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Implementing climate variability adaptation at the community level in the Amazon floodplain

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ABSTRACT

The need to design measures for adapting to climate change is increasingly recognized as important and has encouraged research on the role of local ecological knowledge (LEK) in supporting adaptation. Studies of how LEK can help adapt to increasing climate variability remain limited. This article develops an approach through which the process of adaptation can be tracked at a community level. We describe how community residents in the Amazon floodplains incorporate natural hydrologic and ecological processes into their management systems to optimize ecosystem functioning.

We describe two case studies where LEK is used as a resource by small-scale fisher-farmers in the Amazon floodplains to adapt to the increasing impacts on their livelihoods generated by changing climate patterns. This article draws on local histories and seeks to identify the critical factors that either facilitate or impede household ability to reduce their vulnerability. We found that the LEK of small fisher-farmers has facilitated the adaptation of a resource management system to optimize production across a broad range of floodplain habitats and conditions. There are, however, significant challenges to operationalizing these approaches, including an absence of systematically collected data on adaptation strategies and outcomes. In addition, local people must be integrated into policymaking processes so their knowledge can contribute to the design of locally appropriate policies for adapting to the impacts of climate related events.

1. Introduction

Given well-documented trends of rising temperatures and associated changes in climate, the necessity of taking steps to reduce further climate change is increasingly evident (IPCC, 2014). As recognition of climate impacts grows, adaptation has become a core element of climate policy and research (Pielke et al., 2007; Moser and Ekstrom, 2010; Smith et al., 2011). The Amazon floodplain, one of the more densely populated regions of the Amazon, is widely recognized as one of the most vulnerable to climate change (Goulding, 1980; Pinedo-Vasquez and Sears, 2011). Hydrological trends and the events associated with climate change are expected to result in more seasonal patterns of rainfall with more intense dry seasons and a higher frequency of extreme events including both very high floods in the rainy season and very low water levels during the dry season (Soares-Filho et al., 2006; Davidson et al., 2012). A high frequency of weather events such as flood and drought, coupled with a stagnant economy and high poverty levels, makes the Amazon floodplain a region extremely vulnerable to climate change. In this article, we present the local ecological knowledge (LEK) that small-scale fisher-farmers in the Amazon floodplain apply to adapt their land and resource use management systems in order to secure land, water and food in the face of changing climate patterns. We describe actions that community residents are taking to build resilience and reducing vulnerability in the Amazon floodplain to impacts from the perceived changes in climate patterns.

While global climate models and scientific predictions provide essential information on climate change and regional impacts, local people can provide supporting knowledge on changing local conditions (Brondizio et al., 2009; Pratihast et al., 2013). While they rarely can explain the causes of global climate change, they do see the changes taking place around them, and they understand very

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well what these can mean for their livelihoods (Pinedo-Vasquez et al., 2002; Vogt et al., 2015). The adaptive capacity of local groups as the ability to cope with, prepare for, and adapt to disturbances in social-ecological systems (Armitage, 2005). It is enhanced by social learning, combining different types of knowledge, and self-organizing for sustainability (Folke et al., 2003; IPCC, 2014), as well as by improving the ability to observe and ascribe meanings to climate-related changes (Boillat and Berkes, 2013).

Today, there is widespread recognition of the valuable role that local ecological knowledge (LEK) can play in the management of natural resources (Gadgil et al., 1993; Davis and Wagner, 2003). LEK may be defined as the knowledge set of a given community on ecological aspects of the environment and the various practical implications of that knowledge (Sturtevant, 1964; Johnson, 1974). LEK may be shared extensively or only partially by the community members (Romney et al., 1986), and has been more widely used in natural resource management, conservation and development planning (Berkes and Berkes, 2008) than in mitigation and adaptation studies. Local knowledge of species, their life histories, distributions, and environmental characteristics are nested within resource management systems, tools, and measures (Berkes, 2008). In turn, these are embedded within the norms, rules and decision making procedures of community management systems (Weber, 2003). There is increasing recognition of the need to incorporate LEK into climate impact and adaptation assessments, as local people have a significant knowledge of how local ecosystems respond to environmental change and are often quite vulnerable to the impacts of climate variability (Berkes, 2009a; Salick and Ross 2009; Green and Raygorodetsky 2010; Agrawal and Perrin, 2009; Raygorodetsky, 2011; IPCC, 2014).

Local people can contribute place-based, fine-scale spatial and temporal information, whereas scientific knowledge provides a systematic approach that links many of the elements observed by fishers and other local people for understanding large-scale ecological processes (Moller et al., 2004; Brondizio and Moran, 2008; Wohling, 2009; Ruiz-Mallén et al., 2015). This integration can also help local people to understand why changes are happening, and contribute to a better understanding of trends and intensities of changes and the implications for their livelihoods (Folke, 2004; Berkes and Turner, 2006; Davidson-Hunt, 2006; Berkes, 2009b; Brondizio et al., 2009).

Agrawal (2008) reported that adaptive actions in the context of environmental risks to livelihoods can be classified into five analytical categories: mobility, which helps address risks across space; storage (time); diversification (asset classes); communal pooling (across households); and market exchange (when households and communities have access to markets). The author argues that adaptation is inherently local and the effectiveness of these adaptive actions is in part a function of the social and institutional contexts in which they are pursued. However, the argument that adaptation is local does not necessarily hold true given the lack of: (i) adaptation planning, (ii) information sharing among institutions, and (iii) translation of climate information to the community level (Van Aalst et al., 2008; Raymond and Robinson, 2013; Nalau et al., 2013).

The research presented here is set within the Amazon floodplain where LEK has contributed to the development of community-based management systems (McGrath et al., 2015; McGrath et al., 2003; Oviedo, 2006). Floodplain fisheries present an important opportunity to apply approaches that integrate scientific and local knowledge. They are typically small but complex social ecological systems, involving a wide range of climatic patterns and species exploited within various different property regimes (McGrath et al., 1993; Yandle, 2007; Pinkerton, 2009). We argue that community residents build resilience in the Amazon floodplain by generating innovative knowledge of a range of natural resource issues. These management systems are implemented in different locations depending on the environmental context, and they increase flexibility in adapting to short term changes (Pinedo-Vasquez et al., 2002). Fishing and farming practices are thus important indicators of adaptive capacity in the face of uncertainty and change. Additionally, an important adaptive capacity is the interpretation of climate variability in relation to the short timespan considered in the study. We address these aspects by focusing on linking LEK with a consensus-building model. We explore two community-based initiatives in the Brazilian Amazon floodplain to (1) examine how small-scale fisher-farmers make observations of natural resources and climate variability; (2) explore how they interpret climate variability; and (3) investigate actions that they propose for adapting to climate conditions. The results of this article are divided in three sections. In the first section, we present small-scale fisher-farmers' LEK of climate patterns and natural resource use and management. In the second section, we describe small-scale fisher-farmers' knowledge for adapting to climate variability to (a) secure drinking water and (b) maintain habitats and natural resources for subsistence. In the third section, we discuss the implications for public policies for adapting to climate change.

2. Material and methods

This article focuses on areas of the Amazon floodplain, which in the last twenty years have developed community-based fisheries management systems, including floodplain communities of the Lower Amazon and Upper Purus rivers (McGrath et al., 1993; Mitraud and McGrath, 2013; Oviedo, 2006). The two study areas are representative of floodplains in two important zones of the Amazon basin, the floodplain of the upper portion of a major white water river, and the floodplain of the main stem of the Amazon river in the lower Amazon region. The former is part of a river basin in the southwestern Amazon, and the latter is near the mouth of the Amazon where the floodplain is influenced by changes occurring throughout much of the basin. With these case studies, we seek to understand the perceptions and views of households and their responses to climate variability in their respective regions. The project field areas are: (i) the community of Santo Antonio in the municipality of Manoel Urbano, state of Acre, in the upper Purus river; and (ii) the community of Igarapé do Costa in the municipality of Santarém, on the Lower Amazon River in western Pará (Fig. 1).

Research findings build on ethnographic fieldwork carried out in the two communities during 2008–2013, with the objective of exploring the use of LEK in adapting to climate variability. The dataset is composed of natural resource use data, patterns of flooding and drought, and adaptive actions. Participatory and qualitative methods were used as part of an inductive and exploratory approach to investigate people's observations and interpretations about changes in natural resources and climate. The fieldwork includes (i) a pre-assessment consisting of a two-day meeting with each municipal Fishers Union (Santarém and Manoel Urbano) for preparatory activities in the target communities, and (ii) three-day workshops with community members in each target community. The sample included 50 community members. Each workshop had twenty-five participants selected according to the categories of age (teenager $<$ 19 years; young adult, 19–25 years; adult, 25–40 years; and middle-aged person, 40–60 years) and livelihood strategies (fishers, farmers and cattle ranchers). Information was collected through a participatory process that draws on the method proposed by the Brazilian educator Paulo Freire (Freire, 2005). To assess the use of LEK, informants were asked (1) what is the inventory of animals and plants (chart identifying animals and plants currently existing in the community