge

1. Introduction

In this paper, we report evidence that a phenomenon by which subsequent generations in a community fail to acquire traditional ecological knowledge (TEK), and thus accurate awareness of rates of change and a consequent synchronization between perceptions of a resource and its measured change, may be occurring in remote, resource-dependent communities in Alaska. We propose that acculturation and desensitization to change may be key mechanisms reducing adaptive capacity (Robards and Alessa, 2004) and explore this with respect to residents' perceptions of change in freshwater resources in the Arctic. Specifically, we predict that perception of change will decrease across generations despite significant changes in Arctic climate trends beginning in the 1950 s (Johannessen et al., 2004).

In the last 50 years accelerations in a wide range of hydrological changes in the Arctic have been detected through physical measurement (Overpeck et al., 1997). The combined observations and documentation form a case that the Arctic hydrological system may rapidly be entering a state not seen before in historic times (Magnuson et al., 2000; Serreze et al., 2000)—a state that will have significant implications for the inhabitants of the region (ACIA, 2005). Humans in the Arctic are dependent on surface and ground water which is affected by the type and distribution of permafrost (ground which remains frozen all year to varying depths).

Observed responses of Arctic river systems to recent increases in temperature (ACIA, 2005), and winter precipitation have been highly variable (Serreze et al., 2000). The magnitude of the warming has been about 0.5 °C, enough to alter ground thermal conditions which

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affects lateral transfers into conduits such as rivers and groundwater (Hinzman et al., 2005). While continuous permafrost exhibits highly variable responses to global warming trends (Osterkamp and Romanovsky, 1999), discontinuous permafrost shows a distinct thawing trend and is correlated to surface hydrology (Jorgenson et al., 2001), resulting in both increased winter base flow rates and lateral transfers of sediment (Hinzman et al., 2005). Increased base flow rates potentially have a wide range of impacts, including changes in stream chemistry and aquatic habitat (Quinn et al., 1997), increased stream and river icing (Pollard, 2005), and poorly understood effects on erosion and sediment flux, including activating latent contamination by historic and current industrial activities such as mining (Vörösmarty et al., 2001). All of these affect water quantity and quality and may be perceived by residents to different degrees.

Currently, climate models apply to large regional and global systems. They have poor resolution at local (community) and very fine (individual agent) scales and the relationships between macro- and micro-phenomena are poorly explored (Wilbanks and Kates, 1999). This represents a critical gap in our ability to understand complex systems: the human–freshwater system described here is affected by both slower, top-down (i.e., exogenous climate change) as well as faster, bottom-up (e.g., local scale land use) factors to tightly couple both spatial and temporal feedbacks. Changes are driven and mediated, but not always perceived, by individual agents (Wilbanks and Kates, 1999). Interactions between individuals (agents) are complex and nonlinear; agent populations are heterogeneous and outcomes, based on decisions, can result in adaptations (Bonabeau, 2002) leading to responses to changes in freshwater resources which may or may not be successful. Despite research which indicates that agents make decisions based on perceptions rather than measured variables (e.g., Adamowicz et al., 1997; Oba and Kotile, 2001) most predictive models regarding the use of water resources fail to incorporate social components, such as perceptions.

Due largely to a lack of empirical studies, perceptions as drivers of behaviors are largely unexplored in the context of specific natural resource challenges, and even less so in the context of humans and freshwater. After an extensive analysis of existing data on regional and global change, Wilbanks and Kates (1999, p. 623) stated that "the global change research effort would benefit from a greater emphasis on a more local scale of data gathering and analysis and on bottom-up perspectives on global change issues, as well as more attention to interactions among domains and processes operating at different scales."

1.1. Perception: a key to resilience of communities to changes in freshwater?

We have defined resilience in the context of this study to be specific to the ability of human communities to successfully respond to changes in freshwater resources.[1] By this definition, we posit that our current understanding of this type of resilience is critically hindered by a lack of studies which examine the mechanisms leading to or impeding it. To date, a growing body of research examining resilience of Arctic communities to environmental change has had several foci. Research that describes traditional knowledge with respect to environmental change has documented oral histories of climate change in the Arctic (Cruikshank, 2001) and contemporary observations of climate change (Reidlinger and Berkes, 2001; Jolly et al., 2002; Krupnik, 2002; George et al., 2004). A more conceptual line of inquiry has focused on the discussion and development of frameworks for assessing vulnerability of Arctic communities to climate change (Smithers and Smit, 1997; Kelly and Adger, 2000; Ford and Smit, 2004; Smit and Wandel, 2006), their adaptation to change (Smit et al., 1999, 2000; Wheaton and MacIver, 1999; Schneider et al., 2000; Ford et al., 2006), and general syntheses of resilience (e.g., Chapin et al., 2006). These studies converge in their agreement that the ability of Arctic communities to adapt to change depends on their flexibility in using resources (Berkes and Jolly, 2001) but do not evolve this concept further.

In general, humans are largely incapable of basing decisions on cost–benefit analyses as defined by economists or extensive numerical datasets (Maule and Hodgkinson, 2002). Instead, decisions are often based on an individual's perception of accumulated and diverse information, including peer reference (Maule and Hodgkinson, 2002). Resource decisions have consequences in the 'real' world, with recursive feedbacks to society. A large difference between the perceived and measured value of a resource means that decisions made about the resource (e.g., resource conservation or extraction) may result in unanticipated feedbacks. We believe that for resources like water, which are essential for human life and well-being, the perceived and actual values of the resource cannot differ widely without incurring serious social and physical consequences (see, e.g., Reisner, 1993).

The phenomenon by which subsequent generations may "forget" what levels of ecosystem services (i.e., intact and productive soils, adequate water, diverse range of species available for subsistence, etc.) existed prior to them and the role of perception in responses of communities to environmental change has been poorly explored but may be key to how resilient our society is to long-term change. We posit that the combination of inherent ecosystem features (e.g., fragility), rates of change and the failure of knowledge systems to balance these characteristics as quickly as they occur may create vulnerability in Arctic communities with respect to their freshwater resources.

[1] Through one or all of the following: developing infrastructure and behaviors to acquire and conserve clean water, using alternative water sources, or moving nearer to other sources.