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Integrating scientific and local knowledge to inform risk-based management approaches for climate adaptation

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ABSTRACT

Risk-based management approaches to climate adaptation depend on the assessment of potential threats, and their causes, vulnerabilities, and impacts. The refinement of these approaches relies heavily on detailed local knowledge of places and priorities, such as infrastructure, governance structures, and socio-economic conditions, as well as scientific understanding of climate projections and trends. Developing processes that integrate local and scientific knowledge will enhance the value of risk-based management approaches, facilitate group learning and planning processes, and support the capacity of communities to prepare for change. This study uses the Vulnerability, Consequences, and Adaptation Planning Scenarios (VCAPS) process, a form of analytic-deliberative dialogue, and the conceptual frameworks of hazard management and climate vulnerability, to integrate scientific and local knowledge. We worked with local government staff in an urbanized barrier island community (Sullivan's Island, South Carolina) to consider climate risks, impacts, and adaptation challenges associated with sea level rise and wastewater and stormwater management. The findings discuss how the process increases understanding of town officials' views of risks and climate change impacts to barrier islands, the management actions being considered to address of the multiple impacts of concern, and the local tradeoffs and challenges in adaptation planning. We also comment on group learning and specific adaptation tasks, strategies, and needs identified.

Introduction

Recommended approaches to climate change adaptation are converging on risk-based management approaches (NRC, 2010b; IPCC, 2012). At their foundation, the ability of these approaches to provide detailed assessment of the potential threats, and their causes, vulnerabilities, and impacts requires understanding of broad processes and the detail of local settings. The integration of both sources of knowledge is important because scientific understanding of local risks and potential impacts is often quite generalized when contrasted to the complex details of community characteristics, such as infrastructure

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design and performance, values, governance structures, and vulnerable populations. At the same time, local managers generally do not have expertise in climate science and impacts or the trends and projections for their regions, although they often have detailed knowledge of local factors that bear on impacts, vulnerability, and requirements for implementation of adaptation strategies (Amundsen et al., 2010; Picketts et al., 2012; Kettle, 2012). Integration of scientific and local knowledge is expected to enhance risk-based management approaches and adaptation by providing insight into the adaptation process, facilitating community-based learning and the co-production of knowledge, and increasing the usability of climate science information (Moser and Dilling, 2007).

This paper illustrates the value of deeper engagement with local knowledge for understanding adaptation goals, planning, and challenges. Using lessons gained through the VCAPS process (Webler et al., 2014) with officials from an urbanized barrier island community, Sullivan's Island, South Carolina, we illustrate significant insights into local climate change impacts and adaptation challenges. The paper begins by discussing the significance and limitations of both scientific and local knowledge and the value of integrating these knowledge classes. In this paper, scientific knowledge is understood as knowledge generated systematically from formalized processes and principles, such as the scientific method. Local knowledge refers to knowledge situated in specific locales that reflects expertise and understanding of local phenomena (Raymond et al., 2010). Our results are presented in two sections. The first section reports on results of the VCAPS process, focusing specifically on the management challenges associated with stormwater and wastewater management. We also discuss local sensitivities, management actions, and the multiple impacts of concern, as revealed through the VCAPS process. Following these results, we discuss how the VCAPS process facilitated deliberative group learning, which led to the identification of specific adaptation tasks and strategies responsive to local tradeoffs. These findings illustrate how deliberative mediated modeling, informed by local engagement and scientific knowledge, support risk based management approaches to adaptation.

Literature review

The need to integrate local and scientific knowledge to inform adaptation is well illustrated by the particular challenges facing barrier island communities. Some research has investigated the vulnerability of barrier island communities to existing hazards and risks because of their high level of exposure and coastal dynamics (Esnard et al., 2001; Stockdon et al., 2007). These studies generally focus on understanding physical processes such as erosion, overwash, breaching, or inlet formation (Ceia and Patrício, 2010; Cañizares and Irish, 2008). Other research has addressed how changes in sea level, coupled with changes in wave climates, hurricanes and Nor'easters, and other climate-related stressors may exacerbate existing and create new management challenges (McNamara and Werner, 2008; McNamara and Keeler, 2013). These studies identify many significant interactions among climatic, geomorphologic, hydrologic, and human factors shaping the management of barrier islands (Stutz and Pilkey, 2005; Oost et al., 2012). For instance, both tidal stage and precipitation influence the height of the water table beneath barrier islands (Corbetta et al., 2000), which has direct implications for the management of septic fields and wastewater treatment systems (Cogger et al., 1988). Stormwater management is also a challenge due to the low land elevations, high water tables, and lack of elevation gradients to drive drainage. These local threats, which are associated with tidal events, complicate planning and risk management efforts on barrier islands. However, comprehensive data inventories and analyses of these factors and their interactions with local infrastructure systems are rarely available on a site-specific basis or as generalized input to broad scale management for adaptation studies.

Scientific knowledge

Climate science is continuing to advance our understanding of system processes, functions, and dynamics, including both climate variability and change. Climate impacts are an essential element of adaptation planning, although the temporal and spatial scale of analysis does not match the scales typically requested by decision-makers (NRC, 2010b; IPCC, 2012). The most recent models included in the IPCC analysis refine the detail of regional projections and the treatment of major climate processes and feedbacks, such as the release of greenhouse gasses from permafrost melt, the role of the stratosphere, and atmospheric fertilization of carbon dioxide on vegetation (IPCC, 2013), rather than locally significant features such as sea breezes which play a major role in the distribution of rainfall along the coast.

Scientific knowledge of climate is critical to understanding of potential impacts, feedbacks, and thresholds associated with climate change and ultimately, to the development of decision support tools. Climate science information may be used to develop seasonal forecasts to address challenges related to food security, water resource management, fire, and public health and safety (Dilling and Lemos, 2011). Outputs from climate scenarios are often used to simulate potential impacts and vulnerabilities to various sectors and regions; however, top down impact assessments are often quite generalized compared to site-specific conditions and less frequently engage the higher order impacts on communities (Stern, 2007; Nicholls et al., 2011). There also remains a limited understanding of processes and interactions in some systems (e.g., barrier islands), which require local knowledge to develop a more detailed understanding of impacts. For example, elevation mapping is too coarse a resolution to anticipate local patterns of flooding and it does not account for the influences of infrastructure nor the combination sea level rise and rainfall that lead to flooding. Such findings suggest that although climate science plays a key role in understanding systems processes and potential changes, local knowledge is needed to develop a more detailed understanding of potential impacts and inform the selection of adaptation strategies.