



# Limits to adaptation to interacting global change risks among smallholder rice farmers in Northwest Costa Rica



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## ABSTRACT

In this paper, we discuss the theoretical relationships among interacting global change risks, valued livelihood goals, and adaptation limits. We build from research on the impacts of multiple and interacting global change risks in lesser-developed countries and seek to understand household adaptation limits in agrarian communities. We ask: What are valued livelihood goals among smallholder farmers in Northwest Costa Rica? How do socio-economic determinants of adaptive capacities determine their ability to meet these goals in the face of the impacts of interacting global change risks? Our data were based on focus groups, interviews, survey responses from 94 smallholder farmers, government statistics, and published literature. We analyzed our data using qualitative content analysis and quantitative logistic regression models. Our analysis showed that farmers perceived rice production as an identity, and that they were being forced to consider limits to their abilities to adapt to maintain that identity. We found that farm size, cattle ownership, years spent farming, and household income variety were determinants of their abilities to remain in rice production while maintaining sufficient levels of livelihood security. We also showed that for those households most vulnerable to water scarcity, their ability to successfully adapt to meet valued livelihood goals is diminished because adaptation to water scarcity increases vulnerability to decreased rice-market access. In this way, they become trapped by the inability to reduce their vulnerability to risks of the interaction between global changes and therefore abandon valued identities and livelihoods.

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## 1. Introduction

Multiple types of global change processes increasingly impact rural development programs; these include regional drought and changes in international crop markets and trade liberalization policies, among others. The interplay between these processes can impact rural livelihoods in unforeseen and surprising ways (Leichenko et al., 2010; Leichenko and O'Brien, 2008; O'Brien and Leichenko, 2000). The study of climate change induced drought, or the study of impacts of global economic changes on rural livelihoods by themselves may not account for the dynamic interrelations and feedbacks between these global change processes. In order to promote the sustainability of rural

development programs, we must begin to systemically address the impacts of these complex interactions on the valued goals of rural households. Global change scientists have studied how these complex interactions can transfer among spatial scales, and how they often increase the vulnerability of the rural poor (Turner et al., 2003). Here, we build on this research and address the complex interactions among global changes that interact to increase the vulnerability of the most vulnerable, which then force households to confront adaptation limits beyond which they may no longer meet valued livelihood goals.

Recent research and understanding about adaptation limits in rural areas provides a working framework to address the impacts of global changes on community-scale smallholder farm populations (Dow et al., 2013a,b; Martin et al., 2013; McDowell and Hess, 2012). Research on the determinants of adaptive capacity has shown that the household socio-economic context often dictates differences in the outcomes of global change impacts at the community scale (Below et al., 2012). These contexts also produce the specific adaptation limits of households throughout lesser

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developed countries (Dow et al., 2013a,b). To date, much of this research has focused on the impacts of and adaptations to climate change, and more commonly climate change induced drought. However, smallholder farming communities often face multiple, interacting risks simultaneously, and the outcomes of the impacts of these risks vary among households (Morton, 2007).

In this research, we seek to understand how different adaptive capacities among smallholder farmers in Northwest Costa Rica determine their ability to continue meeting valued livelihood goals in the face of worsening impacts of interacting global change risks. Specifically we ask: What are valued livelihood goals among smallholder farmers in Northwest Costa Rica? How do socio-economic determinants of adaptive capacities determine their ability to meet these goals in the face of the impacts of interacting global change risks? The Arenal-Tempisque Irrigation Project (*Proyecto de Riego Arenal-Tempisque*, PRAT) in Guanacaste Province, NW Costa Rica, our case study site, has been heavily impacted by drought and trade liberalization. These global changes have caused many smallholder farmers to confront adaptation limits and ultimately many have abandoned valued livelihood goals.

In this paper, we discuss the theoretical relationships among interacting global change risks, valued livelihood goals, and adaptation limits. Then, we describe our case study and data that include focus groups, household surveys, and interviews. We report the results of our analysis and discuss their significance in the context of the Arenal-Tempisque Irrigation Project and research on the human dimensions of global change.

## 2. Theoretical framework and definitions

The ontological framework presented by Morton (2007) dictates that research on smallholder farm adaptations and vulnerabilities should (1) recognize the complexity and location of production systems and (2) incorporate both climate and non-climate stressors on rural livelihoods. We build from this framework and research that has considered how households adapt to the impacts of global change processes, which include changes in both the economy and the climate (Adger et al., 2009a,b; Christoplos, 2010; Eakin et al., 2009; Eakin, 2003, 2005; Eriksen and Silva, 2009; Leichenko et al., 2010; Leichenko and O'Brien, 2008; Neil Adger, 1999; O'Brien and Leichenko, 2000; O'Brien et al., 2009). We conceptualize global change processes as impacting vulnerable households in different ways, resulting in determinate outcomes. Here, we define vulnerability as the degree to which a household may be impacted adversely by the outcomes, or the potential outcomes, of global change risks (Eriksen and O'Brien, 2007; Eriksen et al., 2011). These outcomes depend on household exposure and sensitivity to an impact, and on whether and how households can and do adapt. Exposure represents the condition of being impacted (Leichenko and O'Brien, 2008).

We define adaptations as responses to observed or expected global change risks – their effects and impacts – in order to alleviate adverse impacts of change or take advantage of new opportunities (Adger et al., 2005; IPCC, 2001) to meet valued goals (Füssel, 2007). These adaptations can be made either in anticipation of or following from exposure. Marshall and Marshall (2007) show that adaptations are a function of the capacity of a household to change, and their perceptions of risks to livelihood goals. We distinguish coping mechanisms as specific to a type of household adaptation, and we define them as adaptations that diminish the ability of a household to meet valued livelihood goals in the face of future impacts (Smit and Wandel, 2006). Prolonged coping can reduce household capacity to adapt, and may force households beyond adaptation thresholds, beyond which they cannot meet valued livelihood goals (Jones, 2001; Roncoli et al., 2001).

Valued livelihood goals are critical to our conceptualization of adaptation and in turn, to defining adaptation limits. Household adaptations to global changes that result in a household's ability to better meet valued goals are considered successful within this context. These adaptations are a function of household capacities to pursue new opportunities and to reduce their sensitivity and exposure to the impacts of global change risks. These capacities are largely dependent on the underlying socio-economic context and the larger political economy that also define specific valued livelihood goals (Cohen et al., 1998; Klein et al., 2007; Yohe et al., 2007). In this way, we liken valued livelihood goals to Alkire's (2002) dimensions of human development, and define them as “non-hierarchical, irreducible, incommensurable basic kinds of human ends.” Valued livelihood goals do not “derive from nor divide up an idea about what a good life is, but rather are reasons for action.” Nor are they static. Within different communities and contexts, goals necessarily take different forms. For example, while *identity* may be a basic human end (Max-Neef, 1993), Lerner et al. (2013) found that the *maize-producer identity* among farmers in the Toluca Metropolitan Area, Mexico is a highly valued livelihood goal and therefore persists even through rapid urbanization pressures.

Adaptation limits represent thresholds beyond which households can no longer adapt or cope with the impacts of global change risks to meet valued livelihood goals. As risks associated with global changes increase, risks to livelihood goals may become intolerable, at which point households must either live with intolerable risk of losses, revise attitudes about what is a valued objective, or change behavior radically (i.e., transformative adaptation) to avoid the intolerable risk of loss (Dow et al., 2013a,b). Intolerable risks are those that fundamentally threaten a valued livelihood goal despite adaptive actions to minimize the risks (Dow et al., 2013a,b). We rely on the conceptualization by Adger et al. (2009a,b) of adaptation limits, and define them as constructed by the underlying socio-economic context, which includes ethics, knowledge, and attitudes toward risk. Limits to adaptation depend on valued livelihood goals. In this way, adaptation limits are refined by context and therefore malleable, but they are very real and experienced by households facing risks. At adaptation limits, individuals within households may perceive transformative adaptations as the necessary final response to escape the impacts of intolerable risks to livelihood goals. Transformative adaptations mark adaptation limits beyond which households cannot adapt to intolerable risks to meet existing valued livelihood goals (Dow et al., 2013). In certain socio-economic-ecological contexts, transformative adaptations may allow households to redefine valued livelihood goals and avoid long-term livelihood losses. In other contexts, few alternative livelihood options may be available to households and therefore transformative adaptations may result in loss of land tenure, poverty, and food insecurity.

For the most vulnerable in less-developed countries, household perceptions about the efficacy of adaptive capacities may be closely linked to their ability to avoid adaptation limits and devolve into long-term poverty, where few alternative livelihood options exist. Accordingly, the determinants of transformative adaptations that mark adaptation limits provide insights into household vulnerabilities that may be addressed in rural development programs to better allow households to meet valued livelihood goals in the face of global change risks. However, the same socio-economic determinants of successful adaptation to one risk may increase household vulnerability to another. This interplay between interacting global change risks, valued livelihood goals, and adaptation limits is not well understood in many rural development programs, but it is critical to their success.

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