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Adaptation strategies to climatic variability: A case study of small-scale farmers in rural Mexico

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ABSTRACT

Climate change is predicted to have major consequences for small-scale farmers in the developing rural areas of the world. Rural areas, nonetheless, harbor opportunities to mitigate global climate changes. Identification of innovative adaptation strategies used by small-scale farmers, therefore, is crucial in order to understand the extent of their implications. This paper identifies the relationships between livelihood units and landscapes that they depend upon, in a small-scale farm community. It examines their experiences of increasing climatic variability, and how the different groups in the community are adapting to it. The study was conducted in a typical rural ejido community on the Pacific coast of Mexico (Ejido Ticuiz), where a detailed socio-cultural profile was obtained by means of semi-structured interviews. In the study area we encountered a range of individual and community-based adaptation strategies, built on farmers' recognition of the different types of landscapes which supply goods and benefits. Small-scale farmers have used their landscape diversity to build adaptation strategies to guarantee the supply of goods and benefits to cope with uncertain of climate events. Households rather than individuals or the community as an institution were depicted as the core socio-cultural group for better understanding of patterns, behavior and aspirations related to climate change adaptation at local level. The adaptation capacities of rural communities could be significantly strengthened if political, financial and institutional support is targeted at households rather than at individuals or the community level only.

Introduction

Currently over 50% of the world population still directly depends on rural livelihoods that are highly vulnerable to climate change (McIntyre et al., 2009). The degree of dependency of different groups and their livelihoods, on specific landscape types and resources, determines the groups' vulnerabilities to climate changes. Effective, sustainable solutions to environmental and resource management depend heavily on local actions that address local needs both short-term coping and medium-to-long term adaptation (Smith et al., 2003; Tompkins and Adger, 2004; Smit and Wandel, 2006). But, concurrent with this, a wider range of diversity of livelihoods and spread of landscape types that they function in, strengthens groups' capacities to adapt and cope with climatic variability.

Adaptation, according to Janssen and Ostrom (2006, p. 237), can be defined as the "adjustment of social–ecological systems in response to actual, perceived, or expected environmental changes and their impacts". Adaptation is a key concept in climate change research, because responsiveness and adaptation mechanisms act as indicators of whether social systems are becoming more resilient to climate change impacts. In social systems, the term adaptation refers to adjustments in the behavior and characteristics of a human group that enhance its ability to cope with external stresses; consequently the direct effect of adaptation is to reduce individual and social vulnerability (Adger et al., 2005; Brooks et al., 2005; Smit and Wandel, 2006). Walker and Salt (2006) argue that adaptation reflects learning, flexibility, the ability to experiment with and adopt new solutions, and the development of generalized responses (individual and collective) for a broad class of challenges. We find examples of each of these elements in this case study community.

The differential capacity of people, as individuals and in communities, to respond and adapt is influenced by a wide set of site-specific environmental, historical, socio-economic, and institutional variables which act conjointly (Eakin et al., 2006, 2012;

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Cutter et al., 2008; Below et al., 2012). Therefore a fuller understanding of the potential severity of climate change for any specific location requires placing climate change in a context of multiple stresses at local scales (Wisner et al., 2004; Moser, 2010). People's decisions about landscape management are made in the light of these multiple forces, and include a dynamic range of measures and strategies to adapt to climatic conditions (Reid et al., 2007).

The supply of environmental services in their landscapes depends on the state of the environmental system (Holling and Gunderson, 2002), which in turn is affected by the distribution and management of the services. The landscapes that people use offer varying sets of vital environmental resources and services, essential to their livelihoods, including water, soils, topography, slope, drainage, land (vegetation) cover, and microclimate, and therefore they create different opportunities for adaptation.

Landscape characteristics incorporate a large gradient of possibilities (Joo et al., 2011), and as a consequence, climate change impacts are complex and locally specific and any prediction of the impacts entails a high degree of uncertainty (Morton, 2007). Mexico is classified as a high risk for climate change (IPCC, 2007; Samaniego, 2009) because a significant proportion is semi-arid with climates characterized by low, seasonal, and highly variable rainfall (Appendini and Liverman, 1994; Liverman, 1999; Magaña et al., 2004), and thus there is high biophysical and socio-economic vulnerability to climate variations (Liverman and O'Brien, 1991; Liverman, 1999; Gay et al., 2006; Ibarrarán et al., 2010; Sáenz-Romero et al., 2012). Researchers have identified causal relationships between climate change and migration (Granados-Ramírez and Longar, 2008; Feng et al., 2010; Alscher, 2009) and recognized the vulnerability of Mexican rural society in general to climate variability (Eakin, 2000), including the gender perspective (Buechler, 2009; Jungehülsing, 2010). Climate change is not the only external driver changing landscapes and people's lives in Mexico. Mexico has been experiencing rapid changes in the agricultural sector due to market liberalization under NAFTA (North American Free Trade Agreement), labor migration, and technological innovations with profound transformations in most traditional rural production systems (Eakin, 2005).

Agriculture in Mexico is not only a fundamental economic activity of the rural population involving about 37% of the total population, but also has deep social significance and cultural meaning. Local perceptions and experiences about climate change adaptation in Mexico have been studied by e.g. Conde and Eakin, 2003; Eakin et al., 2006; Wehbe et al., 2007; Eakin and Wehbe, 2009 and Schroth et al., 2009, among others. Outcomes suggest that people's decisions about landscape management in general, and, in particular, for adapting to climate variability with a wide range of measures and strategies, are made in response to multiple forces acting at the local level. The complexity of responses represents opportunities to improve adaptation to climate change. Although it is recognized that Mexican rural communities possess a wealth of knowledge about the local natural environment within embedded geographical contexts and specific spatial associations, few studies have explicitly explored the local-level spatial dimension of adaptation responses. Adoption of specific adaptation and mitigation measures has to be predicated on the recognition of, and in response to, the synergy between climate variability and specific local conditions (Weaver et al., 2006; Smit and Wandel, 2006).

This study examines climate change at the local level (Enarson et al., 2003; Wisner et al., 2004; Bolin, 2007; Peacock and Prater, 2012; Wangui et al., 2012) by assessing the vulnerability of different livelihood units in a Pacific coastal community in Mexico and the spatial relationships of these groups with different landscapes and the inherent environmental services in these landscapes. This paper identifies the relationships between productive strategies of the livelihood units and the landscapes that they depend on, in a small-scale farm community on the Pacific coast of Mexico. It examines their experiences of increasing climatic variability, and how the different groups in the community are adapting to it. This study is built on three inter-connected issues: (i) identification of livelihood units which belong to people with similar productive strategies and socio-economic characteristics; (ii) spatially linking these units with specific landscape units in the area, and, (iii) ranking adaptation opportunities as depicted by informants and relate them to climatic changes. The outcomes are discussed in relation to their outreach to other areas sharing similar conditions.

Study area

The study focuses on Ticuiz, an agrarian settlement under ejidal community land governance – ejido is a common Mexican community-based land tenure system which was created and legitimated by the Mexican Revolution (e.g. Kelly et al., 2010; Bray, 2013). Ticuiz is located in the southwest of Coahuayana municipality in Michoacán state, between 18°38′ and 18°43′ north and 103°44′ and 103°40′ west (Fig. 1), covering 3123 hectares, which is about 10% of the whole municipality area. The South-west coastal region of Michoacan is characterized by a particularly abrupt and complex relief, whose highest peaks reach about 2700 m. However, the study area is located in a flat coastal area with a low altitudinal gradient from 0 to 10 m.a.s.l. Despite this, relief and periodicity of flooding are the most important geo-ecological differentiation factors within the study area, which determine the distribution of hydromorphic soils and hydrophilic vegetation (mangrove) (Campos and Priego-Santander, 2011).

Ticuiz was selected as a case study because it is in many ways typical of such ejidal communities with a community-based organization system in terms of area, socio-economic conditions, and low accessibility to urban agglomerations. The territory has an important ecosystem diversity including mangroves (*Conocarpus erectus* and *Rhizophora mangle*, covering 13.6% of the study area), tropical dry forest and tropical humid broadleaf perennial forest (15.3%), tropical humid deciduous narrow-broad-thicker-leaf of *Sporobolus* sp. (1.6%), and tropical humid evergreen narrow leaf bulrush of *Typha dominguensis* and *Phragmites* sp. (8.2%). Other covers includes agricultural fields (orchards cover 28.1% and *milpa*[1] covers 14.5), secondary grassland (15%), and water bodies (3.7%). The population of Ticuiz (c. 1000) is distributed among small hamlets. There are currently 294 land rights-holders, known as ejidatarios, who reside mostly in three localities in the ejido. Discussions and agreement about management decisions are taken in the Ticuiz "Asamblea" (General Assembly), in which most of the farmers are included. Most of the ejido is parcelized to individual households, but there is a portion surrounding mangroves of communal natural protected area recognized by all the ejido members. Approximately 80% of farmers own their own land, and the rest need to rent land parcels, with an average of 16 ha of land per household. Productive activities are chiefly traditional rain-fed agriculture (milpa) and backyard orchards. Additional small-scale economic activities include tourism and small-scale trade. Another important income source within the community is related to remittances from the USA, accounting for up to 15% of the total household income.

The dry season runs from November until May, and the rainy season from June until October, with an average annual rainfall of 800 mm and mean annual temperature is 26 °C (GEM, 2003; Sáenz-Romero et al., 2010). Climatic irregularities reported from 1997 until 2007 have caused extreme months of drought, followed by

[1] *Milpa* is a small-scale cropping system widespread in Mexico mainly for maize, combined with minor crops for home consumption.