Foreign Aid and Adaptation to Drought: A Case Study in Rufiji, Tanzania

by

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Dedication

For Jess

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Chapter 1

Introduction

Introduction

I began my dissertation with an interest in the potential negative impacts of climate change on rural populations in developing countries, particularly in Africa. It is likely that the world's most marginalized people will be disproportionately harmed by climate change, due to their relatively high dependence on climate-sensitive livelihoods and inability to act autonomously to make themselves less vulnerable to changes (i.e., to "adapt") (Kates, 2000; Adger et al., 2005). Empirical research, we hope, can help with the challenge of designing policies that empower such people to adapt.

During my time at UM, I was able to attend two conferences on climate change adaptation: the first in Bangladesh on community-based adaptation, and then the UNFCCC Conference of Parties 15 in Copenhagen. At these gatherings, I participated in the moral debate about whether developed countries should fund measures to reduce vulnerability to climate change in developing countries (Roberts & Parks, 2007; Adger et al., 2006). I left both conferences knowing that many Least Developed Countries (LDCs) have made some meaningful progress on National Adaptation Plans of Action (NAPAs)

(http://unfccc.int/national_reports/napa/items/2719.php), and that international development institutions are attempting to secure substantial commitments of adaptation funds from developed nations. But I also learned that the *practice* of facilitating climate change adaptation is still limited by several factors, including a lack of theoretical generalizations about what variables are important to adaptation across different settings. Part of the reason for this is that climate change adaptation draws off knowledge from several fields—including hazards and risk assessment, food security, and livelihoods and poverty—and so there is a large list of variables that are hypothesized to be important to adaptation. Much attention has been paid to the physical aspect of climate-related vulnerability, and not enough on the means by which people respond to physical hazards. Empirical studies can test some of the hypothesized variables, and help to strengthen adaptation theory so that more reliable signposts are available to policymakers.

Another reason why adaptation policy is in a nascent stage is that the process of adaptation is one of change, and studying it requires that we obtain data on how people's vulnerability changes over time. In poor areas, such data are scarce, and research programs must either institute long-term monitoring programs or collect relevant proximate data, often through surveys or interviews.

I employed the latter approach when developing my research plan, following a general method that Downing (2010) might refer to as a mix between two approaches to adaptation science: 'Vulnerability Assessment and Sustainable Livelihoods' (VASL) (where the focus is on the distribution of livelihood risks and potential responses) and 'Stakeholder Threats and Opportunities' (STO) (where the focus is on building adaptive capacity and integrating climate risk into development planning). I identified a well-

funded foreign aid project in a poor, drought-prone region of rural Tanzania and used survey and interview data to explore three general themes:

1) Variations in household drought coping strategies, and the connection between coping strategies and vulnerability to drought;

2) The potential role of foreign aid in positively influencing different variables that are hypothesized to be important to coping and adapting to climate change; and

3) The relationships between those variables and actual short- and long-term climate change adaptation outcomes.

The fieldwork

I chose to conduct my research in Rufiji district, Tanzania. Rufiji is an area with great biological wealth, but is the poorest district in the country, home to more than two hundred thousand people, 93 percent of whom are rural smallholder farmers and fisherman (Ochieng, 2002). Farmers rely on a combination of floods and rainfall to create the conditions necessary for cultivation of maize and rice staple crops, and are increasingly exposed to climate-related stressors like drought. With this case, I could learn about current household vulnerability to drought, and also explore the effects of an intensive aid project on that vulnerability.

The Rufiji Environmental Management Project (REMP) was a conservation and livelihood development project that operated in four "pilot villages" in the district from 1998 to 2003.

REMP project documents (e.g., Ochieng, 2002) describe the goals of the project:

> To promote the sustainable use of natural resources and enhance the livelihoods of local communities by implementing sustainable pilot development activities based on 'wise-use' principles.

My research focused on two villages in the western floodplain area of Rufiji district, an area that, due to its topography, is periodically exposed to damaging floods and receives about half the rainfall as the coast, making it relatively prone to drought (Havnevik, 1993: p. 86). One village was a REMP pilot village, while the other shared similar ecological, institutional, and socio-economic features (e.g., weather, social cohesion, leadership potential, and livelihood patterns)—as determined by a project-led village appraisal in 1998 (Mbiha and Senkondo 2001b, p. 2-5)—but was not a pilot village. By using the second village as a natural control, I identified specific influences of REMP's intervention on vulnerability outcomes in the pilot village.

I surveyed 200 farmers—100 in each village—and carried out numerous group meetings (n=10) and individual interviews (n=18) within the villages and at the district headquarters, assembling qualitative data to complement the coded survey data. By and large, I performed Chi-square tests of associations with the survey data in order to identify differences between the two villages in drought vulnerability, or between household assets and vulnerability. I used the qualitative data to explain statistical trends (or lack, thereof) as well as opportunities and limitations—e.g., cultural, economic, or political—to reducing vulnerability in the villages.

The structure of the dissertation

In Chapter 2, I explore the connections between REMP's decentralized natural resource management initiative and variables related to drought-year coping and long-term adaptation outcomes. First, I consider a potential tradeoff of decentralized natural resource management with respect to drought vulnerability: the benefits of more resilient

ecosystems vs. the costs of reduced access to drought-coping natural resources. Second, I explore whether a highly participatory process of developing and implementing village-level environmental rules had the effect of expanding social networks and, as a secondary benefit to better environmental management, improving the ability of villagers to respond collectively to drought over time.

In Chapter 3, I explore the connections between livelihood diversification (and REMP's diversification initiative) and household vulnerability to drought. I look at whether the assisted diversification project had a measurable influence on diversification outcomes, and then whether household diversification measures influenced drought sensitivity. I focus on the importance of demonstrating the results of household investments to securing adoption of diversified livelihood activities among risk-averse individuals, and the role that market access plays in fulfilling the potential of livelihood diversification as a meaningful climate change adaptation.

In Chapter 4, I step away from the influence of the aid project in order to explore the importance of household assets as determinants of household vulnerability to drought. More specifically, I look at how measures of natural, financial, human, and social capital related to proximate variables for drought sensitivity and adaptive capacity.

Finally, I conclude by recounting the major findings of the three chapters, focusing on the multi-scalar nature of climate change adaptations, and the need for long-term data collection in the marginal areas of the world so that we can better study vulnerability and identify specific leverage points for adaptation interventions.

Vulnerability and adaptation to climate change

Throughout the dissertation, I refer to vulnerability as the susceptibility of a system to be harmed by specific perturbations (Adger, 2006, p. 269; Gallopin, 2006), and *social* vulnerability to climate change as conditioned by the following three variables (Adger, 2006; Nelson et al., 2007; Turner et al., 2003; Agrawal, 2008):

1) *Exposure* to climate-related perturbations, such as drought;
2) *Sensitivity*, or the degree to which livelihood factors—such as staple harvest yields—are susceptible to change due to exposure to climate-related perturbations;
3) *Adaptive capacity*, or the capacity of individuals or groups to adjust to current and future climate-related perturbations in beneficial ways.

I acknowledge that the concept of adaptive capacity embodies the ability to carry out either reactive or proactive responses to environmental change, or both (Smit and Wandel 2006). When appropriate, I make a distinction between reactive, or short-term (e.g., seasonal) *coping* actions that might include accessing alternative resources in order to survive after a failed staple harvest; and proactive, or long-term, *adaptations* that might include exploiting lessons from the past or making use of future climate and socio-economic scenarios in order to restructure production or governance systems in beneficial ways. The two concepts are intrinsically linked, however, as some short-term reactions can enable more substantial long-term adjustments, just as some long-term adjustments can make it less likely that people will exposed and/or sensitive to hazards. Some refer to actions that appear to be adaptive, but in reality have substantial negative side effects or exacerbate inequitable resource allocations in society, as *mal*adaptations (for a review of the concept, see Barnett & O'Neill, 2010).

A recent review of the literature defines the related concept of *resilience* as "the capacity of a system to absorb disturbance and re-organize while undergoing change to as to still retain essential the same function, structure, identity and feedbacks" (Folke 2006, referring to Walker et al. 2004). According to Carpenter et al. (2001, as cited in Folke et al. 2006) and others, resilient social-ecological systems absorb disturbance, are capable of *self*-organization, and "can build and increase the capacity for learning and adaptation" (260). I only invoke the term when referring to ecological resilience, or the ability of an ecological system to maintain functional integrity when exposed to external perturbations (Folke, 2006; Walker et al., 2004; Tompkins & Adger, 2004). However, I still find it useful to conceptualize adaptive capacity as a human element of resilient systems: in allowing for reactive and proactive manipulation of system characteristics (from ecosystem to institutional variables and their interactions), adaptive capacity comprises a system's ability to learn and adapt to future change—if mobilized by human agents—and contributes to the system's ability to absorb change and self-organize.

Focusing on the characteristics of *changing* systems encouraged me to invoke also to the concept of *transformability*, or "the capacity to create a fundamentally new system when ecological, economic, or social structures make the existing system untenable" (Walker et al. 2004). We can make the distinction between intentional transformations, in which adaptive capacity is mobilized to overcome a system's "pathological" resistance to change (Nelson et al. 2007; Walker et al., 2004), and unintentional transformations, where a system undergoes an autonomous, unplanned fundamental alteration of state, perhaps due to a lack of adaptive capacity. The term is an extension of the concept of adaptation, distinctly implying more than just a *recovery* of dynamic systems after

perturbations (which in poorer areas of the world, might mean returning to a pre-shock state of chronic poverty), and allowing us to instead consider system *renewal* and *reorganization* (Folke 2006) into less vulnerable states.

The adaptation and resilience framework's "normative slant" (i.e., that we can identify "desirable states" of social-ecological systems [Nelson et al. 2007]), as well as the multi-scalar relationships potentially vital the creation or persistence of those states, led me to consider what kinds of actions people, or even external investments like aid, can take to steer livelihood systems towards those more desirable states. What might infusions of financial, technological, and other forms of support into rural areas yield in terms of drought vulnerability outcomes? In addition to focusing on how people are sensitive to drought (i.e., how drought affects staple harvests) and how they are able to respond (both by coping in the short term and in ways that transform their drought sensitivity), I explored whether particular aid interventions can influence vulnerability at the levels of the household and the village.

Vulnerability to drought & foreign aid

To examine drought vulnerability at the household level, I often refer to household *livelihoods*, defined by Ellis (2000) as "the activities, the assets, and the access that jointly determine the living gained by an individual or household." I explore the potential influence of livelihood *diversification*—defined by Ellis (2000) as "the process by which rural households construct an increasingly diverse portfolio of activities and assets in order to survive and to improve their standard of living" (15)—on drought sensitivity. I also look at asset *entitlements,* or what assets an individual or group has

access to, and their influence on proximate variables for drought sensitivity and adaptive capacity.

To examine drought vulnerability at the village level, I test measures of social capital—broadly identified as relations of trust; degrees of reciprocity and exchange; common norms, rules, and sanctions; and connectedness among different parties (Adger, 2003; Ostrom, 1994; Ostrom, 2010; Pretty, 2003; Pretty and Ward 2001)—on collective abilities to respond to drought in positive ways.

In all cases, there is the underlying question of whether foreign aid can provide assistance in facilitating positive responses to drought. The assumption in the international development community appears to be a resounding, "Yes," despite serious shortfalls in empirical research to guide adaptation policies, as well as unresolved debates about the dismal past performance and future roles of Western foreign aid (see Collier 2007; Easterly, 2006; and Sachs, 2005; Gibson et al., 2005). I hope to contribute to this dialogue with the following work.

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Chapter 2

Biodiversity conservation and coping with drought: A case study in Rufiji, Tanzania

Introduction

Around the world, we are losing species, habitat, and environmental goods and services at an ever-accelerating pace (Hassan et al., 2005). The loss of natural resources, combined with other stressors—from economic shocks to climate change (O'Brien & Leichenko, 2000)—pose significant threats to security of the rural poor, and demand that we seek solutions that recognize conservation and poverty alleviation as interdependent (Agrawal & Redford, 2006; Adams, 2004; Garnett et al., 2007). Over the last three decades, governments and aid organizations have increasingly supported decentralized and co-management of natural resources as approaches to achieving conservation and social development goals in rural parts of the developing world (Lemos & Agrawal, 2006; Agrawal & Gupta, 2005; Agrawal & Redford, 2006; Adams, 2004; Garnett et al., 2007; Hughes & Flintan, 2001). More recently, some scholars have speculated that these approaches might also be effective as a response to climate change. At least two arguments support this position:

(1) **(a)** Due to the inherent qualities of broad local stakeholder buy-in, accountability, and better communication and information management, decentralized natural resource management should be relatively adaptive to change, and thus more effective in conserving the functional integrity of ecosystems when they are exposed to climate-related stressors over time (Tompkins & Adger, 2004). Functional ecosystems are more able than degraded ecosystems to supply important ecological goods and services to the rural poor after climate-related hazards like drought (Tompkins & Adger, 2004; CBD, 2009). **(b)** Because it promotes broad local stakeholder buy-in, accountability, and better communication and information management, decentralized natural resource management should be relatively attentive to the potential problem of limiting local access to natural resources – many of which might be used traditionally for coping with climate-related hazards.

(2) Because decentralized natural resource management typically encourages broad participation among local stakeholders, and often fosters relationships among stakeholders across multiple levels of government (co-management), it can potentially expand social networks and improve the ability of groups to respond collectively to climate change over time (Tompkins & Adger, 2004; Adger, 2003*b*).

We have lacked empirical studies that test these hypotheses—and, more generally, the relationships among conservation, coping behavior, and climate change adaptations—across different settings. Here, I present a case study from Rufiji District, Tanzania that explores how a five-year, aid-supported decentralized natural resource management project influenced household drought coping abilities, measures of social capital, and collective drought adaptations. Such studies can help guide policymakers tasked with

investing potentially substantial financial resources in climate change adaptations in the developing world.[1]

The case study is relevant for several reasons. Smallholder farmers in Rufiji are vulnerable to extreme and often unpredictable weather events due to their near-exclusive reliance on climate-sensitive staple crops, and typically use natural resources to cope with hazards like drought. The aid project engaged a broad range of villagers in the design and implementation of a village environmental management plan to regulate the consumption of forest and wetland resources – many of which are used to cope with droughts. The project also aimed to facilitate relationships among village leaders and their counterparts at the district and regional levels so as to eventually assimilate the village plan into a district-wide environmental management plan.

The research looks at two villages in Rufiji, only one of which participated in the natural resource management project; the other village served as a control site. In a poor setting like Rufiji, we lack both baseline and long-term monitoring data that can be used to evaluate the impacts of aid projects on ecological and social outcomes. As a result, my research depends largely on proxy data derived from surveys and open-ended discussions with local people about *perceived* changes in ecological and social variables over time.

[1] Much of the existing adaptation financing is in the form of bilateral aid for small projects and small grants distributed by the Global Environmental Facility (GEF) of the United Nations (UNFCCC, 2009; IDS, 2008). From this pool, some financing already supports rural natural resource management efforts: GEF's Special Climate Change Fund (SCCF) targets, among other "priority areas for adaptation," activities such as water resources management, land management, and fragile ecosystems (GEF, 2010). In the post-COP 15, nonbinding "Copenhagen Accord," developed nations agree to provide $30 billion to poorer nations by 2012 and $100 billion a year by 2020 to support efforts to mitigate greenhouse gas emissions and cope with the effects of climate change (UNFCCC, 2009).

The study is a valuable empirical contribution to the established literature on decentralized natural resource management, and to the growing body of work on the use of foreign aid to support climate change adaptations in the developing world.

In the next section, I describe the case study site and aid project. I then describe my data collection techniques and analytical methods, and review the literatures on decentralized natural resource management, ecological resilience, and social capital in order to build my analytical framework.

Study Site: Rufiji District, Tanzania

The Rufiji is the largest river basin in Tanzania, draining about 20 percent of the country. The Rufiji watershed is well known for its significant biodiversity, and consequently draws the attention of international conservation organizations (Doody & Hamerlynck, 2003; Havnevik, 1993). Despite this biological wealth, Rufiji District is the poorest in the country, home to more than two hundred thousand people, 93 percent of whom are rural smallholder farmers and fisherman (Ochieng, 2002). In typical years, floods, influenced by rainfall and runoff patterns throughout the vast watershed, inundate the river basin, depositing nutrient-rich silt on the land, thus creating suitable conditions for floodplain agriculture. Flooding also enables productive fishing by refilling hundreds of permanent and temporary riverside lakes and ponds each year. Local rainfall can compensate farmers for poor floods, and vice versa.

It is rare for people in the Lower Rufiji Floodplain to store food or to keep financial savings that they can draw on during hard times. Village granaries, once commonplace

throughout the *ujumaa* villages,[2] have long been abandoned. A dearth of reliable markets and prices for staple and cash crops and products like chickens and honey, as well low productivity, mean that money is hard to come by in these subsistence communities. Kasthala et al. (2008) reported that only 4 percent of citizens of one village in the region have bank accounts, and only 3 percent had received credit or loans over the previous year (p. 32). Among the few who are fortunate enough to find informal paid labor, it is commonly argued that wages aren't increasing proportionally with the price of food, resulting in declining purchasing power.

Because people rarely save, they rely on coping strategies that are immediately available to them when harvests are insufficient or fail, outright, after hazardous floods or drought. These include soliciting family support, engaging in employment, businesses, and chicken-keeping, and, importantly, consuming or selling natural resources (Mbiha and Senkondo, 2001a; Havnevik, 1993; Ochieng, 2002).

Village leaders in Rufiji claim that in recent decades, the timing and volume of floods have become increasingly unpredictable (personal communication, May, 2008)—perhaps due to changing land-use patterns and resulting runoff dynamics, and to changes in climate. Also, villagers claim that in recent decades, rainfall has been more erratic and less reliable as compensation for poor floods (IUCN, 2004; personal communication, May, 2008). Funk et al. (2008) projected that main growing-season rainfall in East Africa – which is already down 15 percent since 1980 – will continue to decline due to the warming of the Indian Ocean, thereby threatening agricultural production in communities already vulnerable to drought. Looking forward, questions arise about

[2] *Ujumaa* was the post-colonial policy implemented by President Julius Nyerere that encouraged disparate rural dwellers to concentrate into defined settlements. See Havnevik (1993) for a lengthy profile of the policy.

whether existing coping capacities of households and villages in Rufiji will be sufficient if precipitation and flood patterns change—especially given widespread and significant limitations to many forms of productive capital and forecasting knowledge (Havnevik, 1993)—and about what kinds of investments can help farmers and villages adapt.

Study Site: The Rufiji Environmental Management Project

The Rufiji Environmental Management Project (REMP) was a conservation and livelihood development project that operated in four "pilot villages" in the district from 1998 to 2003. It was spearheaded by the International Union for Conservation of Nature (IUCN), and implemented with the help of a number of partners including the Tanzania National Environment Management Council, Coast Region offices, the Rufiji Basin Development Authority, and the Dutch Embassy.

REMP project documents (e.g., Ochieng, 2002) describe the goals of the project:

> To promote the long-term conservation through "wise use" of the lower Rufiji forests, woodlands and wetlands, such that biodiversity is conserved, critical ecological functions are maintained, renewable natural resources are used sustainably and the livelihoods of the area's inhabitants are secured and enhanced.

My research focuses on two villages in the western floodplain area of Rufiji district, an area that, due to its topography, is periodically exposed to damaging floods and receives about half the rainfall as the coast, making it relatively prone to drought (Havnevik, 1993: p. 86). One of the two villages was a REMP pilot village—referred to as 'Project Village' here. The second village shared similar ecological, institutional, and socio-economic features with the Project Village (e.g., weather, social cohesion, leadership potential, and livelihood patterns)—as determined by a project-led village appraisal in 1998 (Mbiha & Senkondo 2001b, p. 2-5)—but was not a pilot village for

REMP. The main centers of both villages, including permanent houses, are located just north of the Rufiji River, while most farms and temporary shelters are miles away (Figure 2.1).

In addition to introducing economic activities to complement traditional maize and rice production in the Project Village—including chicken- and bee-keeping and horticulture—and methods for fishing inland lakes sustainably, REMP aimed to engage as many villagers as possible in writing up and implementing a village environmental management plan.[3] Eventually, this plan—which would limit the consumption of natural resources from village-owned forests and wetlands, many of which are used by villagers to cope with climate-related hazards like drought (Havnevik, 1993; Hogan, 2004)—would be assimilated into a district-wide plan. Each step of the process—from initial socio-economic profiling, to selecting the planning team and developing and implementing the plan—required significant community coordination and cooperation, and resulted in village by-laws (Table 2.1). The by-laws were endorsed by the district government not only because they would eventually cohere with larger-level environmental management plans, but because of the assumption that district-level support would provide credibility to the nascent institutions and help them to take root and strengthen over time (Tengo & Hammer, 2005).

[3] See IUCN (2004, p. 11) for a description of how REMP facilitated the creation and implementation of the village environmental management plan. Completing the environmental management plan entailed several steps: "Socio-economic and natural resource studies; problem and opportunity analysis; selection and training of a temporary village environmental management planning team; development of village environmental management plan (objective hierarchy and action plan); implementation of the village environmental management plan; and review, revision of the plan, verifying and/or developing supporting legislation for the plan." Villagers were then encouraged to evaluate their progress and then request for specific additional support in the future—which resulted in several more local government training workshops.

It is important to note that the Non-Project Village, too, has general village by-laws derived from district law books, many of which are meant to protect natural resources. The relevant difference between the two villages is the extent to which REMP engaged villagers in the design and implementation of a village environmental management plan tailored to their specifications (IUCN, 2004), and the predicted efficacy of the institutions for monitoring and enforcement of rules.

Throughout the duration of the project, REMP strived to garner social acceptance of changes to traditional patterns of resource use in the village, and encouraged "flexible, evaluative decision making" (Tompkins & Adger, 2005, p. 568) and learning in the rule-making process (Ochieng, 2002). It also focused on developing village leadership capacity through numerous workshops, and facilitated many meetings between the village government and officials in the district and regional governments to design and legitimize the village environmental management plan. REMP expected that over time, the pilot villages would develop the ability to self-organize (without external assistance), and therefore be able to (1) improve autonomously upon any initial conservation gains and (2) take anticipatory action to address shared, and often unpredictable, threats to long-term livelihood security (Ochieng, 2002).

Originally designed to last a decade or more (Ochieng, 2002), REMP was terminated prematurely in 2003 due to institutional changes in the Dutch aid system (personal communication with project officer, July, 2008).

Due to its focus on developing enforceable rules to manage natural resources that are important to household drought coping, and on facilitating productive relationships within pilot villages and between village leaders and higher-level government actors,

REMP is a good test case to explore the influence of decentralized natural resource management projects on coping and adaptation outcomes; and possibly to inform aid interventions among the many of the world's marginalized farming communities that are vulnerable to climate change.

Data Collection

With the assistance of a trusted Tanzanian field assistant, between January and June 2008 I conducted 1.5 to 2-hour surveys with 200 heads of households—100 in each village, all randomly selected from village office registries—as well as 5 group meetings in each village and 18 semi-structured interviews with key informants in the villages and at the district headquarters, including some who were involved in the aid project. Qualitative data come from additional open-ended questions from the survey interviews, group meetings, and semi-structured interviews; reviews of past research in the region; and from REMP and Rufijij District development documents.

Respondents were remarkably candid throughout the research: most did not appear to be intimidated by the experience or to be withholding in their responses. We took time and care to pursue accurate responses, and discarded only a few responses that we judged to be unreliable due to confusion on the part of the respondents. Survey responses were carefully coded in the field in order to avoid the bias of any preconceived "theoretical positions or expectations" (King, Keohane, & Verba, 1994, p. 157). Because the behaviors I examined are influenced by many, often dynamic factors, I used a large sample size and am conservative when making inferences and generalizations.

In the following section, I justify the proxy variables used in the research and present their associated survey questions.

Theoretical Framework & Empirical Data

Coping

Much scholarship has explored how poor people are vulnerable to particular hazards, as well as how people, being "actively engaged in diverse strategies to reduce risk" (Eriksen et al., 2005, p. 302) *cope* with hazards. Coping is a term usually reserved for short-term actions—either production or exchange (Agrawal, 2008)—that allow individuals or groups to recover from stresses. Another way of describing coping is "the ways in which communities and households, mobilize and allocate resources in times of crisis" (Adams et al., 1998, p. 263). Some have viewed household coping as a sequential process of engaging in different, increasingly costly strategies in pursuit of maintaining short-term security when exposed to perturbations (Adams et al., 1998; Corbett, 1998). Some of the strategies further along the coping continuum could result in digging the household deeper into long-term poverty—for example, those involving the liquidation of household assets and means of production, and migration (Corbett, 1988).

Research on coping has tended to focus on case-specific, individual- and household-level coping portfolios among the poor, an approach that allows us to consider how multiple factors can interact to influence overall coping capacities and, thus, vulnerabilities to external stressors (e.g., Eriksen et al., 2005). Agrawal (2008), attempting to make theoretical sense out of the many such case studies, examined over 300 cases of rural "adaptation practices" in the UNFCCC's coping strategies database

and identified five general categories of practice: forms of mobility, storage, diversification, communal pooling, and market exchange. He and others (e.g., Adger & Kelly, 1999; Devereux & Naerra, 1996; Sen, 1981) have argued that individual and household access to coping strategies is contingent upon household "entitlements," or what assets an individual or group controls. Entitlements are determined not only by individual endowments, but by multi-scalar (especially local) institutional environments that facilitate individual access to productive assets.

While in other papers I pay more explicit attention to how household livelihood activities and assets relate to drought coping and vulnerability in Rufiji (Parker, 2010*a*; Parker, 2010*b*), in this paper I explore on how access to natural resources, specifically, determines drought coping capacity, and how the experience of broad local participation in natural resource management influences the capacity of groups to collectively respond to drought.

DNRM, Ecosystem Resilience, & Coping with Drought (Figure 2.2, 1(a) & 1(b))

Ecosystems are considered to be "resilient" if they are able to maintain functional integrity when exposed to external perturbations (Folke, 2006; Walker et al., 2004; Tompkins & Adger, 2004). For a long time, scholars and professionals in fields of conservation and poverty reduction have argued that ecological resilience—and, by association, conservation and restoration of ecosystems—is important to the livelihood security of people in developing nations that rely on a continuous supply of ecosystem goods and services (e.g., MA, 2005; Hassan et al., 2005; CBD, 2009; Garnett et al., 2007).

More recently, some scholars have posited that *promoting* ecosystem resilience may represent an important adaptation to more frequent and severe stresses on ecological systems due to climate change (CBD, 2009). The rationale is that a resilient ecosystem might not only reduce human exposure to climate-related hazards—for example, in-tact forests regulate local climate variability and reduce hazardous precipitation runoff, and healthy wetlands buffer against floods and storm surges and retain moisture during drought—but also provide important coping resources to farmers when livelihood systems *are* exposed and adversely affected by such hazards (CBD, 2009, p. 21-23; Eriksen et al., 2005).

There are several arguments for why decentralized natural resource management, in particular, can be an effective strategy for building or maintaining resilient ecosystems. If institutions for natural resource management are truly democratic—and not a set of 'self-selected' arrangements that reinforce existing inequalities within a group (see Agrawal & Gupta, 2005)—they can operate more efficiently and create more equitable environmental and social outcomes than more centralized arrangements (Ribot, 2002; Hayes & Ostrom, 2005; Agrawal & Chhatre, 2006; Fiszbein, 1997). Local participation in decision making and policy implementation can enable communities to characterize human-environment relationships with relative accuracy and lower organizational (including communication) costs, resulting in governments that are better informed and more responsive to citizen values *over time* (Ribot, 2002; Garnett et al., 2007; Dietz, 2003; Ostrom, 1995).

These characteristics—broad local stakeholder buy-in, accountability, and better communication and information management—support two initial theoretical

assumptions of this paper. First, decentralized natural resource management structures should be relatively good at learning from experience and adapting to external stressors, including climate change (Tomkins & Adger, 2004; Folke et al., 2005) (Figure 2.2, 1(a)). And second, because these structures learn and adapt, they should be relatively good at balancing conservation goals with traditional local dependence on natural resources for coping with climate-related hazards (Figure 2.2, 1(b)). To explore these arguments, we would ideally require long-term monitoring data on environmental governance decisions and supplies of ecological goods and services. These being unavailable to me, I relied instead on proxy data from survey responses and interviews. First, I surveyed farmers about the *perceived* state of their surrounding ecosystems (Figure 2.2, 1(a)) and the importance of natural resources to coping with drought. Then, I asked the following questions to acquire nominal proxy data about the influence of conservation measures on coping capacity (Figure 2.2, 1(b)):

- Do you like rules that protect natural resources? Would you like to see any rules changed?
- Has your ability to cope with drought changed over the previous ten years? How?
- Has REMP affected your ability to cope with drought? How?

Free-responses associated with these questions helped to fill in gaps in data about changes in ecological integrity, as well as the distribution of survey response types.

Where appropriate, I calculated relevant descriptive statistics and percent distributions of response types to questions in the survey; and to explore potential differences between the two villages, I performed t-tests and calculated Pearson Chi-Square statistics and adjusted residuals using SPSS v 13.0. I conducted a qualitative analysis on additional open-ended questions from the same household survey and from

semi-structured interviews with village groups and public officials, and used the results to explain patterns from the statistical analysis and to develop theoretical insight into the relationships among my variables of interest.

DNRM, Social Capital, & Collective Drought Adaptations (Figure 2.2, 2 & 3)

Social capital is broadly defined as relations of trust; degrees of reciprocity and exchange; common norms, rules, and sanctions; and connectedness among different parties (Adger, 2003; Ostrom, 1994; Ostrom, 2010; Pretty, 2003; Pretty and Ward, 2001). Generally, social capital is viewed to be the "glue" that enables collective actions in the pursuit of common goals—from the management of common-pool natural resources (Pretty, 2003; Pretty & Ward, 2001; Dietz et al., 2003), to collective mediation of risks associated with climate change (Adger, 2003; Adger & Tomkins, 2004; Ostrom, 2010).

Some make the useful distinction between *bonding* social capital, which is based on friendship and kinship among local actors, and *networking* social capital, which is based on synergistic relationships among actors at different levels of organization – e.g., between governments at the village and district levels (Adger, 2003; Evans, 1998; Pelling & High, 2005). The participatory and *iterative* nature of some forms of decentralized natural resource management—meaning that many local stakeholders have repeated interactions with each other, and with individuals at higher levels of governance in the case of co-management structures, to institute and effectively monitor, enforce, and adjust rules for resource use—initially requires and then reinforces mutual trust, and can lead to the development of both types of social capital over time (Adger, 2003).

Some argue that the social networks established to enable decentralized natural resource management, or other institutions, could possibly increase the capacity of groups to respond collectively to *other* social dilemmas, such as climate change (Tompkins & Adger, 2004; Ziervogel et al., 2006). For example, farmers might be more able to develop networks of reciprocation and help each other cope with droughts (Adger, 2003; Ziervogel et al., 2006); or communities might work with their local leaders, or village leaders with higher-level officials—as individuals might recognize that they are more powerful acting as a group—to invest in infrastructure that can make livelihoods less sensitive to climate-related hazards. External actors who facilitate these actions might be considered to be "bridging organizations," which serve the function of "reducing the (nonmonetary) transaction costs of collaboration…[and] providing social incentives to stakeholders to invest in building trust, identification of common interests, and resolving conflict" (Folke et al., 2005, p. 462).

There is an important assumption contained in the hypothesis that social capital derived from natural resource management—whether "created" or "awakened" from a latent state (Pelling & High, 2005)—can be drawn upon to improve collective responses to climate change. The assumption is that social capital, like other forms of capital (e.g., physical, human, natural, and financial), is sometimes fungible—i.e., a given form of social capital that is valuable in one context might also be useful in others, or even convertible into productive human capital (Coleman, 1988; Foley, 1999).

In this paper, I explore these assumptions in several ways. First, I asked the following questions to acquire nominal proxy data about *perceptions* of *bonding* social capital (Figure 2.2, 2(a)):

- Do you rely on community to cope with drought? More today or ten years prior?
- Has village cooperation changed over the previous ten years?
- Do you participate in village meetings?

By reviewing open-ended survey responses, I attempt to identify factors that explain any observed differences in the distribution of survey response types—including the influence of REMP. I also observed how village government officials interacted with each other during meetings, and examined REMP project updates and the minutes from past REMP meetings in order to learn about the extent to which Project Village leaders were interacting with district and regional officials, i.e., developing *networking* social capital (Figure 2.2, 2(b)).

Finally, I explored the question, Does social capital lead to actual collective adaptations to climate change (Figure 2.2, 3)? I analyzed open-ended survey responses and group interviews with farmers to explore whether measures of social capital can predict that village governments address common problems related to climate change.

Results

Natural Resource Management & Perceptions of Ecological Integrity (Figure 2.1, 1(a))

Villagers were asked to rank—on a scale of zero being bad and getting worse, to four being very good and getting better—the condition of forests, fish abundance, and arable land. None of the average rankings were below "Fair" (Table 2.2) and, compared to numbers collected in a similar district-wide survey in 2000 (Mbiha and Senkondo, 2001a, p. 35), the average rankings provided by respondents of both villages in this research are

relatively high. Those who rely on fishing or foraging for forest products as their principal means of coping with drought (see next section) did not rank those resources differently from the rest of the sample.

Even if these positive scores are partly a product of pressure to provide "normatively right" responses about the environment during interviews (Watkins, 2009), it appears that, at the very least, environmental *awareness* campaigns have been influential in the two villages. More specifically, villagers seem to be cognizant of the relationship between active environmental stewardship and long-term productivity—for example, many claimed that forest conservation improves local rainfall.

Village Drought Coping: An Overview

Ninety-three percent of Project Village respondents and all Non-Project Village respondents claimed that their households periodically suffer drought-related food shortages.

The most recent drought experienced by the villagers was in 2007—which, due to apparent micro-climatic variations across villages, was more pronounced in the Project Village than in the Non-Project Village (personal communication with villagers, May, 2008). Villagers reported a variety of *principal* drought coping strategies (Table 2.3). This included casual labor—which involves traveling, or sending your children, to work on the farms of those who are better off—which was cited by more than half Non-Project Village respondents (explained by the Non-Project's relative proximity to the large estate

farms on the coast). Importantly, foraging forest products in the Project Village and fishing in both villages are important drought coping strategies.[4]

Village Drought Coping: Natural Resource Use **(Figure 2.1, 1(b))**

The distribution of principal drought coping strategies say little about the ability of villagers to *access* natural resources, or if and why that ability has changed over time.

Villagers were asked whether it was easier to cope with a drought today or ten years prior (before REMP). The results clearly indicate that restricting access to natural resources in the Project Village did not have a widely damaging effect on people's abilities to cope with drought—only 15 percent of Project Village respondents claimed that it was easier to cope ten years prior because natural resources were more available then (compared to 9 percent in the Non-Project Village) (Figure 2.3).

When Project Villagers were asked if REMP, specifically, affected their abilities to cope with droughts, only one respondent claimed that the project led to limits on a "rightful" drought harvest of natural resources like fish and forest products. Sixteen percent claimed that REMP *helped* them to cope with drought by introducing non-farm activities that are, apparently, less sensitive drought, including horticulture production and chicken- and bee-keeping. Seventy-seven percent claimed that REMP had no effect on their ability to cope with drought (Table 2.4).

Over half of respondents of both villages claimed that they like rules that protect natural resources because conservation leads to greater production in the future (e.g.,

[4] Because I did not seek to record entire portfolios of household coping strategies (I only looked at *principal* coping strategies), I do not have data about *overall* reliance of villagers on natural resources during droughts.

"trees bring rain"). Again, there is a possibility that these are largely "normatively right" responses and products of environmental education—i.e., it is unclear if villagers actually *experience* production benefits derived from conservation. This question would benefit from longitudinal research on the supply of ecological goods and services.

Finally, while a majority of respondents in both villages claimed that they could comfortably approach the village leaderships to change a rule that they didn't like – either on their own or with the help of other villagers – most claimed that no rules that manage natural resources should be changed. Only 5 percent of Project Village respondents expressed a desire to be allowed more access to natural resources, compared to 15 percent of Non-Project Village respondents.

How can we explain why Project Village household drought coping capacities have been largely unaffected by the village environmental management plan? While the process of designing and initially implementing the village natural resource management plan in the Project Village appears to have been highly inclusive and designed to be adaptable over time, there is no indication that these qualities are responsible for these results. Open-response data and experience in the Project Village reveal that the original village environmental management plan has been rigorously enforced (whereas in the Non-Project Village, illegal logging trucks were frequently observed, and villagers appeared to be less aware of the existing rules that govern natural resources)—i.e., it isn't likely that a lack of enforcement can explain these results, either.

It is also possible that the opportunities from livelihood diversification have offset the costs of more restricted access to natural resources during drought. In fact, many in both villages claimed that it is easier to cope with drought today than in the past because of

increased diversification and market access (Figure 2.3)—this is likely due to improved access to casual labor in the Non-Project Village, REMP's complementary livelihood diversification activities in the Project Village, and marginally improved access to public transportation in the district. This finding is consistent with theory on vulnerability of the rural poor (see Ellis, 2000; Agrawal, 2008; Kelly & Adger, 2000; IPCC, 2007), and is put into sharper focus in another paper of mine (Parker, 2010).

Also, as mentioned above, there might be more pressure to provide "normatively right" responses to questions like these in the Project Village in order to give the impression that (1) external assistance is effective and (2) the village is worthy of future investments.

Looking closely at the use of non-timber forest products and fishing as coping resources might help shed more light on the results reported above.

Village Drought Coping: Non-Timber Forest Products **(Figure 2.1, 1(b))**

Of those who rely principally on foraging the forest to cope with drought (Figure 2.3), 18 percent claimed that drought coping was easier in the past due to more access to natural resources (8 percent of those in the Project Village) – including forest products, presumably – and only 11 percent claimed that the rules governing natural resources negatively affected their ability to cope (7 percent in the Project Village) (Figure 2.5). It is clear that in the Project Village, most of the foraging—for grasses, seeds, and edible plants—takes place *outside* of 'Conserved' forests, in 'Use' forests and woodlands where few, if any, restrictions exist. It is unclear if this behavior is sustainable, or if village

environmental institutions are, in fact, "learning" institutions that will adjust to new information about degradation in the 'Use' forests.

Village Drought Coping: Fishing **(Figure 2.1, 1(b))**

Sixty-six percent of those who fish in the Project Village and 47 percent of those in the Non-Project Village claimed that fishing helps to cope during drought "a fair amount or a lot;" and only one respondent of all those who fish claimed that fishing does not help him to cope at all.

Of those in the Project Village who rely principally on fishing to cope with drought (Figure 2.3), 21 percent claimed that drought coping was easier in the past due to more access to natural resources (20 percent of those in the Project Village) – including fish, presumably – and 17 percent claimed that the rules governing natural resources negatively affected their ability to cope (16 percent in the Project Village) (Figure 2.6).

Some fishermen expressed their desire for fishing laws to be loosened, making two arguments: (1) that fish yields are dependent on favorable flood conditions, and so the permitting system does not allow them to allocate their efforts efficiently; and (2) during drought, "the fish would die, anyway." In the Project Village, many more claim that the rules regulating fish catch are effective and lead to improve yields for those who secure permits. It is likely that any higher yields would translate into more cash (a lack of relevant infrastructure in Rufiji means that long-term fish storage is impossible, and so fishermen sell their surplus), which can be used for a variety of purposes, from savings to purchasing alcohol.

Still, because permits are scarce, *legal* fishing is limited as a coping strategy. Also, because fish habitat in the permanent and temporary riverside lakes and ponds becomes poor during drought, fishing exhibits similar exposure and sensitivity to drought as staple crops. *Illegal* fishing might serve as an important solution to these limitations, and to temper criticism of the rules that restrict fishing access in the villages. Many villagers in the Project Village (usually younger men) admitted to traveling for weeks on end to fish illegally in the national Selous Game Reserve—located relatively close to the Project Village—where fish habitat is much less sensitive to drought, but also where overzealous game wardens can pose a serious safety risk.

This problem of "leakage"—i.e., when conservation programs "export over-use of resources to other areas" (Chopra et al., 2005, p. 451)—is recognized in several sub-disciplines, from integrated conservation and development initiatives to avoided deforestation. In the context of vulnerability to drought, leakage might mitigate some of the negative effects that conservation has on coping capacities, but also undermine long-term, landscape-level natural resource management objectives. If natural resource management is to be propped up as a potential climate change adaptation policy, this potential tradeoff must be taken into account. Co-management approaches to natural resource management might be a remedy for such cross-scale conservation problems (Chopra et al., 2005), and it is clear that the Project Village would benefit from efforts to further integrate its Village Environmental Management Plan with higher-level plans that manage resources in the Game Reserve.

Bonding Social Capital & Drought Coping **(Figure 2.1, 2(a))**

Community Coping Support

Seventy-six percent Project Village respondents claimed to rely on "community" in coping with drought, compared to 56 percent of Non-Project Village respondents (p=.011; FET). Nineteen percent of Project Village respondents claimed that presently they rely on community in coping with drought *more* than they did ten years prior, compared to only 4 percent of Non-Project Village respondents, representing a significant difference (χ^2 (2, N = 194) = 10.726, p = .050) (Table 2.7). It is unclear from the data what "community" refers to—e.g., neighbors, friends, family—and it is possible REMP effectively expanded household networks beyond those including only immediate neighbors, and thus relationships of reciprocity.

One possible explanatory variable is staple harvest quantity, i.e., a larger staple harvest allows communities to support each other more during drought. While the mean 2007 (drought-year) corn harvests was significantly greater in the Project Village (t(165) = 2.561, p < .011), there is no significant association between 2007 corn harvest quantity and community coping support. This is understandable, given that the 2007 annual harvests of 302kg in the Project Village and 205kg in the Non-Project Village were already insufficient to feed an average family size of nearly five in both villages. Historical harvest data are not available to compare the impact of *changes* in harvest quantity on community coping support.

Village Cooperation & Participation in Village Governance

When asked whether they felt that *cooperation* in the village was more prevalent today or ten years prior, 59 percent of Project Village respondents claimed that cooperation was better today, compared to only 22 percent of Non-Project Village respondents (χ^2 (3, N = 184) = 38.827, p = .001) (Table 2.8). Opinions about the extent of community cooperation are probably informed by several factors such as patterns of participation in village governance and corruption.

Project Village respondents attend and participate in village meetings significantly more than Non-Project Village respondents (Table 2.9). There is enough evidence that REMP's focus on village governance created substantially more opportunities for villagers to interact with village leaders. Most Project Village respondents claimed that it was not difficult to participate in REMP meetings or other initiatives. Only a few claimed that there was a problem of "self-selection" (Bikhchandani et al., 1992), where only the educated were allowed to participate in REMP-related activities.

Limitations to Bonding Social Capital

Despite any indications of bonding social capital described above, it is clear that many people from both villages have poor relationships with their local governments. Many people from both villages distrust their governments—some for what they characterize as ambitious, underhanded motives of their leaders, and others for perceived incompetence. I heard claims that "the leaders oppress their people," that "leaders *used* to be smart and noble," and that leaders should be sent to "good-governance" training –

something that REMP *did* assist with, to a limited extent. These sentiments appear far more prevalent in the Non-Project Village (see next section), where citizens claimed that they "can change their representatives but not improve leadership," and where rumors of financial corruption within the Village Council were widespread.

Elder respondents, especially, resent the village governments for excluding them from most village matters. While more pronounced in the Project Village, there appears to be a cultural shift in both villages in which traditional hierarchies are being reorganized and younger leaders established. Some claimed that younger leaders are unable or unwilling to organize the villages to confront common challenges like periodic drought.

Another factor contributing to the general mistrust between villagers and the village governments is the growing influence of national party politics. Slowly, the two main national political parties are making inroads with rural villages, where they can assemble teams of supporters and secure votes. This problem is particularly bad in the Non-Project Village, where many claimed that partisan politics has created a combative atmosphere among villagers during gatherings, to the extent that many "argue politics instead of development." It is possible that the Village Council of the Project Village is relatively unaffected by politics due to the leadership skills it developed with REMP's assistance.

***Networking Social Capital & Collective Adaptations to Drought* (Figure 2.1, 2(a), 3)**

From observing village meetings in the Project Village, there is evidence that Village Council members are cordial with one another and fair in their discussions and voting. This is not the case in the Non-Project Village, where political arguments are rife, Village Council members are openly critical of both their Executive Officer (an official appointed

as a liaison to the District Headquarters) and the Village Chairman—both of whom appear to be negligent in their leadership responsibilities—and the meetings are dominated by only a few individuals. While an explanation for this difference could not be substantiated through interviews and group meetings, I have a strong impression that REMP—who sent leaders to governance training workshops and assisted in organizing a great number of planning meetings early in the life of the project—improved the ability of the Project Village government to hold productive meetings. Does this make the Project Village relatively able to collectively adapt to stressors like climate change?

In both villages, many people feel that it is the duty of the Village Council to lead collective efforts to mitigate drought risk by finding investors for communal projects—e.g., irrigation and farm mechanization projects, road construction, and market development (in the Project Village, many residents are concerned about what a potential political separation of their two sub-villages might mean for their future—believing that their capacity to solicit resources from the district and central governments and NGOs would be significantly diminished). A review of REMP project updates and the minutes from past REMP meetings shows that Project Village leaders were actively engaged in leadership workshops and meetings with district and regional government officials over the course of several years (this is a rare opportunity in the district, unavailable to leaders of the Non-Project Village). Despite the relationships forged in that period, village leaders claimed that their ability to initiate collective projects was constrained by a lack of coordination with and financial and technical support from higher levels of government. After visiting the district headquarters many times, it is clear to me that the lack of interaction is largely due to a scarcity of financial resources.

Rufiji is the poorest district in Tanzania, and village outreach is predictably limited. Given the high costs of potential collective drought adaptations, it appears that village governments would ultimately need the ability to solicit support from foreign aid. Without sustained interactions with the district government, at least, it is improbable that village leaders can develop this ability.

Conclusion

Several key themes emerge from the results of the study of how a decentralized natural resource management initiative in rural, Tanzania related to drought coping behaviors, indicators of social capital, and climate change adaptations.

While decentralized natural resource management might be effective in managing natural resources in the short-term, there is no guarantee that early conservation gains will withstand stresses brought about by increasing rates of environmental change. In poor areas characterized by very low savings rates and limited access to reliable off-farm employment, many farmers already turn to natural resources when staple harvests are poor or fail (Adams, 2004; Garnett et al., 2007), and will likely turn to them in greater intensity if and when harvests fail more frequently due to climate change. Unsustainable consumption of natural resources can occur on land peripheral to formally protected areas, which will likely lead to landscape-level losses to ecological integrity and supplies of ecosystem goods and services.

In both villages of this study, it was clear that natural resources such as fish and non-timber forest forage products are still important drought coping resources. There are indications that more formalized natural resource management rules have not, at least yet,

negatively affected coping capacities. This is partly explained by the availability of alternative sources of natural resources, and the emergence of non-farm economic activities that are, apparently, less sensitive drought (Ellis, 2000; and see Parker, 2010 for a companion paper that explores the impacts of REMP's livelihood diversification initiative on climate change adaptation outcomes).

While social capital has been widely demonstrated to be important to initiating and/or sustaining projects that improve ecological integrity and livelihood security, clearly it is not sufficient. While the Project Village government in this study demonstrated admirable organizational skills during meetings, they were also greatly limited by a lack of complementary capital assets—e.g., financial, physical, and human (Garnett et al., 2007)—that would enable them to engage in new, productive, community-based endeavors. This calls to mind the argument made by Eakin and Lemos (2006) that "building adaptive capacity under globalization is complex and multidimensional, demanding new skills and roles of decision-makers at all levels of government" (16). It might be that the Tanzanian government is the only stakeholder that could provide the capital required to allow village governments to lead collective actions to respond to climate-related stressors. Due to budget constraints, as well as the fact that the development sector remains enamored by the ideals of decentralization, it is unlikely that Rufiji will solicit such attention from the central government. Consequently, social relations between villagers and their leaders will continue to be strained due to unrealized expectations.

If social capital is to be transferred from the context of natural resource management to that of livelihood responses to climate change, not only do we need to understand how

it interacts with other capital assets, but also the incentive structures within which poor farmers operate, and what these farmers are capable of achieving in leadership positions. Even though village officials, by acting collectively, might have relatively greater influence with higher-level government actors than if they acted alone, substantial free-riding problems exist when (largely unpaid) village leaders are tasked with initiating or building upon village-level conservation and development projects (Gibson et al., 2005, p. 59).

It is unfortunate that REMP was forced to leave with an uncompleted record of engaging citizens in village environmental governance, training village leaders, and developing relationships between village leaders and their district and regional counterparts. The project planned to continue providing logistical support and education at the village level, and to develop social networks further. REMP's early departure highlights the potential negative impact of short donor time frames on conservation and development outcomes.

This research was limited by a lack of longitudinal ecological and livelihood data, and relied on proxy data derived from discussions with local people about *perceived* changes in social and ecological variables. As a result, the research was prone to receiving "normatively-right" responses from participants. It is abundantly clear that if we are to invest wisely in promoting ecological resilience and improving people's abilities to adjust to future climate change, donors need to start establishing coordinated monitoring protocols that can be used to evaluate progress towards clearly defined goals.

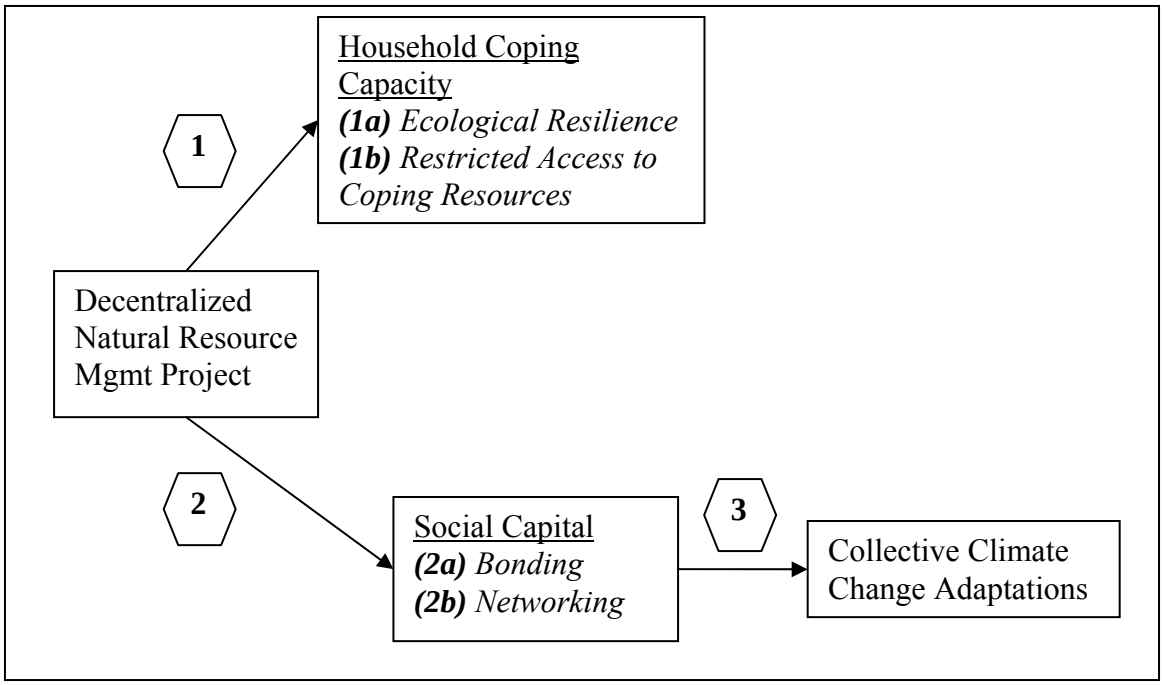

Figure 2.1: The case study research examines how an aid-funded decentralized natural resource management project influences vulnerability outcomes. Specifically, it examines **1)** household coping capacity (**(1a)** ecological resilience v. **(1b)** restricted use of coping resources); **2)** social capital (**(2a)** local "bonding" and **(2b)** vertical "networking"); and **3)** the relationship between measures of social capital and actual collective climate change adaptations.

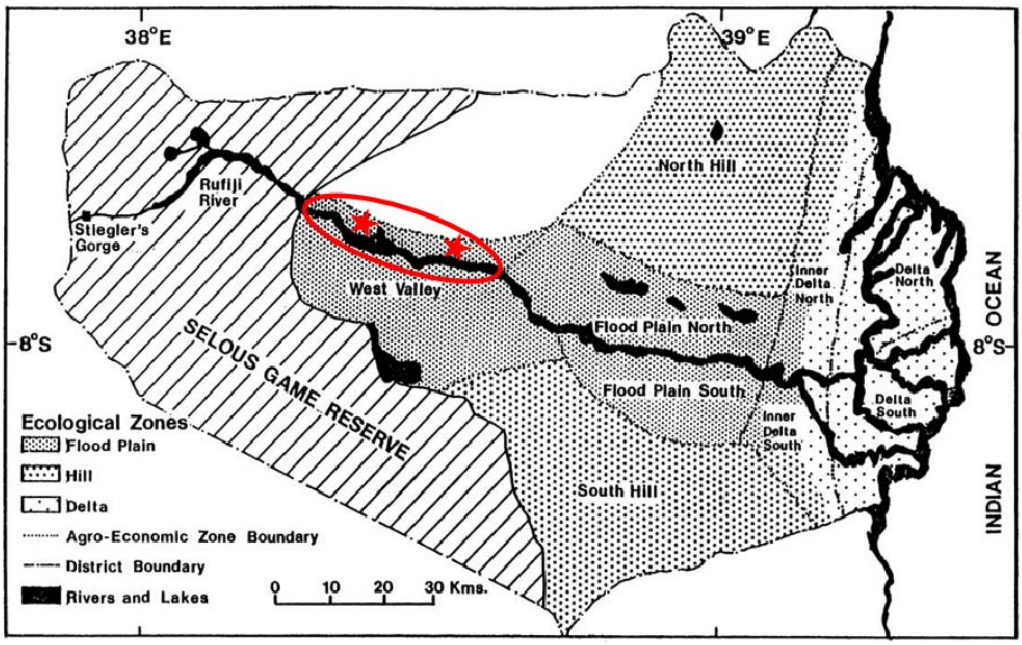

Figure 2.2: Rufiji District. The left star is the Project Village, the right star the Non-Project Village. *Source: Havnevik, 1993.*

Forest Conservation	**Fish Conservation**

• Village focuses on education and awareness; and enforcing village by-laws via patrolling of Village Natural Resource Scouts
 	
• *Conserved Forest*: Off-limits for all activities.
  • Not allowed to carry a suspicious tool near conserved forests
 	
• *Use forests*: Need to obtain permits from Village Council for commercial purposes (e.g., logging)
  • Fires and bark stripping not permitted
  • Without permits, villagers can fell trees for home use or for use in carpentry and other enterprises; make charcoal for their own home use; and collect fruits and medicines
 	
• *Fines*: 40, 000 Tanzanian Shillings (approximately $30 USD)
 	
• It is forbidden for anyone to hunt in village lands without permit from Village Council (*Fine*: 45,000 TSH + confiscation of equipment)
	• No temporary or permanent houses are allowed near the lakes
	
	• Fishing in lakes closed during alternating periods
	
	• Fishermen must pay entry fees to village and cannot share permits
	
	• Prohibited to use nets of mesh sizes of 2 in. or 1.25 in., but are allowed to use 2.5in. and above
	
	• Prohibited to 'cast net,' 'shark net,' poison or dynamite, or remove vegetation
	
	• *Fines*: 500 Tanzanian Shillings + confiscation of gear (1st offense); 1,000 TSH + gear (2nd & 3rd offenses); court hearing (+3rd offense)

Table 2.1: Project Village Environmental By-Laws. *Source: IUCN, 2004.*

		Project Village Mean (σ; N)	Non-Project Village Mean (σ; N)
How would you rank the state of the following? ***(0=bad & getting worse; 4=very good & getting better)***	**Wild Animals**	3.03 *(.900; N=96)*	2.23 *(.883; N=98)*
	Forests	3.22 *(.619; N=96)*	2.86 *(.609; N=98)*
	Fish	2.15 *(1.105; N=96)*	2.39 *(.890; N=99)*
	Arable Land	3.25 *(.616; N=96)*	3.11 *(.656; N=98)*

Table 2.2: Mean values of perceived states of different local ecosystem components. All average rankings were "Fair" and above.

Principal Coping Strategy	Project Village (n=95)	Non-Project Village (n=100)
Fish	31	22
Timber	1	0
Forage Forest	12	2
Chickens	9	6
Beekeeping	0	1
Weaving	1	2
Family	14	8
Friends	1	2
Government	0	1
Beg	1	3
Business	9	9
Horticulture	4	0
Casual Labor	7	43
Employment	0	1
Undefined "Struggling"	5	0

Table 2.3: Distribution of Principal Drought Coping Strategies (Count). Fishing appears to be an important coping strategy in both villages; while casual labor is very important in the Non-Project Village.

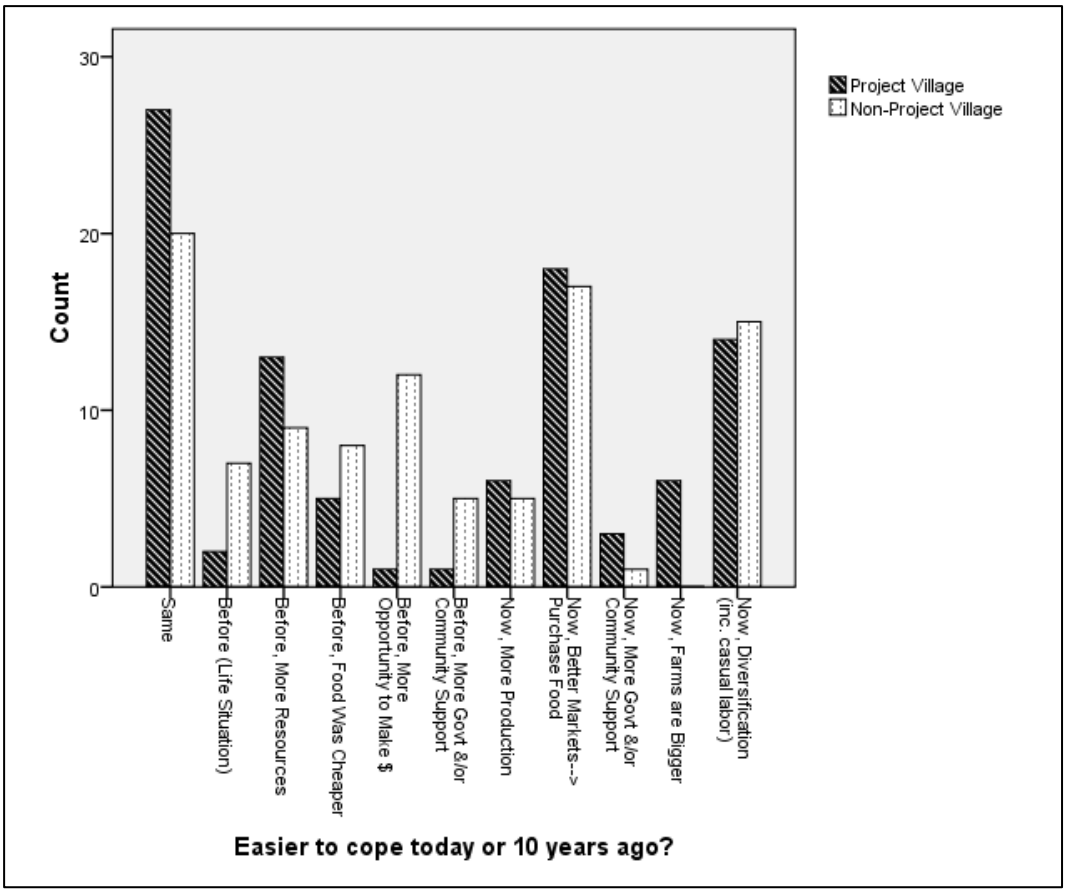

Figure 2.3: Easier to Cope With Drought When? The highest frequency response was that it is easier to cope today due to increased diversification and market access. Clearly, though, access to natural resources plays a role in coping.

		Percent of Valid Responses
Did REMP affect your ability to cope with drought?	No	77
	Don't Know/Irrelevant Response	5
	Helped With Non-Farm Production/Money For Drought	16
	Conservation → Rain	1
	Limited Rightful Harvest During Drought	1

Table 2.4: Distribution of Project Village responses to whether REMP affected household drought coping capacity (percent of valid responses). Most claimed that it had no effect, followed by several who claimed that the project *improved* coping by introducing alternative economic activities. Only one respondent claimed that the project limited his ability to access natural resources to cope.

Among those who rely principally on forest products to cope with drought		**Percent of Valid Responses**
Has your ability to cope with drought changed in the last ten years?	No	35
	Easier in the past due to better access to natural resources	18
	Easier now due to increased livelihood diversification and market access	41
	Easier now due to better government/community support during drought	6
Do natural resource rules affect your ability to cope with drought?	No	83
	Conservation leads to improved production (e.g., conservation→rain)	6
	Limits rightful harvest of natural resources	11

Table 2.5: Of those who rely principally on foraging forest products to cope with drought, how has coping capacity changed? Most claimed that coping with drought has improved due to increased livelihood diversification or hasn't changed at all; and fewer claimed that it was easier in the past due to better access to natural resources including, presumably, forest products.

Among those who rely principally on fishing to cope with drought		**Percent of Valid Responses**
Has your ability to cope with drought changed in the last ten years?	No	26
	Easier in the past due to better access to natural resources	21
	Easier in the past due to more access to money	9
	Easier now due to "more production"	17
	Easier now due to increased livelihood diversification and market access	26
Do natural resource rules affect your ability to cope with drought?	No	60
	Conservation leads to improved production (e.g., conservation→higher stock)	23
	Limits rightful harvest of natural resources	17

Table 2.6: Of those who rely principally on fishing to cope with drought, how has coping capacity changed? Most claimed that coping with drought has improved due to increased livelihood diversification or hasn't changed at all; followed by nearly 1/5 who claimed that it was easier in the past due to better access to natural resources including, presumably, fish.

(p = .011, FET)		**Percent of Valid Responses: Project Village**	**Percent of Valid Responses: Non-Project Village**
Do you rely on community to cope with drought?	No	26	44
	Yes	74	56
(χ^2 (2, N = 194) = 10.726, p = .050)		**Percent of Valid Responses: Project Village**	**Percent of Valid Responses: Non-Project Village**
Do you rely on community to cope with drought more today or ten years prior?	Same	48	57
	Today	19	4
	Ten Years Prior	33	39

Table 2.7: Community coping. Significantly more Project Villagers rely on community to cope with drought than Non-Project Villagers.

(χ^2 (3, N = 184) = 38.827, p = .001)		**Percent of Valid Responses: Project Village**	**Percent of Valid Responses: Non-Project Village**
Was there more cooperation in your village today or ten years ago?	Ten Years Prior	19	56
	Today	59	22

Table 2.8: Perceived village cooperation. There is significantly greater *perceived* village cooperation in the Project Village today than in the past; while the opposite is true for the Non-Project Village.

(χ^2 (2, N = 200) = 9.42, p = .009)		**Percent of Valid Responses: Project Village**	**Percent of Valid Responses: Non-Project Village**
Do you attend village meetings?	No	44	62
	Yes	56	38

Table 2.9: Participation in village meetings. Villagers in the Project Village participate in village governance significantly more than villagers in the Non-Project Village. This is likely due to the Project Village's experience with REMP.

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Chapter 3

Assisted livelihood diversification as an adaptation to drought: A case study in Rufiji, Tanzania

Introduction

Climate-related stressors—e.g., trends towards greater weather variability and more frequent and severe weather extremes—have the potential to alter social-ecological systems in ways that are harmful to human security. The negative effects of future climate change will likely fall disproportionately onto the world's poor – and especially on those who rely heavily upon locally-sourced natural resources and who lack capital to invest in responding to change (Kates, 2000; Kelly & Adger, 2000; Adger et al., 2003). For example, in sub-Saharan Africa, an estimated 212 million people (1/3 of the region's population) are chronically undernourished (FAO, 2008) and in many places food and freshwater insecurities will intensify as climate patterns change (FAO, 2008; IPCC, 2007). These vulnerable populations are typically exposed and sensitive to unpredictable climate-related hazards like droughts and floods, and lack many of the factors that contribute to individual and collective capacities to (1) cope with these hazards on a seasonal basis, and (2) adjust to longer-term changes in environmental trends. These factors might include human, social, political, and financial capital, information and

technology, material resources and infrastructure, wealth, and institutions (Eakin & Lemos, 2006).

Many scholars of poverty and climate change adaptation argues that livelihood diversification can reduce household vulnerability to such climate-related stressors as drought (Ellis, 2000; Ellis, 1998; Agrawal, 2008; Kelly & Adger, 2000; IPCC, 2007; Ziervogel et al., 2006) because when people engage in multiple livelihood activities that exhibit different patterns of risk—which, in the rural sector, often means that farmers become less dependent on staple crop production—they can become less sensitive to climate-related hazards (Davies, 1993; Ellis, 2000).

While there is empirical evidence that livelihood diversification is an important climate change adaptation strategy around the world (Agrawal, 2008), there is relative less attention on understanding the potential of development aid to *facilitate* diversification as a climate change adaptation strategy. This is a serious gap, as many international development institutions are currently debating how to invest potentially substantial financial resources to help reduce vulnerability to climate change around the world (e.g., World Bank 2006).[5]

Here, I present a case study on an aid-supported livelihood diversification project in Rufiji, Tanzania, primarily examining its influence on proxy measures of household livelihood diversification and, in turn, drought coping capacity. I compare two villages in

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[5] Oxfam (2007) provides an in-depth analysis of estimates of necessary "adaptation" financing, settling on a relatively conservative $50bn of additional aid per year. UNFCCC (2007) estimates the adaptation financing needs specific to the agriculture, forestry and fisheries sectors—essentially, the rural sector—to be an additional $7 billion by 2030. In the post-COP 15, nonbinding "Copenhagen Accord," developed nations agree to provide $30 billion to poorer nations by 2012 and $100 billion a year by 2020 to support efforts to mitigate greenhouse gas emissions and cope with the effects of climate change (UNFCCC, 2009).

rural Tanzania, one of which participated in an aid-supported conservation-diversification project in the last ten years (the other village served as a control site**)**. In addition to helping to improve village environmental governance capacity, the project organized groups of villagers around different livelihood activities that complement traditional maize and rice production—including horticulture, chicken- and bee-keeping, and sustainable fishing—in order to facilitate the adoption of improved production techniques. Between the two villages, I expected to see significantly more livelihood diversification in the village that participated in the diversification project, as well as associations between livelihood diversification measures and proxies for household drought coping capacity. The results showed that while many more people had *attempted* new off-farm livelihood activities in the project village, current aggregate diversification measures were not significantly different between the two villages—indicating that diversification attempts did not necessarily take root. To explain these results, I focus on the importance of market access in fulfilling the promise of livelihood diversification as a drought adaptation strategy in Rufiji.

In the next section, I introduce the analytical framework for the case study, where I connect the concepts of social vulnerability and livelihood diversification. Then, I describe the case study setting and data collection methods, and present results and discussions.

Vulnerability & Diversification

The prevailing understanding of vulnerability to climate change comes from a synthesis of thought from several fields (Adger, 2006) such as risk and natural hazards

(e.g., Wisner et al., 1994; Ribot et al., 1996), food security (e.g., Dilley & Boudreau, 2001), and theories on "entitlement" (e.g., Sen, 1981; Adger & Kelly, 1999; Kelly & Adger, 2000; Prowse & Scott, 2008; Devereux & Naerra, 1996). Here, I refer to vulnerability as the susceptibility of a system to be harmed by specific perturbations (Adger, 2006, p. 269; Gallopin, 2006), and *social* vulnerability to climate change as conditioned by the following three variables (Adger, 2006; Nelson et al., 2007; Turner et al., 2003; Agrawal, 2008):

1) *Exposure* to climate-related perturbations, such as drought;
2) *Sensitivity*, or the degree to which livelihood factors—such as staple harvest yields—are susceptible to change due to exposure to climate-related perturbations;
3) *Adaptive capacity*, or the capacity of individuals or groups to adjust to current and future climate-related perturbations in beneficial ways—including the ability to exploit lessons from the past or to make use of future climate and socio-economic scenarios in order to restructure production or governance systems in productive ways.

Empirical research can help us draw useful theoretical generalizations about how exposure, sensitivity, and response capacity influence vulnerability to climate change, and to design policies to reduce vulnerability. In this paper, I focus on livelihood diversification as a potential leverage point for aid projects to help reduce the sensitivity of rural livelihoods to seasonal drought.

Livelihood diversification is defined by Ellis (2000) as "the process by which rural households construct an increasingly diverse portfolio of activities and assets in order to survive and to improve their standard of living" (15). There is evidence that diversification can make people less reliant on activities that are exposed and/or sensitive to climate-related hazards (Agrawal, 2008; Ribot, 1996; Sabates-Wheeler, 2008). For example, by replacing or complementing the cultivation of drought-prone crops with

activities or production techniques that exhibit different patterns of drought risk, households can insure themselves against individual droughts (Davies, 1993; Ellis, 2000). In theory, if diversification improves aggregate production, households might then increase savings and investments—uncommon behaviors in subsistence farming communities—to further reduce their livelihood exposure and/or sensitivity to drought. Some might distinguish such livelihood changes as *transformations* (Osbahr et al., 2008; Nelson et al., 2007; Walker et al., 2004; Folke et al., 2005), or the creation of "fundamentally new system[s] when ecological, economic, or social structures make the existing system untenable" (Walker et al. 2004). The term is an extension of the concept of adaptation, distinctly implying that livelihood diversification can promote the *renewal* and *reorganization* of dynamic systems after perturbations, instead of merely encouraging their *recovery* (which, in poorer areas of the world, might mean returning to a pre-shock state of chronic poverty) (Folke, 2006).

Agrawal (2008) demonstrated that livelihood diversification is an important climate change adaptation strategy in local contexts around the world, especially when coupled with market access. Of course, diversified livelihood production does not necessarily predict enhanced market access, and research is needed to better understand the dynamic between the two variables in poor, relatively geographically isolated settings.

The development of a diverse portfolio of off-farm livelihood activities is a defining characteristic of rural livelihoods around the world (Ellis, 2000; Freeman et al., 2004). However, "autonomous" diversification efforts—actions undertaken without external support—are rarely sufficient today to lift the global poor out of chronic poverty. While the worst off might benefit the most from livelihood diversification (Kelly & Adger,

2000), they are also relatively *in*capable of diversifying their livelihood production, autonomously—either in a reactive or anticipatory manner—because they lack the assets to do so (Prowse & Scott, 2008). External assistance—e.g., foreign aid, public extension services, or private investment—might be able to provide "transitional assistance" to the poor by improving access to resources that enable livelihood diversification (UNFCCC, 2007). This might only be possible if structural conditions in society (infrastructure, higher-level institutions) enable the proliferation of diversified livelihood activities, a point empirically demonstrated elswhere (e.g., Osbahr et al., 2008; Eakin & Lemos, 2006).

A diversification project might provide access to financial and technical resources to subsidize short-term adoption of non-traditional off-farm activities among risk-averse farmers, and further develop farmers' confidence in these activities by guaranteeing benefits are demonstrated. Ideally, external assistance would lead to positive feedbacks between the experienced benefits of new livelihood activities and subsequent, autonomous household and community investments that reduce vulnerability

In this paper, I argue that if aid can facilitate diversification, we should observe relatively more livelihood diversification (i.e., higher average number of off-farm activities per household, and/or less reliance on staple crops) in a village that participated in an aid-supported diversification project (Figure 3.1, 1). Furthermore, we should observe positive relationships between livelihood diversification and proxy variables for household coping capacity (Figure 3.1, 2). I explore potential limitations to this relationship, including the degree of household market access, as well as limitations to

facilitating transformative changes to rural livelihood systems through external assistance (see Table 3.1 for relevant variables and associated survey questions).

Study Site: Rufiji District, Tanzania

The Rufiji is the largest river basin in Tanzania, draining about 20 percent of the country. The Rufiji watershed is well known for its significant biodiversity, and consequently draws the attention of international conservation organizations (Doody & Hamerlynck, 2003; Havnevik, 1993). Despite this biological wealth, Rufiji District is the poorest in the country, home to more than two hundred thousand people, 93 percent of whom are rural smallholder farmers and fisherman (Ochieng, 2002). In typical years, floods, influenced by rainfall and runoff patterns throughout the vast watershed, inundate the river basin, depositing nutrient-rich silt on the land, thus creating suitable conditions for floodplain agriculture. Flooding also enables productive fishing by refilling hundreds of permanent and temporary riverside lakes and ponds each year. Local rainfall can compensate farmers for poor floods, and vice versa (to maximize potential agricultural production, farmers need to time these events accurately—yet they have very limited forecasting abilities).

Historically, both river flow and rainfall in Rufiji have exhibited high variability at various timescales (Duvail & Hamerlynck, 2007; Havnevik, 1993). Havnevik (1993) claims that "…the history of Rufiji is one of adaptation to change by attempts to establish a buffer between the harsh natural environment and production;" and points to a wide range of local rice varieties that exhibit different growing times and sensitivity to floods, droughts, and salinity (p. 109). However, Havnevik also points to many instances in the

last century when the government provided famine relief to the district after hazardous floods and droughts,[6] indicating that existing coping strategies—including soliciting family support, engaging in employment, businesses, and consuming or selling natural resources (Mbiha & Senkondo, 2001a; Havnevik, 1993; Ochieng, 2002)—are insufficient.

How will farmers in Rufiji cope if precipitation and flood patterns change for the worse due to climate change? Village leaders in Rufiji claim that in recent decades, the timing and volume of floods have already become increasingly unpredictable (personal communication, May, 2008)—perhaps due to changing land-use patterns and resulting runoff dynamics, and to changes in climate. Also, villagers claim that in recent decades, rainfall has been more erratic and less reliable as compensation for poor floods (IUCN, 2004; personal communication, May, 2008). Funk et al. (2008) projected that main growing-season rainfall in East Africa – which is already down 15 percent since 1980 – will continue to decline due to the warming of the Indian Ocean, thereby threatening agricultural production in communities already vulnerable to drought. Clearly, it is worthwhile to understand vulnerability to drought in this setting, and to examine potential investments that can help farmers and villages adapt.

Study Site: The Rufiji Environmental Management Project

The Rufiji Environmental Management Project (REMP) was a conservation and livelihood development project that operated in four "pilot villages" in Rufiji district

[6] Despite employing different strategies to mitigate the risk of complete crop failure—e.g., sowing many times in different locations—households face food shortages relatively often in Rufiji (IUCN, 2004). Havnevik (1993) reports that a very damaging flood "spurred the Tanzanian government to initiate its *ujumaa* policy [encouraging concentrated settlements] in Rufiji District…to avert the loss of lives and reduce the heavy costs incurred by the frequent supply of famine relief to the area." (p. 111)

from 1998 to 2003. It was spearheaded by the International Union for Conservation of Nature (IUCN), and implemented with the help of a number of partners including the Tanzania National Environment Management Council, Coast Region offices, the Rufiji Basin Development Authority, and the Dutch Embassy.

REMP project documents (e.g., Ochieng, 2002) describe the goals of the project:

> To promote the sustainable use of natural resources and enhance the livelihoods of local communities by implementing sustainable pilot development activities based on wise use principles.

My research focuses on two villages in the western floodplain area of Rufiji district, an area that, due to its topography, is periodically exposed to damaging floods and receives about half the rainfall as the coast, making it relatively prone to drought (Havnevik, 1993: p. 86). One of the two villages was a REMP pilot village—referred to as 'Project Village' here. The second village shared similar ecological, institutional, and socio-economic features with the Project Village (e.g., weather, social cohesion, leadership potential, and livelihood patterns)—as determined by a project-led village appraisal in 1998 (Mbiha & Senkondo 2001b, p. 2-5)—but was not a pilot village for REMP. The main centers of both villages, including permanent houses, are located just north of the Rufiji River, while most farms and temporary shelters are miles away (Figure 3.2).

The "development" aspect of REMP involved, in part, the creation of "user groups" (of over twenty villagers each) through which the project aimed to facilitate the adoption of improved production and marketing techniques for several livelihood activities that villagers were already engaged in, though at smaller scales. For example, REMP assisted in the following ways:

- Horticulture group: Provided a gas-powered irrigation pump and taught techniques for relatively efficient large-plot ("block") horticulture (non-staple vegetables) production

- Chicken-keeping group: Taught how to house chickens in safe and healthy ways, and introduced a simple and cheap method for purchasing, storing, distributing, and administering a vaccine to chickens that protects them from a common respiratory disease

- Bee-keeping group: Taught sustainable bee-keeping and honey processing techniques, and helped to organize a honey cooperative that would sell honey to markets outside of the district

- Sustainable fishing group: Helped to implement rules to limit the number of villagers permitted to fish, thus ensuring larger harvests for permit holders; and taught methods to sustain fishing productivity for those *with* permits (e.g., protecting recruitment patterns by improving the harvests of adult fish with large mesh sizes of fishing gear)

Aware of the potentially large markets for vegetables, chickens, honey, and fish that exist outside of the district, REMP also organized workshops on accounting and other business practices, and began the process of developing relationships between villagers and external market actors.

This kind of project may be particularly challenging in Rufiji, where there is a long history of colonial subjugation of native people, a record of post-colonial top-down development failures, and a general feeling of mistrust among villagers towards external "assistance" (Havnevik, 1993). REMP understood this context, and focused on engaging as many people as possible in its workshops; securing buy-in of its initiatives by initially subsidizing the fixed costs of necessary inputs like pump irrigation and chicken vaccinations; and developing village leadership capacity and productive relationships among villagers and between villages and other stakeholders inside and outside of the district. REMP was originally designed to last a decade or more (Ochieng, 2002)—hoping that, over time, it could help individuals to become less risk averse to new

livelihood activities, and help the village become better able to confront common and often unpredictable challenges without external support. However, REMP was terminated prematurely after five years due to institutional changes in the Dutch aid system (personal communication with project officer, July, 2008), and operates now as a poorly-funded extension of the environmental offices at the district level, tasked with monitoring progress on environmental management throughout the district.

Data Collection

With the assistance of a trusted Tanzanian field assistant, between January and June 2008, I conducted 1.5 to 2-hour interviews with 100 households in each village—all randomly selected from village office registries—as well as 5 group meetings in each village and 18 semi-structured interviews with key informants in the villages and at the district headquarters, including some who were involved in the aid project. Qualitative data come from additional open-ended questions from the survey interviews, group meetings, and semi-structured interviews; reviews of past research in the region; and from REMP and Rufijij District development documents.

Respondents were remarkably candid throughout the research: most did not appear to be intimidated by the experience or to be withholding in their responses. We took time and care to pursue accurate responses, and discarded only a few responses that we judged to be unreliable due to confusion on the part of the respondents. Survey responses were carefully coded in the field in order to avoid the bias of any preconceived "theoretical positions or expectations" (King, Keohane, & Verba, p. 157).

Where appropriate, I calculated relevant descriptive statistics and percent distributions of response types to questions in the survey; and to explore potential differences between the two villages, I performed t-tests, one-way ANOVA's, and Pearson's correlations, and calculated Pearson Chi-Square statistics and adjusted residuals using SPSS v 13.0. I conducted a qualitative analysis on additional open-ended questions from the same household survey and from semi-structured interviews with village groups and public officials, and used the results to explain patterns from the statistical analysis and to develop theoretical insight into the relationships among my variables of interest. Much of the qualitative analysis was used to identify particularly important limitations to (1) diversification as a drought adaptation, and (2) using foreign aid to facilitate changes in livelihood patterns.

Because the behaviors examined in this research are influenced by many, often dynamic factors, I collected a large sample size and am conservative when making inferences and generalizations. It is impossible to account for all original differences between the villages or possible influences on the variables examined in this paper. Any conclusions from the data are made cautiously and used to motivate future research that makes use of clear baseline data and monitoring of changes in livelihood patterns and drought response capacity over time.

Results

Household Staple Crop Production During Drought

Maize and rice are the only important staple crops grown in the two villages—maize in the floodplain and rice in the northern valley. About a fifth of respondents from each village grow some cassava to supplement their diets.

Seventy-eight percent of Project Village respondents grow corn as a staple crop, compared to 89 percent of Non-Project Village respondents. Thirty-nine percent of Project Village respondents grow rice as a staple crop, compared to 89 percent of Non-Project Village respondents. Only 30 percent of Project Village respondents cultivate *both* maize and rice, compared to 72 percent of Non-Project Village respondents—a result that might be explained by differences in access to suitable land.

The most recent drought experienced by the villages was in 2007—which, due to apparent micro-climatic variations across villages, was more pronounced in the Project Village than in the Non-Project Village (personal communication with villagers, May, 2008). The modal 2007 harvest quantity of maize across both villages was 200kg, while that of rice was 0kg – a failed harvest, indicating that rice is more sensitive to drought than maize (Figure 3.3). Most farmers explained that insufficient drought-year harvests are not due to a lack of individual effort—but rather to pests, weeds, and a lack of inputs and infrastructure such as irrigation. Many respondents also claimed that illness (related both to limited health care access and relatively low nutritional levels) prevents them from guarding staple crops against pests or carrying out manual irrigation consistently.

Clearly, these drought-year harvest quantities are not sufficient to feed an average family of nearly 5. Alternative livelihood activities – those reported and not – as well as

remittances and charity, make up the apparent household food deficits.[7] Notably, no associations were found between staple harvest quantity or the number of staple crops cultivated and proxies for coping capacity (see below). This might indicate that even relatively productive farmers still produce too little to be able to save and/or invest in reducing their vulnerability to droughts.

Household Drought Coping Behavior

Parker (2010) described the distribution of principal coping strategies in the two study villages. An important difference between the villages is the extent to which people rely on casual labor—i.e., traveling, or sending your children, to work on the farms of those who are better off—which was cited by more than half Non-Project Village respondents (explained by the Non-Project's relative proximity to the large estate farms on the coast). Foraging forest products in the Project Village and fishing in both villages are also important drought coping strategies. Business activity, to more limited extent, is also important (Table 3.2).

Reponses to a question about whether it was easier to cope with a drought ten years prior (before REMP) or presently were significantly different between the two villages ($p = .021$). The highest frequency response in both villages was that coping hadn't changed, followed by the claim that it's easier to cope due to the emergence of small shops in the district from which people can purchase meal during hard times. The third most frequent

[7] Even in years of favorable weather, harvest quantities might not be sufficient to feed families. Adding to food stress in Rufiji is a tradition that calls for harvest parties. These parties are meant to bring good luck to future harvests (personal communication with villagers, May, 2008), and possibly to allow farmers to recover from nutritional deficiencies acquired during the long cultivation period (Bantje, 1980, p. 22 via Havnevik, 1993, p. 103). The parties consume a potentially profitable product and deplete stores of food that could be drawn upon during hard times. Many respondents spoke about the need for a village rule that discourages them.

response in both villages was that *increased diversification and market access has made it easier for households to cope with drought* (Figure 3.4). While in the Non-Project Village this result is most likely due to more demand for casual labor, increased diversification in the Project Village is most likely due to REMP-led efforts. The significance of the difference between the two villages, however, is explained by the frequencies of respondents who claimed that coping was easier in the *past*: 23 percent of Project Village respondents, compared to 41 percent of Non-Project Village respondents. Non-Project Village respondents appeared to be impacted today by higher food prices (which limits their purchasing power during droughts), a more competitive casual labor market, and less government food support after failed harvests.

Household Livelihood Diversification: Overview

The mean number of off-farm livelihood activities per household in 2007 (those not related to staple production, including remittances) was practically the same in both villages ($\bar{x}_P = 3.34$, $\sigma_P = 1.007$; $\bar{x}_{NP} = 3.37$, $\sigma_{NP} = .096$) (Table 3.3). Of course, without baseline data, it is impossible to know how these averages have changed over time. The mean number of off-farm livelihood activities per household attempted and initiated *in the last ten years* in the Project Village ($\bar{x}_P = .98$, $\sigma_P = .899$) and the Non-Project Village ($\bar{x}_{NP} = .50$, $\sigma_{NP} = .785$) were significantly different ($p<.001$) (Table 3.3). Presumably, this is due to REMP's activities in the Project Village. However, no associations were found between either of these *aggregate* measures of household off-farm livelihood activity and changes in drought coping capacity—and so, in order to know whether or not these numbers are meaningful from a vulnerability standpoint, we need to take a closer look at

specific off-farm activities.

Household Livelihood Diversification: Horticulture

Commercial-scale production of horticulture crops (production with the intention to sell surpluses) could be an effective drought response strategy in Rufiji for at least three reasons: (1) horticulture is already practiced to a limited extent by farmers, and presumably could be scaled up relatively easily; (2) horticulture plots are substantially smaller than staple crop plots and can be irrigated relatively easily (especially if situated adjacent to or close to homes); and (3) there is high demand for horticulture crops outside of the district (particularly in the cities), and cash acquired from selling produce could be used to purchase food to compensate for drought-related food deficits (when consumed, horticulture crops add vital nutrients to Rufiji's staple-heavy diets. However, it is likely that even scaled-up horticultural projects could not produce enough *food* to compensate for a poor staple harvest. Cash could also be saved and/or reinvested to further reduce vulnerability to future droughts.

While horticultural production isn't the *principal* drought coping strategy for most farmers in the study villages (Figure 3.2)—only four percent of Project Village respondents and no Non-Project Village respondents claimed that it was—it is still helpful to many during droughts. There is a statistical difference between the two villages with respect to how much horticulture helps to cope with droughts ($p = .020$), with substantially more Project Village respondents claiming that horticulture helps them "a lot," and substantially more Non-Project Village respondents claiming that it helps them "only a little."

The mean number of horticulture crops cultivated per household in 2007 in each village were not significantly different ($\bar{x}_P = 5.66$, $\bar{x}_{NP} = 6.22$), and there is no meaningful difference in the distribution of varieties cultivated in each village. This is an unexpected result given the time, effort, and resources that REMP put into creating the pump-irrigation horticulture group in the Project Village. Some respondents familiar with this group claimed that a lack of cooperation among members led to a failure to maintain the communal irrigation pump (which lies idle in a village government building), and the subsequent dissolution of the group. These results are limited by the fact that it was not possible to acquire quantitative data on crop yields of individual varieties, a variable that could predict variation in drought coping outcomes.

There is a relatively weak positive relationship between 2007 household corn harvest (kg) and the household number of horticulture crops cultivated ($r = .319$, $n = 167$, $p = .000$), indicating that some productive farmers also diversify their farm production. The positive relationship is slightly higher in the Project Village than in the Non-Project Village. There is no observed relationship between 2007 household rice harvest (kg) and the household number of horticulture crops cultivated.

No associations were found between the number of horticulture crops cultivated per household and changes in household drought coping capacity. Because it was not possible to acquire quantitative data on horticultural crop yields, I was unable to examine whether yield quantity is associated with changes in household drought coping capacity.

These results all suggest that for horticultural production to be a viable backstop for poor staple harvests in Rufiji, it needs to be scaled up significantly and integrated with a strategy to improve farmers' access to reliable crop markets.

Household Livelihood Diversification: Chicken-keeping

Chicken-keeping has the potential to be an effective drought response strategy in Rufiji for at least two reasons: (1) chickens have no problem foraging for themselves during drought, and even if this was not the case, it is logistically simple (and, many argue, financially practical) to purchase chicken feed from outside of the district; and (2) there is very high demand for live chickens outside of the district (particularly in the cities). Chickens, as a source of food, almost certainly do not help villagers to cope with a failed staple harvest, as households reported eating an average of fewer than 7 chickens in 2007.

Almost 10 percent of Project Village respondents claimed that chicken-keeping was the most important principal coping strategy during drought, compared to 6 percent of Non-Project Village respondents. Across both villages, very few of those who kept chickens claimed that doing so did not help them at all to cope during drought; and 60 percent of Project Village and 45 percent Non-Project Village respondents claimed that it helps a "fair amount" or "a lot" (these results are not significantly different).

The mean number of chickens sold in the Project Village ($\bar{x}_P = 33.38$, $\sigma_P = 44.06$) and the Non-Project Village ($\bar{x}_{NP} = 24.89$, $\sigma_{NP} = 21.54$) are not significantly different. When three outliers above 150 chickens are dropped from the sample, the means are effectively the same ($\bar{x}_P = 24.79$, $\sigma_P = 21.66$; $\bar{x}_{NP} = 24.89$, $\sigma_{NP} = 21.54$). The outlier respondents gave two clear reasons for their relative success: They specialize in chicken-keeping as the most significant complement to their staple crop production, and they isolate their flocks

during highly damaging outbreaks of a common respiratory disease among village chickens.

It is unclear why chicken-keeping is not a more widely commercial activity in the villages, and especially in the Project Village where REMP created the chicken-keeping group project in order to teach cheap and reliable methods for vaccinating chickens against the respiratory disease. Respondents familiar with this group claimed that the group project dismantled after only a year due to strained relationships among members. Furthermore, while it was reported that it is still profitable to import the vaccination to the village and to store it underground, individually, very few actually do so.

No meaningful associations were found between the number of chickens sold in 2007 or engagement in chicken-keeping and changes in drought coping capacity. This is probably due to the fact that the average scale of chicken-keeping is still relatively small in the villages.

Household Livelihood Diversification: Bee-keeping

It is unclear if bee-keeping could be an effective drought response strategy in Rufiji. Honey production is sensitive to drought in similar ways to staple crops, and farmers typically receive low returns for the effort they put into keeping bees (I have observed this in other parts of East Africa, as well). Even if a beekeeper harvests and sells several liters of honey a year (in this study, those who kept bees in 2007 averaged 11 liters of annual production), profits are limited by low market prices and would do little to help compensate for a failed harvest. In this study, no associations were found between engagement in bee-keeping and changes in drought coping capacity.

In the case study villages, bee-keeping is not a relatively important off-farm livelihood activity: only 6 percent of Project Village respondents claimed to engage in bee-keeping, compared to 1 percent of Non-Project Village respondents. REMP's bee-keeper's cooperative in the Project Village quickly dissolved after it experienced problems with an untrustworthy, exploitative middleman who brought the product to markets outside of the district. Some still harvest honey, but mostly for medicinal purposes and as a small dietary supplement.

Household Livelihood Diversification: Sustainable Fishing

Fishing, like horticultural production and chicken-keeping, represents a potentially effective drought response strategy in Rufiji for at least two reasons: (1) fishing can occur in Rufiji's permanent lakes during droughts (though to a relatively limited extent); and (2) there is high demand for dried and smoked fish outside of the district (particularly in the cities). While fish are an important source of protein to villagers, those who rely on fishing to cope with drought do so by *selling* fish in order to secure cash for purchasing maize meal or rice.

Fishing was reported to be the most important principal coping strategy during drought in the Project Village (32.6 percent of respondents), and the second most important in the Non-Project Village (22 percent of respondents). Sixty-six percent of those who fish in the Project Village and 47 percent of those in the Non-Project Village claimed that fishing helps to cope with drought "a fair amount" or "a lot;" and only one respondent of all those who fish claimed that fishing does not help him to cope at all.

There is no statistical difference between the two villages with respect to how much fishing helps to cope with droughts.

Quantitative data related to fish sales are unreliable, but it is clear that because lake fishing permits are scarce in the Project Village, and because fish stocks drop during drought, *legal* fishing is limited as a drought response strategy (still, many in the Project Village claimed that the rules regulating fish catch are effective and lead to improve yields for those who are able secure permits). On the other hand, many young men, especially from the Project Village, often travel to the lakes of Selous Game Reserve to fish illegally. By all accounts, this artisanal fishing is sustainable and profitable, but still dangerous to the fishermen due to the presence of armed, overzealous game wardens. Also, it was observed that many of these fishermen do not spend their earnings on food, but rather on alcohol (also see Parker, 2010).

No associations were found between engagement in fishing and changes in drought coping capacity. This is most likely explained by the fact that most people fish only to supplement their diets, and that many those who sell fish either spend revenues on alcohol or other non-food goods or do not fish at a large-enough scale to compensate for a failed harvest.

Assisted Livelihood Diversification: The Importance of Market Access

The analyses of horticultural production, chicken- and bee-keeping, and sustainable fishing indicate that these activities, to be effective drought response strategies in Rufiji, need to be able to compensate for substantial staple harvest losses during drought. Reliable market access is vital to fulfilling this potential.

In the two study villages, many respondents claimed that they have "easy access" to crop, chicken, and fish markets. However, I observed some intra-village trade (e.g., women carrying vegetables from house to house, and men selling dried fish in the market square), and it is probable that respondents included such small-scale, informal trade in how they perceived 'ease of access' to markets. This reasoning might help to explain why there were no associations between ease of access to crop, chicken, and fish markets and changes in drought coping capacity: The scale of market activity is too small to impact drought responses in meaningful ways. Further, the data suggest that merely engaging in off-farm livelihood activities does not necessarily create or improve market opportunities.

It appears that most households in the district fail to engage in "spatially diverse transactions"—loosely defined as transactions that occur across space or, more specific to Rufiji, transactions that occur between villagers and actors outside of their home villages—due to poor negotiating skills and costly and unreliable transport (the principal mode of transportation in the district is a single passenger bus that makes, at most, one round-trip each day on a single dirt road prone to washing out due to heavy rains). These kinds of transactions are what Sabates-Wheeler et al. (2008) claim unleash "the beneficial effects of diversification" (p. 56) because, presumably, they generate an influxes of *external* capital (e.g., financial and human) that people can draw upon to respond to climate-related stressors. It is unclear if a project like REMP could facilitate improvements in transportation infrastructure in Rufiji, a district that falls near the bottom of the central government's priority list. However, some villagers argued that if REMP had continued its work in the pilot villages, it could have at least helped to

improve production and accounting skills, as well as their collective marketing power—factors consistently shown to limit smallholder market activity in the developing world (Kruijssen et al., 2009; Bernard & Spielman, 2009; World Bank, 2008). Many pointed to the absence of community cooperatives, specifically, and believed that REMP could have expanded the work it had started with the bee-keeping cooperative, to organize local producers around other goods.

Responses to questions about why no substantial markets for crops exist were not significantly different between the two villages (Figure 3.5). Some pointed to a lack of demand, others to a lack of supply—a 'chicken or the egg' dilemma with no clear resolution (still, eighty-seven percent of respondents claimed that if local markets *were* established, they would both produce and sell more goods). Many respondents were simply unaware of a solution to the problem. Many others were concerned about the lack of initiative (or ability) on the part of their village government to develop markets—either by building them locally and facilitating external demand, or enabling non-local transactions.

Any strategy to improve market networks would clearly require substantial financial, human, and/or physical capital, and points to the need for local actors to partner with stakeholders at higher levels, be they government actors, international donors and development NGOs, and the private sector. Agrawal (2008), in his review of local adaptation strategies around the world, found that "partnerships among local public and civil society institutions are associated…with adaptation practices related to diversification" while those "between private and civil society institutions are relatively uncommon and need greater encouragement" (p. 3). Parker (2010) suggested that there

might not be insufficient *networking* social capital in Rufiji (synergistic relationships among actors at different levels of organization [Adger, 2003]) to allow substantial partnerships to develop. Nonetheless, the case study demonstrates the potential benefits of "bridging" between traditional infrastructure-focused development approaches and novel climate change adaptation policies like diversification (Ziervogel et al., 2006, p. 302); and supports Agrawal's assertion that the private sector can potentially play a more important role in helping reduce vulnerability to stressors like drought.

Assisted Livelihood Diversification: The Importance of Demonstrating Results

Even if structural elements such as markets *were* improved, we need to return to an obvious question that underlies the argument that livelihood diversification is a potentially important climate change adaptation strategy: How can external assistance transform traditional livelihood patterns in poor, risk-averse communities?

This study suggests that even though the initial costs of a the off-farm livelihood projects in the Project Village were subsidized by REMP, and the longer-term costs spread across many members of the user groups, villagers quickly abandoned the projects after REMP departed. It is likely that the benefits of the new off-farm livelihood projects – initially articulated by REMP through a series of user-group workshops – were *experienced* by villagers to a very limited extent. Because risk-averse farmers will often weigh potential losses of new investments more than potential gains (Kahneman & Tversky, 1979), it is important that those assisting with diversification effectively frame potential outcomes – i.e., the stakes involved (Kuznar, 2001) – by *actually demonstrating* them. Empirical studies have shown that demonstrating the results of agricultural

innovations is vital to encouraging farmers to move from being merely aware of their potential benefits to full adoption (e.g., Okuneye, 1985)—i.e., transforming risk-averse behavior to risk-taking behavior (Kuznar, 2001).

REMP, because of its premature withdrawal from the pilot villages, might have done too little to demonstrate the associated benefits of the off-farm livelihood activities to villagers. Many villagers claimed that REMP hadn't "matured" in the five years that it was active in the villages. Some mentioned that they had not seen successes among others engaged in the projects, and so were not persuaded to invest in similar activities, themselves. Furthermore, people rarely claimed that REMP-related activities diffused throughout and across villages. Indeed, only 40 percent of Project Village respondents claimed that people have "continued on" with REMP-related livelihood initiatives (presumably in *independent* ways); and nearly 70 percent of respondents expressed that they wished REMP had stayed to continue working with the village.

The fact that the benefits of livelihood diversification weren't adequately demonstrated might also explain why we don't observe more of a particular kind of innovative thinking among Project Village respondents: response types (productive v. unproductive) to questions about hypothetical *individual, community, and higher-level government* investments to prepare for future droughts were not significantly different between the two villages; or associated with any of the diversification proxies discussed earlier (staple harvest production, aggregate measures of diversification, number of horticulture crops cultivated per household, number of chickens sold in 2007, or engagement in chicken-keeping, bee-keeping, or fishing). In fact, despite REMP's work with the Project Village, the Non-Project Village held a slight edge in 'productive' ideas

regarding hypothetical community and government investments (Table 3.4).

Conclusion

Some argue that "if 'diversification' is widened to include non-farm activities, then diversification becomes unambiguously positive for improving livelihoods" (Sabates-Wheeler et al., 2008, p. 57). In the context of vulnerability climate change, we need to look beyond marginal improvements to livelihoods to explicitly consider what combined factors change people's exposure, sensitivity, and/or adaptive capacity to climate-related stressors like drought. I have shown that staple crop agriculture in Rufiji, Tanzania is very sensitive to drought, resulting in high rates of poor or failed harvests during years when floods and rainfall are inadequate. In this context, livelihood diversification, as a meaningful drought adaptation strategy, should account for such losses. This, it appears, can only happen when technical training is coupled with expanded market access, so that people can engage in an entirely new livelihood strategy (commercial market exchange) and earn enough money to purchase sufficient food after failed harvests. Expanding market access, however, might require capital investments from actors well above the village level, highlighting the potential of coordinating national-level adaptation policies (where much of the existing financing is channeled, largely earmarked for large-scale infrastructural improvements) with local livelihood development projects.

Local projects dedicated to climate change adaptation will focus largely on strategies like livelihood diversification, i.e., on facilitating adjustments to established production habits. This paper has cautioned against the assumption that poor people will willingly, and in short time, change such habits. The challenge is a serious one for development

policymakers, requiring equally serious time and resource commitments from donors. Even if the donor community recognizes this reality, many question how the aid system will restructure its financial incentive structure in order to begin prioritizing long-term investments (Gibson et al., 2005).

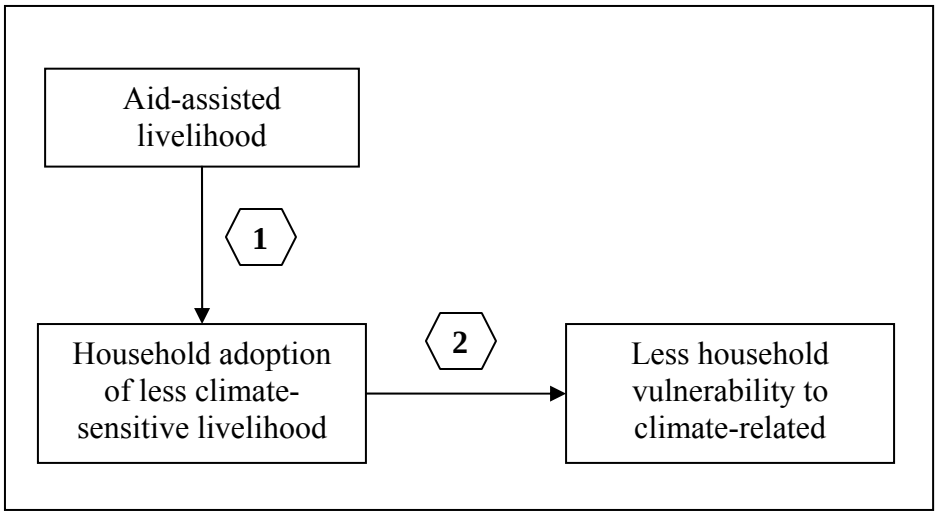

Figure 3.1: The case study research examines an aid-funded decentralized livelihood diversification project. Specifically, I examine the project's influence on **1)** proxy measures of livelihood diversification, and **2)** whether engagement in off-farm livelihood activities reduces social vulnerability to climate-related stressors (specifically, drought).

Variable (Household)	Description
Principal coping strategy	What is the most important household strategy to cope with drought?
Change in coping capacity	Easier to cope currently or ten years ago? If droughts became more frequent, what would you do?
2007 staple crop production (drought year)	Maize & rice (kg)
2007 off-farm activity	2007 aggregate number and distribution of off-farm economic activities
Off-farm activity (last 10 years)	Number and distribution of off-farm economic activities attempted and initiated in last ten years
2007 horticulture production	Number of horticulture crops cultivated
Contribution of off-farm activities to coping capacity	How much does horticulture/chicken-keeping/fishing help feed your family during drought?
Access to markets	How would you characterize your ease of access to markets to sell your goods?
Hypothetical future drought adaptations	If *you/community/government* had the money, what should be done to prepare the village for future droughts?

Table 3.1: Variables and associated survey questions of this study.

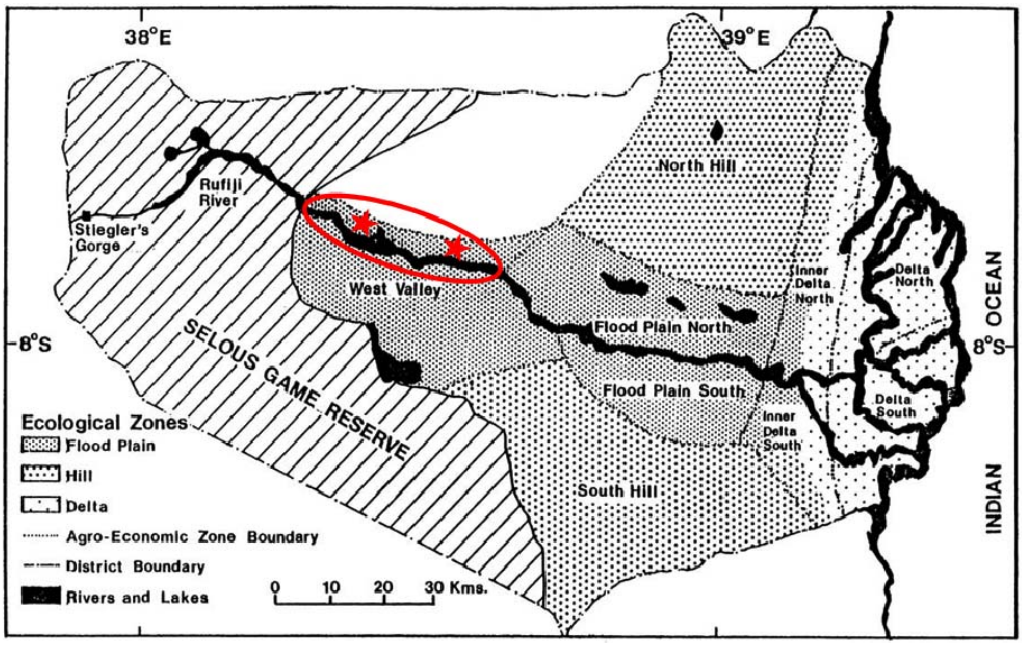

Figure 3.2: Rufiji District. The left star is the Project Village, the right star the Non-Project Village. *Source: Havnevik, 1993.*

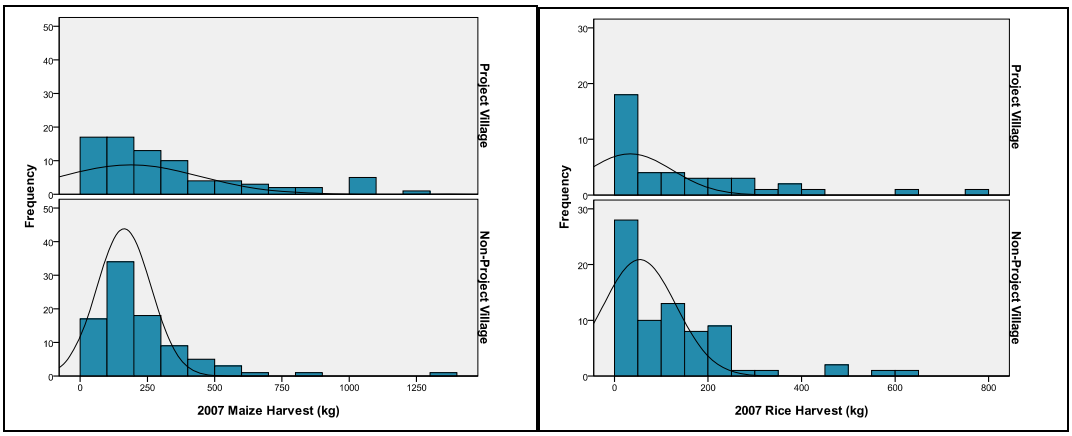

Figure 3.3: 2007 (Drought-year) Maize and Rice Harvests (kg). Modal quantities of both staple crops are insufficient to feed an average family of nearly 5, and so farmers rely on other activities to fill their food deficits.

Principal Coping Strategy	Project Village (n=95)	Non-Project Village (n=100)
Chickens	9	6
Beekeeping	0	1
Weaving	1	2
Business	9	9
Horticulture	4	0
Casual Labor	7	43
Employment	0	1
Fish	31	22
Timber	1	0
Forage Forest	12	2
Family	14	8
Friends	1	2
Government	0	1
Beg	1	3
Undefined "Struggling"	5	0

Table 3.2: Distribution of principal coping strategies during drought (count). Aside from casual labor, fishing, chicken-keeping, and business activity appear to be important coping strategies.

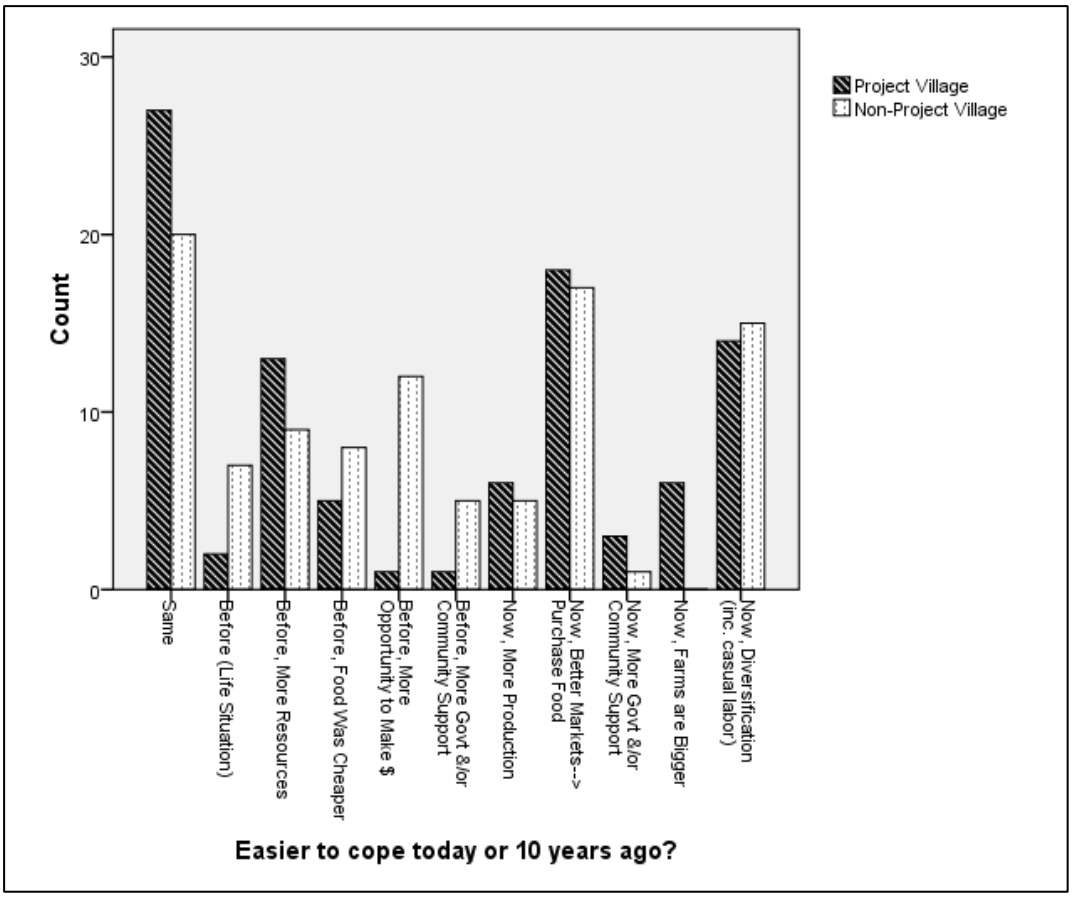

Figure 3.4: Was it easier to cope with drought ten years prior, or currently? The highest frequency response was that it is easier to cope today due to increased diversification and market access.

Activity	Project Village Today (n=100)	Non-Project Village Today (n=100)	Project Village Attempted & Initiated in Previous Ten Years (n=100)	Non-Project Village Attempted & Initiated in Previous Ten Years (n=100)
Commercial Horticulture	0 *	0 *	12	0
Animal Husbandry	81	63	51	36
(Daily) Business	22	13	12	7
Natural Resource Products/Crafts; Employment	49	81	19	6
Fishing	51	37	4	2
Total	**203**	**194**	**98**	**51**

Table 3.3: Household Production and New Activities Attempted in the Previous Ten Years (n). While the mean number of activities per household was the same in both villages in 2007, Project Villagers *attempted* more new activities in the previous 10 years.

** I did not include garden horticulture in this sample, and have no quantitative data that could inform us about the scale of household horticulture activity.*

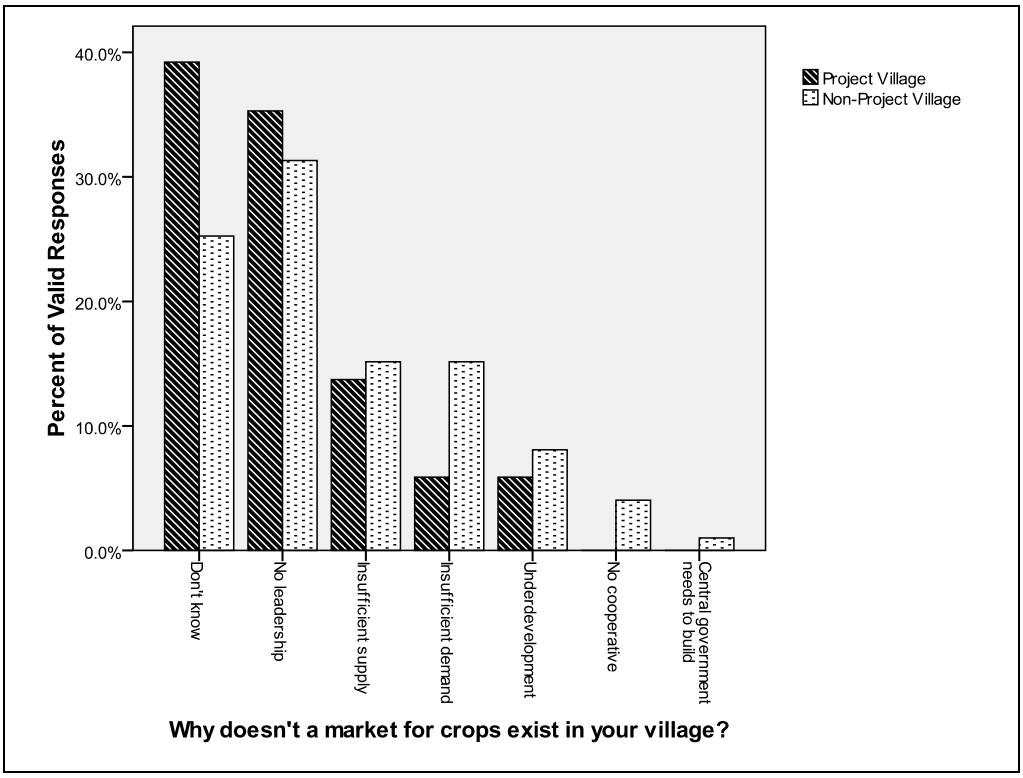

Figure 3.5: Many villagers blame village leaders for failing to build and develop markets.

	Hypothetical *Individual* Investment	Hypothetical *Community* Investment	Hypothetical (higher-level) *Government* Investment
Productive Response: *Project Village*	37	32	44
Productive Response: *Non-Project Village*	35	43	52

Table 3.4: Percent Distribution of responses to questions about hypothetical *individual, community, and higher-level government* investments to prepare for future droughts. Surprisingly, despite their experience with diversified livelihood development, Project Village respondents did not provide more productive responses than Non-Project Villagers.

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Chapter 4

An asset-based approach to understanding drought vulnerability in Rufiji, Tanzania

I. Introduction

Climate-related stressors—e.g., trends towards greater weather variability and more frequent and severe weather extremes—have the potential to alter social-ecological systems in ways that are harmful to human security. The negative effects of climate change will likely fall disproportionately onto the world's poor—and especially onto those who rely heavily upon climate-sensitive natural resources and who lack access to private and public assets that can help them to respond in meaningful ways (Kates, 2000; Kelly & Adger, 2000; Adger et al., 2003). Many aid organizations are already committed to helping to reduce climate change vulnerability throughout the developing world[8] by helping to reduce people's exposure and sensitivity to climate-related stressors and to

[8] Oxfam (2007) provides an in-depth analysis of estimates of necessary "adaptation" financing, settling on a relatively conservative $50bn of additional aid per year worldwide. UNFCCC (2007) estimates the adaptation financing needs specific to the agriculture, forestry and fisheries sectors—essentially, the rural sector—to be an additional $7 billion by 2030. In the post-COP 15, nonbinding "Copenhagen Accord," developed nations agree to provide $30 billion to poorer nations by 2012 and $100 billion a year by 2020 to support efforts to mitigate greenhouse gas emissions and cope with the effects of climate change (UNFCCC, 2009).

improve their capacity to adapt (Adger, 2006; Nelson et al., 2007; Turner et al., 2003; Agrawal, 2008).

We lack empirical studies that can help guide policy by showing what factors, or combinations of factors, influence vulnerability across different contexts. Here, I explore potential household-level determinants of drought vulnerability in two villages of subsistence farmers in Rufiji, Tanzania. I use data from household surveys and interviews to examine how different kinds of household assets—in particular, types of natural, financial, human and social capital—correlate with (1) household sensitivity to drought, measured by drought-year staple harvest quantity and livelihood diversification; and (2) household adaptive capacity to drought, measured by perceived changes in coping capacity over time, and response types to questions about hypothetical investments to respond to future droughts.

I hope to contribute to the growing body of literature on the *social* dimensions of climate change vulnerability—distinct from the larger body of work on how physical hazards, themselves, influence vulnerability (Prowse & Scott, 2008; Eriksen et al., 2005). Research that focuses on household assets—including those other than financial capital—is especially relevant to the challenge of mainstreaming climate change adaptation into existing sustainable development approaches (Klein et al., 2007; Prowse & Scott, 2008), many of which already pay considerable attention to the importance of assets (Moser, 2008; Carter & Barrett, 2006). Additionally, while asset-based studies of *urban* vulnerability are relatively prevalent in the hazards and disasters literature (e.g., Moser, 1998), this study is a relatively scarce *rural* case (Prowse & Scott, 2008).

I first explain why an assets-based approach is useful to climate change adaptation policy, before briefly introducing specific hypotheses, the study setting, and methods of analysis. I then present the empirical results and discuss their implications for adaptation policy.

II. The Assets-Based Approach to Climate Change Adaptation

In previous papers (Parker, 2010*a*; Parker, 2010*b*), I examined the potential impact an aid-funded biodiversity conservation and livelihood diversification project on drought vulnerability among the same farmers studied here. I focused principally on village-level differences in access to natural resources and measures of social capital and livelihood diversification—all hypothesized to be important to reducing vulnerability to climate change in the developing world—and examined whether any apparent differences could be traced to influences of the aid project. My research revealed no clear-cut positive impacts of the aid intervention on village-level drought vulnerability—a result that perhaps reflects the limitations of local, short-lived aid projects that aim to tackle the long-term challenges of transforming livelihoods and improving societal infrastructure that enables many forms of climate change adaptation. Here, I step back from examining the influence of the aid project to focus more explicit attention to the potential impact of various assets on drought vulnerability in the villages.

For some time, scholars have acknowledged that *income*-based approaches to measuring poverty fail to capture the dynamic nature of poverty or what determines whether it is transitory or entrenched (Moser, 1998; Sen, 1999; Moser, 2007; Carter & Barrett, 2006). Driven by the assumption that social vulnerability is largely conditioned

by “the assets and entitlements that individuals, households, or communities can mobilize and manage in the face of hardship” (Moser, 1998, p. 3; also see Adger & Kelly, 1999; Devereux & Naerra, 1996), long-term empirical work has begun to shed light on the relative influence of different categories of assets on poverty outcomes (Moser, 1998; Bebbington, 1999; Moser, 2007; Solimano, 2007). For example, Bebbington (1999) studied how people in the high Andes manage complex portfolios of capital assets, especially social capital, to meet their "material and their experiential needs" (p. 2021). Moser (1998) compared four urban settings—in Zambia, Ecuador, Philippines, and Hungary—on the relative importance of labor, housing and infrastructure, and household relations on poverty outcomes. Solimano (2007) focused on the importance of access to natural capital (i.e., natural resource consumption) in reducing vulnerability to external economic stressors in Latin America.

Recently, some have argued that research on household entitlements—defined as the assets that a household controls—affecting exposure, sensitivity, and the capacity to adapt to climate change can complement existing work on how physical hazards shape vulnerability, and help to guide climate change adaptation policies (e.g., Prowse & Scott, 2008; Eriksen et al., 2005). In other words, policies to reduce vulnerability through facilitating asset *accumulation*—i.e., building people’s capacity to accumulate autonomously particular assets that help them respond to hazards effectively—can benefit from empirical studies that make sense of local variability in vulnerability to climate-related stressors across (Eriksen et al., 2005) by identifying asset-based indicators of vulnerability.

Here, I employ a version of what others (e.g., Moser, 1998) have termed an "asset vulnerability analysis": I examine relationships between access to different types of household assets (natural, financial, human and social capital) and subjective indicators of household drought sensitivity and adaptive capacity in two subsistence farming communities in Tanzania.

I hypothesize that subsistence-farming households will be better able to cope with droughts today and adapt to future droughts if they have the following attributes:

- They are relatively large (i.e., they are able to draw off more labor);
- They are relatively young and educated (i.e., they receive better returns on their labor);
- They maintain good relationships within their communities (i.e., they can acquire community support when coping with droughts); and
- They are endowed with large farms that are less sensitive to drought conditions (i.e., moist and fertile land).

III. Study Site and Data Collection: Rufiji District, Tanzania

The Rufiji is the largest river basin in Tanzania, draining about 20 percent of the country. The Rufiji watershed is well known for its significant biodiversity, and consequently draws the attention of international conservation organizations (Doody & Hamerlynck, 2003; Havnevik, 1993). Despite this biological wealth, the Rufiji District is the poorest in the country, home to more than two hundred thousand people, 93 percent of whom are rural smallholder farmers and fisherman (Ochieng, 2002). In typical years, floods, influenced by rainfall and runoff patterns throughout the vast watershed, inundate the river basin, depositing nutrient-rich silt on the land, and creating suitable conditions

for floodplain agriculture. Flooding also enables productive fishing by refilling hundreds of permanent and temporary riverside lakes and ponds each year. Local rainfall can compensate farmers for poor floods, and vice versa (to maximize potential agricultural production, farmers need to time these events accurately—yet they have very limited forecasting abilities).

Historically, both river flow and rainfall in Rufiji have exhibited high variability at various timescales (Duvail & Hamerlynck, 2007; Havnevik, 1993). Havnevik (1993) claimed that "…the history of Rufiji is one of adaptation to change by attempts to establish a buffer between the harsh natural environment and production;" he points to a wide range of local rice varieties that exhibit different growing times and sensitivity to floods, droughts, and salinity (p. 109). However, Havnevik also pointed to many instances in the last century when the government provided famine relief to the district after hazardous floods and droughts,[9] indicating that existing coping strategies—including soliciting family support, engaging in employment, businesses, and consuming or selling natural resources (Mbiha & Senkondo, 2001; Havnevik, 1993; Ochieng, 2002)—are insufficient.

How will farmers in Rufiji cope if precipitation and flood patterns change for the worse? Village leaders in Rufiji claim that in recent decades, the timing and volume of floods have already become increasingly unpredictable (personal communication, May, 2008)—perhaps due to changing land-use patterns and resulting runoff dynamics, and also to changes in climate. Villagers claim that in recent decades, rainfall has been more

[9] Despite employing different strategies to mitigate the risk of complete crop failure—e.g., sowing many times in different locations—households face food shortages relatively often in Rufiji (IUCN, 2004). Havnevik (1993) reported that a very damaging flood "spurred the Tanzanian government to initiate its *ujumaa* policy [encouraging concentrated settlements] in Rufiji District…to avert the loss of lives and reduce the heavy costs incurred by the frequent supply of famine relief to the area." (p. 111)

erratic and less reliable as compensation for poor floods (IUCN, 2004; personal communication, May, 2008).

Funk et al. (2008) projected that main growing-season rainfall in East Africa – which is already down 15 percent since 1980 – will continue to decline due to the warming of the Indian Ocean, thereby threatening agricultural production in communities already vulnerable to drought. Clearly, it is worthwhile to learn about vulnerability to drought in this setting, and to examine potential investments that can help farmers and villages adapt. Empirical research can explore whether, despite the apparent homogeneity of livelihood patterns among people Rufiji, vulnerability to climate-related stressors might differ in substantial ways across households, and why such variation might exist.

Between January and June 2008, I collected data in two villages of the western floodplain area of Rufiji district. This inland area, due to its topography, is relatively exposed to damaging floods; and receives about half the rainfall as the coast, making it relatively prone to drought (Havnevik, 1993, p. 86). The main centers of both villages, including permanent houses, are located just north of the Rufiji River, while most farms and temporary shelters are miles away.

With the assistance of a trusted Tanzanian field assistant, I conducted 1.5 to 2-hour interviews with 100 heads of households in each village who were randomly selected from village office registries. I also held 5 group meetings in each village and 18 semi-structured interviews with key informants in the villages and at the district headquarters, including some who were involved in the aid project. Respondents were remarkably candid throughout the research: most did not appear to be intimidated by the experience or to be withholding in their responses. We took time and care to pursue accurate

responses, and discarded only a few responses that we judged to be unreliable due to confusion on the part of the respondents. Survey responses were carefully coded in the field in order to avoid the bias of any preconceived "theoretical positions or expectations" (King, Keohane, & Verba, 1994, p. 157).

Qualitative data come from additional open-ended questions from the survey interviews, group meetings, and semi-structured interviews; from reviews of past research in the region; and from Rufijij District development documents.

(a) Dependent Variables

Dependent variables are indicators of drought sensitivity and adaptive capacity at the household level (Table 4.1). First, as an indicator of farmers' sensitivity to drought conditions, I used drought-year maize and rice harvest quantities. I also used household livelihood diversification—defined as the degree to which production is spread across multiple activities with different drought risk profiles, including market activity (Davies, 1993; Ellis, 2000). I assume that while particular structural realities (e.g., poor market access) limits the potential of off-farm livelihood production as an adaptation to drought (Parker, 2010*b*), diversification still spreads drought risk, as most farmers turn to off-farm livelihood strategies to cope with drought. Also, people who are relatively engaged in market-oriented livelihood activities—e.g., cash crop production, chicken-keeping, and fishing—are better positioned to take advantage of potential future improvements to societal infrastructure like roads and markets.

As indicators of adaptive capacity to drought, I used (1) household perceptions of whether their ability to cope with drought has changed over the previous ten years; and

(2) response types to questions about hypothetical investment strategies to prepare for future droughts (*productive* responses such as, "invest in irrigation," or *unproductive* responses such as, "I don't know") (Parker, 2010*b*).

(b) Independent Variables

Independent variables include household-level natural, financial, human and social capital assets—farm quality, wealth class, age, education, household size, and participation in village meetings (Table 4.2).

Farm quality was determined by recording relative measures (scores) of different environmental variables (wetland extent, weed cover, and soil fertility) from each household staple-crop farm; and by estimating the size of each farm.

To assign household wealth class in each village, I combined physical and financial assets. I collected but did not use data on the physical assets of each individual household (e.g., farming equipment, furniture, etc.) because variation was too low to be useful. I was told by village leaders that households rarely display signs of wealth due to cultural concerns related to envy, and that a wealth measure would be better determined by knowledgeable villagers. Financial assets are also difficult to measure because virtually nobody in the villages (including shop owners, surprisingly) keep records. To determine wealth class in each village, then, two separate groups of village leaders were asked to make subjective determinations of both physical and financial assets of the sample households, and to place each household into one of three classes; and a third group of leaders was asked to reconcile any conflicts.

For social capital, I use the indicator of whether the respondents regularly participated in village meetings, assuming that more engagement in village affairs produces more opportunities for people to form relationships of reciprocation that can improve mutual coping capacities (Adger, 2003).

Data for age, education, household size, and participation in village meetings were collected from the household surveys. Wealth, age, and education, refer to the survey respondents, which were almost always the *heads of household*.

Finally, assuming that the dependent variables might display some spatial significance, I recorded the GPS waypoints of the principle staple-crop farms of each household respondent.

IV. Data Analysis

Using the GPS waypoints of the household farms and ArcGIS 9.2, I tested for spatial patterns—i.e., clustered, dispersed, or random—in the dependent variables by calculating Moran's statistics (ESRI, 2009). I calibrated the model with a distance threshold (ESRI, 2009) in order to prevent it from testing the villages against each other. I did not do spatial analyses on *combinations* of dependent variables.

To test for one-on-one associations between independent and dependent variables (all categorical) I conducted cross tabulations and conducted Pearson Chi-square *exact* tests and adjusted residuals using PASW (SPSS) Statistics Module v.17.

I conducted a qualitative analysis on additional open-ended questions from the same household survey (n=200) and from semi-structured interviews with village groups (n=10) and public officials (n=18), and used both results to explain patterns from the

statistical analysis, and to develop theoretical insight into the relationships among my variables of interest. I used a focused coding approach to organize my fieldnotes around the core themes of household assets and drought vulnerability (Emerson et al., 1995, p. 160). I then coded the data into individual asset categories, and identified and explained connections between them and the dependent variables.

Because the behaviors I examined are influenced by many, often dynamic factors, I collected a large sample size and make only conservative inferences and generalizations. Any conclusions from the data are made tentatively and used to motivate future research.

V. Results

(a) Spatial analysis

By entering the GPS waypoints of the household farms into Google Earth™, I generated a map that displays the spatial distribution of the farms (Figure 4.2).

The Moran's I values (ESRI, 2009) of the spatial analysis fell near zero, suggesting that the spatial patterning in each dependent variable is random. This means that if there are differences in the dependent variables among households, those differences aren't spatially significant—i.e., the location of one's farm does not correlate with the variables for drought sensitivity or adaptive capacity.

(b) Statistical analysis

I produced 5 tables that display the cross tabulations and Chi-square tests of association for each one-on-one cross between my independent and dependent categorical variables of interest. I present two full tables and, in the interest of space, report the

remaining results in the text and in condensed tables. When I report significant associations from the cross tabulations in the text, I refer *only* to the specific cells that are major contributors to the significance, i.e., those that have adjusted residual values of +/- 2 (Agresti & Finlay, 1986, p. 492), and largely omit significant associations that cannot be explained intelligently.

(i) Household Assets v. Drought-Year Harvest and Livelihood Diversification

There was a significant association between farm size and drought-year maize harvest quantity ($p = .044$): those with large farms grow relatively large quantities of maize, while those with small farms grow relatively little (Table 4.3). Surprisingly, wetland extent did not correlate with drought-year staple harvest. However, during group interviews, many people claimed that access to wetland areas *outside* of their principal staple farms—in drained, depressed floodplains closer to the river—was very important to securing a modest maize harvest during drought years. They also claimed that this land was limited to fewer than half of those who would want it, and that it was claimed on a first-come, first-serve basis during drought years. The data analyzed here, therefore, do not capture all of the nuances of drought-year staple production in the two villages—indicating that there are questions of informal land tenure to consider when assessing drought vulnerability.

When considering livelihood diversification, the data showed several significant associations. Those in the middle age class (30-40 years) were engaged in relatively many (two or more) off-farm livelihood activities at the time of the research ($p = .057$). Those who had reached the sample's modal educational level of Standard 7 (equivalent to

just before high school in the West) engaged in relatively many off-farm livelihood activities, while those with no formal education engaged in relatively few ($p = .084$). At first glance, one might assume that there would be little noticeable difference in livelihood diversification between those with at least some education and those without. This is because schools in Rufiji are notoriously overcrowded, under-resourced, and based on a curriculum of rote reading, writing, and mathematics without practical (e.g., agricultural) training; and because most of the off-farm livelihood activities observed in the villages involved the use of natural resources—e.g., fishing, mat-making, chicken-keeping—and didn't appear to require knowledge that could be acquired in primary school (this observation was not investigated further). A more obvious explanation for the difference might be that many of those without formal education are *older* respondents, none of whom were subject to the universal primary education policies enacted at independence and subsequently pursued with vigor in Tanzania, and most of whom engaged in relatively few (one or none) off-farm activities.

Notably, the few respondents that had attained more than the modal educational level did not engage in many off-farm activities. These people represented the small professional working class in the villages (e.g., teachers and health workers), and did not have time to take up multiple livelihood activities.

Those in the higher wealth class, and those who were younger or more educated, claimed to have initiated relatively many (two or more) off-farm activities in the last ten years ($p = .004$, $p < .001$, $p < .001$, respectively); while many who were relatively old, poor, or with no formal education hadn't initiated a single new project in the last ten years (Table 4.4). Financial assets – small though they may be in these poor villages

(Kasthala et al. (2008) reported that only 4 percent of citizens of one of this study's villages had bank accounts, and only 3 percent had received credit or loans over the previous year) – might represent a small safety net that allows people to attempt to diversify their livelihoods. That wealth class did not correlate with the *current* number of household off-farm livelihood activities, however, indicates that livelihood diversification attempts do not always take root.

Those with smaller households initiated relatively few off-farm activities in the previous ten years ($p = .028$)—also a consistent finding given that small households were, on average, occupied by older villagers whose children had already moved out.

Notably, none of the financial and human capital variables correlated with drought-year maize or rice harvest yields. Investments that might be necessary to reduce household sensitivity to drought (e.g., irrigation infrastructure and other mechanical farming equipment) are probably cost prohibitive at the individual level—especially in Rufiji, where liquid capital is very scarce. Also, none of the natural, financial, or human capital variables were associated with ease of access to markets, probably meaning that market access is determined by non-local conditions—for example, public investments in roads—that affect all local stakeholders in similar ways.

Finally, those who do *not* participate in village meetings were also relatively unlikely to have begun any new off-farm projects in the previous ten years. Part of this result is explained by the fact that many people in one of the two villages had participated in an aid-funded livelihood diversification project from 1998-2003 (Parker, 2010*b*). The project had organized groups of villagers around different livelihood activities that complement traditional maize and rice production—including horticulture, chicken- and

bee-keeping, and sustainable fishing—in order to facilitate the adoption of improved production techniques.

It is worth mentioning that, by and large, I surveyed only the heads of households, and so the results rarely reflect the importance of differentiated labor among household members—a shortcoming that limits our understanding of drought vulnerability in the villages. For example, the survey data don't include responses from teenagers, traditionally a very important source of labor in Rufiji, where a tiny fraction of students progress to secondary (high) school. However, qualitative data from the survey open responses and group meetings give us some insight into the importance of this group to livelihood production. Time and again, villagers commented on how these youth are becoming increasingly "lazy," and how this trend is devastating to household food security. Pressed to explain this cultural change, most claimed simply that "the mothers allow it." Many mentioned that families are less cohesive today than in the past, perhaps due to their growing size, which might, when coupled with economic and cultural integration (and the proliferation of communications technology like transistor radios and satellite television) result in a general breakdown of cultural norms related to livelihood production. Others expressed a concern that the youth will increasingly leave the villages to make new lives in the city, which, from the perspective of labor, might make households more vulnerable to droughts and other stressors in the future (especially considering the fact that most who move to the city make too little, often by informal employment, to send remittances back to their home villages).

(ii) Household Assets vs. Responding to Drought

Those with relatively small farms were far less likely to report that their ability to cope with drought had improved over the previous ten years ($p = .075$) (Table 4.5). This suggests that people might not only spread drought risk across different livelihood activities, but also across greater tracts of land dedicated to staple crop production (maize production, in particular (see above)). It is possible that because drought-year maize harvests do not typically fail completely (unlike rice; see Parker, 2010*b*), planting greater areas of maize can guarantee *some* yield after inevitable losses that occur due to both moisture stress and animal pests (which also become much more of a problem during droughts). Even small drought-year harvests could represent a meaningful asset, preventing households from falling deeper into persistent poverty.

Older respondents (above 60 years) mostly gave unproductive responses to all three questions about hypothetical investments to prepare for drought (*individual*: $p = .067$; *community*: $p = .065$; *government*: $p = .086$), suggesting that they are either less aware of potential livelihood investments or more comfortable in their established production patterns than younger respondents (Table 4.5). Many older respondents in both villages expressed resentment towards an apparent cultural shift in which traditional hierarchies are being reorganized and younger leaders established; and some claimed that younger leaders are unable or unwilling to organize the villages to confront common challenges like periodic drought. That the older respondents didn't provide specific collective investment ideas, themselves, might be an example of why district officials commonly characterize Rufijians (in knee-jerk fashion) as "lazy people" with poor self-organization who are "waiting for the government to solve their problems" – something, one man

explained, that can be attributed to the post-colonial Socialism experiment in Tanzania (personal communication with district officials, June, 2008).

Those in the above-average wealth class gave relatively more productive responses to questions about hypothetical investments to prepare for droughts (e.g., "Invest in irrigation."), while those in the below-average wealth class gave relatively more unproductive responses (e.g., "I don't know."). This holds for *community*- and *government*-level investments ($p = .016$ and $p = .005$, respectively) (Table 4.6), but not for *individual*-level investments. This suggests that those with more wealth might have had positive experiences with investing financial capital in the past, and were therefore relatively more attuned to the potential benefits of investments specifically targeting drought sensitivity. This group might also be aware of the fact that, as mentioned above, such investments are cost prohibitive at the individual level.

Finally, many of those who participated in village meetings also claimed that drought coping had improved over the previous ten years. It is unclear why this relationship exists, as I didn't observe any village-level drought safety nets, and there is no significant relationship between participation in village meetings and the degree to which households rely on community coping support (χ^2 (1, N=197) = .931, $p = .371$). It is likely that this relationship occurred by chance.

VI. Discussion

The results identified several assets that were correlated with the variables for drought sensitivity and adaptive capacity (Figure 4.3). I argue below that land tenure, age, and wealth might be particularly important in the context of drought adaptation *policy*.

(a) Land Tenure

Environmental characteristics of principal household staple farms weren't significantly related to drought sensitivity (and neither was geographical location), meaning that variations in wetland extent, soil quality, and weed cover of permanent farms in the two villages were not large enough to cause differences in drought-year harvest potential. However, the analysis might have produced significant results if it had included survey and spatial data from the temporary farms that form when floods recede. Villagers claimed that access to these plots guaranteed a modest maize harvest during drought years. These bits of land—often mere spits or islands of less than an acre, located adjacent to or near the banks of the Rufiji river—shift location after new floods, meaning that they are not subject to the informal land tenure systems that exist in the villages (nearly all respondents claimed that they either inherited their permanent land from family or "just took it," and in both cases the land is respected as private property by customary law). There was consensus in the group meetings that the temporary plots were available to only about half of those who would want them during droughts, and that there was no established hierarchy that determines who can claim them. These comments cannot be corroborated without longitudinal data on land use. However, this result, as well as the result suggesting that smaller farms are more sensitive to drought, underscores the importance of land tenure in influencing drought vulnerability among subsistence farmers, and the potential of land tenure reform as a focal point for adaptation policy. By taking advantage on existing natural capital (i.e., land), aid can focus its resources on adaptive institutional arrangements that do at least two things.

First, aid could facilitate land-use planning and titling that takes into account known sensitivities to particular stresses like drought. In the case of the two villages in this study, it could formalize the temporary tenure of the drought-year wetlands to ensure that they are equitably shared over the years; or help to establish group farming sites (sometimes referred to as "block farming") that allow farmers to take advantage of economies of scale and perhaps to cooperate to manage moisture stress, animal pests, and other drought-related stresses.

Second, while there are no apparent problems with customary land demarcation and titling in the study villages *today*, there are concerns that in the future, as population density increases and development interests encroach inland along the river (especially agricultural interests, which will be motivated largely by global prices of cash crops), villagers will be increasingly confronted with challenges to their land (Havnevik, 1993, p. 308; personal communication with village leaders, 2008). Aid can help to ensure that household land tenure is legally recognized (i.e., in more than a customary manner) among local and higher-level governments. In this way, farmers would be preparing for joint exposure to both economic and climate-related stressors (O'Brien & Leichenko, 2000; Ziervogel et al., 2006; Adams et al., 1998).

Whereas land reform is a topic of concern throughout the literature on agricultural development in sub-Saharan Africa (e.g., UKFG, 2008), it is relatively absent from the literature on climate change adaptation (Quan & Dyer, 2008). Adaptation policies can learn a lot from sharing knowledge with existing work on the subject.

(b) Age

Age correlates with drought vulnerability in the villages, driven largely by the fact that older villagers engage in less diversified production and appear less prepared to adapt to droughts than younger villagers. This presents an interesting challenge for asset-based adaptation approaches. On one hand, extensive scholarship has demonstrated the importance of recipient "ownership" of aid initiatives—without which, "recipients do not make the kind of commitments needed to ensure the realization of the intended long-term results of donor assistance" (Gibson et al., 2005, p. 11). In much of the world, "ownership" involves the participation and endorsement by local elders high in the social hierarchy (this generalization still includes the case study villages, despite the resentful feelings that some of the older respondents expressed towards the younger leadership). On the other hand, scarce aid resources might be put to better use by targeting those who are not necessarily the most exposed and sensitive, nor those who most lack adaptive capacity. Rather, aid might be more efficiently used if it targeted those who are closer to a threshold of pulling themselves out of entrenched, vulnerable states—i.e., those who, with some assistance, would be relatively able to maintain or even build upon their asset bases and to meet their long-term needs—and who can then be better positioned to assist others in their communities. Engaging with vulnerability as a dynamic concept like this is one important way in which we can distinguish it from the more static conceptualizations of poverty (Moser, 1999)—but by focusing on the long-term potential instead of "snapshots" of people, we raise equity concerns that are politically, and perhaps morally, questionable.

The "problem of youth laziness" is acutely felt by people in the two study villages, to the extent that adaptation investments might be justified in developing youth development programs that attempt to counter the cultural changes that are affecting household production—and, critically, drought-year production—so dramatically. These might involve programs that incentivize local staple crop production and innovation (and that prevent out-migration to cities where steady employment is rare). For example, aid might invest in training young people in modern agricultural techniques, as well as off-farm activities and business practices (improving on standardized, but otherwise non-practical primary educations); subsidizing local entrepreneurship programs; and investing in communications technologies that can be used to build market networks.

(c) Wealth

While wealth might correlate with diversification *attempts*, it does not correlate with *current* household off-farm production. Because risk-averse farmers will often weigh potential losses of new investments more than potential gains (Kahneman & Tversky, 1979), new endeavors might require significant and sustained subsidization or, at least, that the potential outcomes – i.e., the stakes involved (Kuznar, 2001) – are framed accurately. Empirical studies have shown that demonstrating the results of agricultural innovations is vital to encouraging farmers to move from being merely aware of their potential benefits to full adoption (e.g., Okuneye, 1985)—i.e., transforming risk-averse behavior to risk-taking behavior (Kuznar, 2001).

Similarly, while wealth might correlate with productive investments ideas among household respondents, its potential for reducing vulnerability to drought is largely

limited to its use in purchasing staple meal to compensate for a failed harvest, and *not* as investment capital to improve drought-year livelihood production. This is because the kinds of investments that are required to improve drought-year production—namely, improved agricultural production technology (communal irrigation and mechanical equipment), better transportation, and more developed market networks—are cost prohibitive at the individual scale (Parker, 2010*b*). For example, even if credit access improved in the district, allowing families to build and diversify assets (Hammill et al., 2008), most families still wouldn't be able to make individual investments that transform their long-term vulnerability to drought. Similarly, even if all farmers are able to employ low-cost improvements to farming methods that make *marginal* improvements to drought-year yields (Ziervogel et al., 2006)—such as manual irrigation and pest management—most are still unable to invest to substantially reduce their vulnerability to drought. This highlights the multi-scalar nature of climate change adaptation, and the potential benefits to coordinating national-level adaptation policies (where much of the existing financing is channeled) with local asset accumulation projects.

V. Conclusion

Asset-based approaches to vulnerability analysis and, by extension, adaptation policy, are concerned with the potential of people to absorb and respond to change, and to consequently move in and out of different level of risk. Climate change is a looming threat to human security requiring that we acquire a better understanding of how access to different assets affects exposure, sensitivity, and adaptive capacity to particular climate-related stressors. In this study, I examined how household-level assets are associated

with indicators of drought sensitivity and adaptive capacity in two villages in rural Tanzania. Land tenure, human capital (age and education), and wealth emerged as important assets in the villages, but were limited by the need for additional complementary capital.

This study was limited in duration and, consequently, I often made use of data derived from subjective responses about drought outcomes and hypothetical scenarios. It could be improved upon by collecting data over time on particular household assets and actual drought-year production outcomes (additional to staple crop production). Aid projects are in a unique position to develop standardized monitoring protocol to track such questions over time, but the institutional incentives for such work appears to be lacking in the industry.

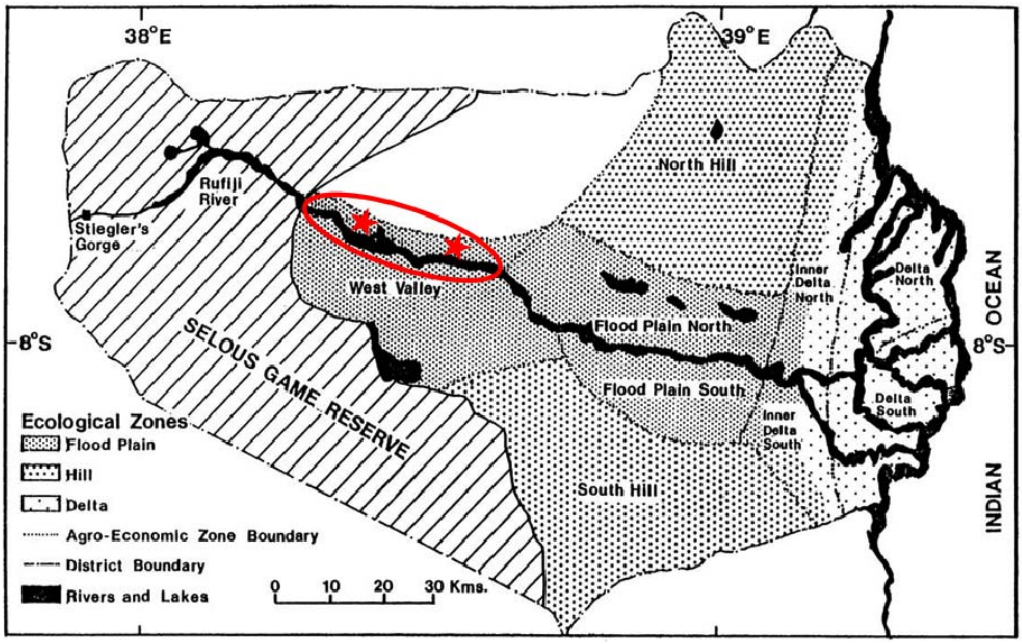

Figure 4.1: Rufiji District. The stars represent the two villages of this study. *Source: Havnevik, 1993.*

Variable (Household)	Survey Question
Drought Sensitivity	
2007 (drought-year) staple harvests	Maize and rice harvests (kg)
2007 off-farm activity	Aggregate number of off-farm economic activities
Off-farm activity (last 10 years)	Number of off-farm economic activities attempted and initiated in last ten years
Access to markets	Is it easier to access markets to sell crops currently or ten years ago?
Adaptive Capacity to Drought	
Change in coping capacity	Is it easier to cope with drought currently or ten years ago?
Future drought responses	If *you/community/government* had the money, what should be done to help you prepare for future droughts?

Table 4.1: Dependent variables and corresponding household survey questions: drought sensitivity and adaptive capacity.

Variable	Data Organization
Household Characteristics	
Natural Capital	
Wetland extent	Scored 0 – 3 (low – high)
Soil quality	Scored 0 – 3 (low – high)
Weed cover	Scored 0 – 3 (low – high)
Financial Capital	
Wealth class	Relatively poor, average, relatively wealthy
Human Capital	
Age class	20-30, 30-40, 40-60, 60+
Formal education	Years in public school
Household size	Determined by *current* number of dependents
Social Capital	
Participation in village meetings	Yes/No

Table 4.2: Independent variables and data organization: household natural, financial, human, and social capital.

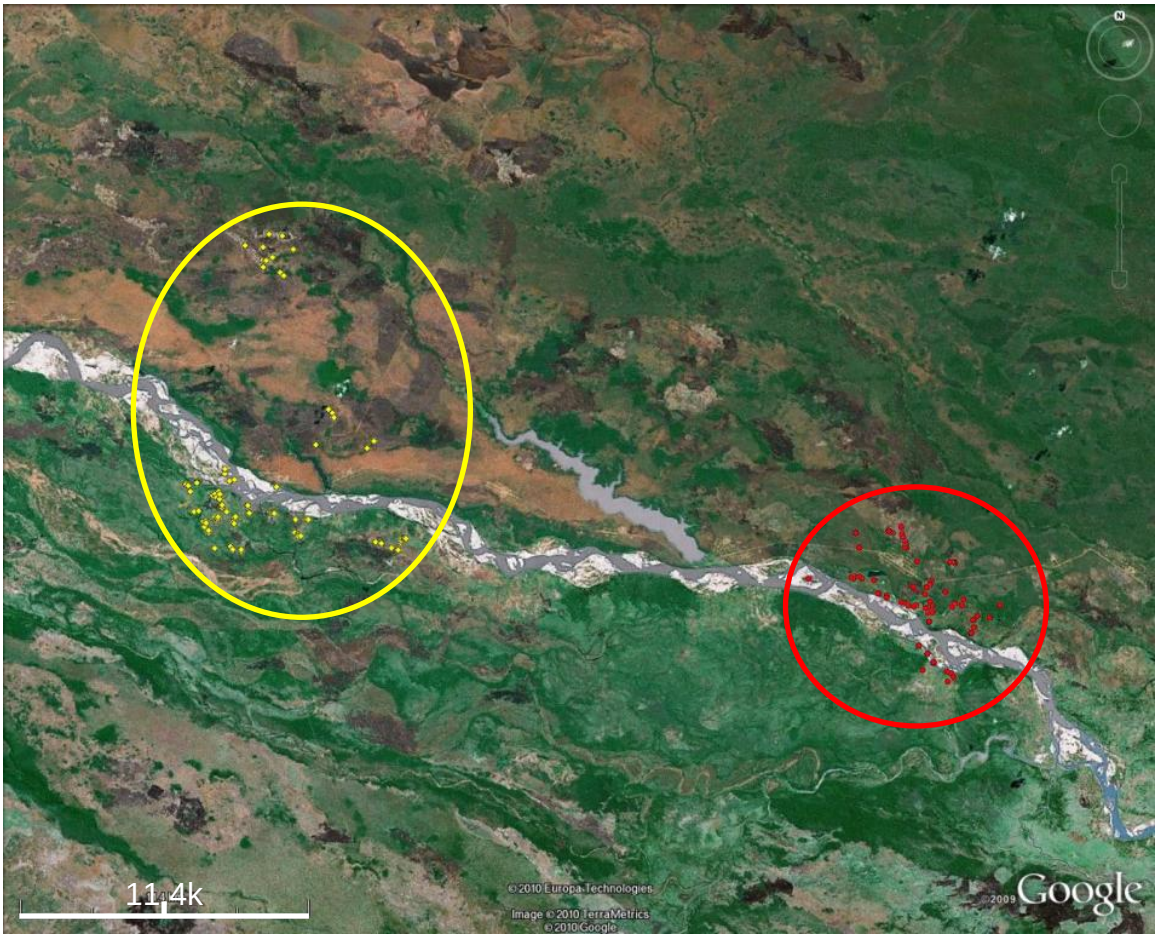

Figure 4.2: Google Maps™ image of the distribution of farms (represented by the small dots) in both of the study villages. The spatial analysis revealed that the location of one's farm does not correlate with the variables for drought sensitivity and adaptive capacity.

Variable	2007 Maize Harvest/Rice Harvest	2007 Off-Farm Production	Off-Farm Production Previous 10 Years	Access to Crop Markets
NATURAL CAPITAL				
Wetland extent	*p* = .304 / *p* = .839^	*p* = .627	*p* = .714	*p* = .843
Soil quality	*p* = .491^ / *p* = .841	*p* = .793	*p* = .224	*p* = .925
Weed cover	*p* = .810 / *p* = .910	*p* = .127	*p* = .235	*p* = .218
Acres	*p* = .044**/ *p* = .878	*p* = .642	*p* = .691	*p* = .612
FINANCIAL & HUMAN CAPITAL				
Wealth class	*p = .453/ p = .621*	*p = .277*	*p = .004***	*p = .930*
Age class	*p = .102/ p = .200^*	*p = .057**	*p = .000***	*p = .001*
Formal education	*p = .153/ p = .861*	*p = .084**	*p = .000***	*p = .707*
Household size	*p = .690/ p = .551*	*p = .295*	*p = .028***	*p = .757*
SOCIAL CAPITAL				
Participate in meetings	*p = .497/ p = .866*	*p = .854*	*p = .079**	*p = .635*

**α < .05, *.05< α<.10; ^ = Fisher's Exact Test

Table 4.3: Pearson's Chi-square *exact* tests of association between household assets and variables related to drought sensitivity.

Age Class	***No. Off-farm Livelihood Activities* Initiated in the Last 10 Years**			**Total**
	Zero	*One*	*Two +*	
20-30 years	10 *(-4)*	16 *(1.2)*	17 *(3.6)*	43
30-40 years	21 *(-1.2)*	16 *(.5)*	12 *(.9)*	49
40-60 years	27 *(.2)*	16 *(.0)*	10 *(-.2)*	53
60+ years	42 *(4.6)*	12 *(-1.6)*	1 *(-4.0)*	55
Total	100	60	40	200
	Value	*Df*		*Significance*
Chi-square (exact)	34.217	6		.000

[a] Cell entries represent the number of respondents followed by the Chi-squared adjusted residuals in parentheses.

Table 4.4: Pearson's Chi-square *exact* test of association between age class and the number of off-farm activities initiated by households over the previous ten years. The youngest class of respondents initiated many new off-farm activities, while the oldest class initiated very few, if any.

Variable (Household)	Change in Coping Capacity	Hypothetical *Individual* Drought Response	Hypothetical *Community* Drought Response	Hypothetical *Government* Drought Response
NATURAL CAPITAL				
Wetland extent	*P* = .585	*p* = .699	*p* = .449	*p* = .026**
Soil quality	*P* = .074*	*p* = .848	*p* = .901	*p* = .973
Weed cover	*P* = .633	*p* = .686	*p* = .414	*p* = .288
Acres	*P* = .075*	*p* = .361	*p* = .848	*p* = 1.000
FINANCIAL & HUMAN CAPITAL				
Wealth class	*p = .156*	*p = .200*	*P = .016***	*p = .005***
Age class	*p = .140*	*p = .067**	*P = .065**	*p = .086**
Formal education	*p = .289*	*p = .325*	*P = .130*	*p = .144*
Household size	*p = .047***	*p = .465*	*P = .403*	*p = .350*
SOCIAL CAPITAL				
Participate in meetings	*p = .026***	*p = .658*	*p = .381*	*p = 1.000*

**α < .05, *.05< α<.10; ^ = Fisher's Exact Test

Table 4.5: Pearson's Chi-square *exact* tests of association between household assets and variables related to adaptive capacity to drought.

Wealth Class	**Government Drought Investments**		**Total**
	Productive Response	*Unproductive Response*	
Below Average	30 *(2.8)*	12 *(-2.8)*	42
Average	67 *(-1.2)*	68 *(1.2)*	135
Above Average	5 *(-2.0)*	12 *(2.0)*	17
Total	102	92	194
	Value	*Df*	*Significance*
Chi-square (exact)	10.115	2	.005

[a] Cell entries represent the number of respondents followed by the Chi-squared adjusted residuals in parentheses.

Table 4.6: Pearson's Chi-square *exact* test of association between wealth class and hypothetical government investments to help people prepare for future droughts. Largely, those with above average wealth gave productive responses, while those with below average wealth gave unproductive responses.

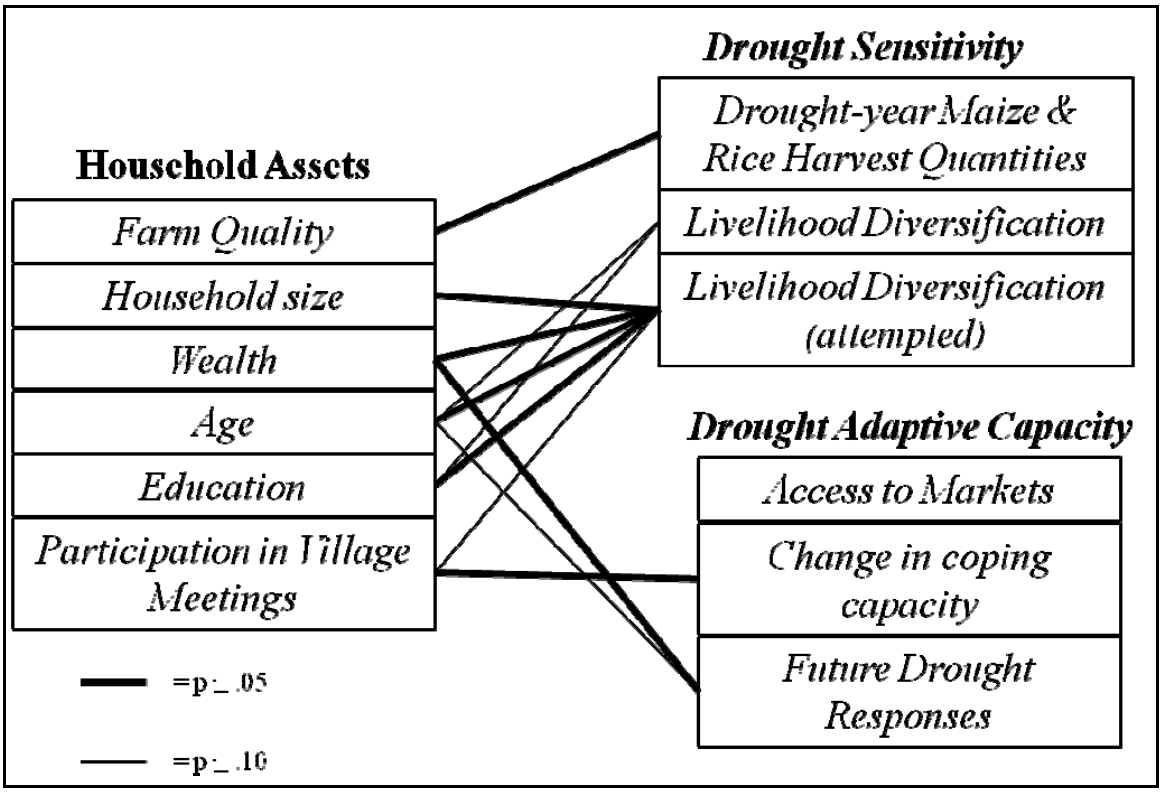

Figure 4.3: Associations between household assets and measures of drought sensitivity and adaptive capacity. There are many significant associations, with wealth and education being especially prominent predictors of drought sensitivity and adaptive capacity.

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Chapter 5

Conclusion

I have shown that staple crop agriculture in Rufiji, Tanzania is very sensitive to drought, resulting in high rates of poor or failed harvests during years when floods and rainfall are inadequate. Meaningful response strategies—be they short-term and reactive, or long-term and proactive—should account for such losses.

In both villages of this study, it was clear that natural resources such as fish and non-timber forest forage products are still important drought coping resources. While decentralized natural resource management might be effective in managing natural resources in the short-term, there is no guarantee that early conservation gains will withstand stresses brought about by increasing rates of environmental change—especially at the landscape level, given the problem of "leakage." This could lead to additional problems of increased scarcity of traditional coping resources – most of which are already relatively ineffective in that they only allow households to *recover* to pre-drought states of chronic poverty. It is clear that the villages would benefit from alternative coping strategies that (1) relieve pressure on ecosystems and (2) significantly reduce long-term exposure and/or sensitivity to climate-related stressors like drought.

The results showed that livelihood diversification and entitlement to particular household assets have the potential to reduce household vulnerability to drought *only if* accompanied by substantial capital transfers – presumably from the state or other actors like foreign donors and NGOs. For Rufiji farmers, a threshold to a less vulnerable life appears insurmountable absent specific larger-scale infrastructural and institutional improvements (like communal irrigation, agricultural mechanization, and improved transportation and market access). In other words, the results suggest that while many recognize that adaptations to climate change will ultimately be local (e.g., Huq & Reid, 2007; Agrawal, 2008), they will also be dependent upon suitable enabling environments that bridge many levels of society (Eakin & Lemos, 2006).

Multi-scalar adaptation & policy coherence

Both the problem of ecological resilience and the multi-scalar nature of climate change adaptations highlight the importance of *policy coherence*, defined as "the systematic promotion of mutually reinforcing policy actions across government departments and agencies, creating synergies towards achieving the defined objective" (OECD 2001, 90). Policy coherence has been a subject of concern for foreign assistance for over forty years (Easterly 2006, 191), and remains a significant problem today to policy problems of many kinds. Agrawal (2008) recognized the importance of policy coherence in his review of local adaptation strategies across the world, claiming that "there must be far greater coordination between adaptation policies and measures adopted by institutions and decision makers at the national level, and their counterparts at the local level" (p. 51).

One explicit goal of REMP was to cooperate with several project partners, including the National Environment Management Council, the (Tanzanian) Coast Region Offices, the Rufiji Basin Development Authority, the Ministry of Natural Resources and Tourism, and the Royal Netherlands Embassy—and by all accounts, facilitating communication among these different stakeholders was a strong point of the project. However, though the original plans of the project were for long-term logistical support and education at the village level, as well as fostering relationships between local and higher-level governments, it is unclear if the project's scope was large enough to facilitate the kinds of structural changes needed to help reduce vulnerabilities to drought. In other words, REMP's potential as a "bridging organization" (Folke et al., 2005) appears to have been limited in Rufiji due to significant household poverty and a lack of relevant public and private infrastructure.

Long-term vulnerability research

Even if REMP could have influenced higher-level structural changes, it was forced to leave after only five years—and in doing so it demonstrated the importance of donor time frames in the context of adaptation policy. If climate change adaptation policy is much about facilitating adjustments to established production habits or institutions (perhaps continually, depending on the nature of different stresses affecting livelihoods), it needs to acknowledge that such rapid behavioral shifts are highly uncommon in risk-averse settings, and that serious time and resource commitments might be required to affect transformational changes. Agrawal (2008, p. 4) sums up the policy challenge nicely:

> An adaptive perspective on development will require the willingness to experiment, capacity to take the risk of making mistakes, and flexibility to make space for social

and institutional learning.

Relatively long donor time commitments might also serve as a vital source of data from which we can conduct research on vulnerability, argued to be a dynamic concept that requires information about livelihood security over time (Ziervogel et al., 2006, p. 303):

> Vulnerability is contextual and changes over time. Information gathered in one year cannot necessarily be used to predict future vulnerability or how responses to information will occur over the coming ten years. It is therefore necessary to acknowledge dynamic vulnerability and to develop tools that enable salient processes to be captured and contribute to a broader understanding of vulnerability pathways.

My study was limited in duration and, as in most poor, marginalized settings around the world, relevant biophysical and socio-economic data were scant. Consequently, I often made use of data derived from subjective responses about vulnerability to drought. Aid projects, because they operate in settings with high levels of vulnerability and are attempting to facilitate beneficial *changes* in society, are in a unique position to develop and implement standardized monitoring protocols to track questions of vulnerability and adaptation over time, and to evaluate progress towards clearly-defined adaptation goals.

However, the international aid system often incentivizes *against* long-term commitments and costly data collection programs (that would feed objective research or self-evaluation). This is largely because donor countries are responsible first to their governments and respective constituencies, who don't necessarily require exhaustive evaluations in order to approve funding; and because NGOs may be limited by their dependence on financing from larger donors (Gibson et al. 2005, 230). At the 3rd Annual Conference on Community-Based Adaptation in Dhaka, Bangladesh (February, 2009), the director of the UN Global Environmental Facility's (GEF) climate change adaptation

small-grants program lamented that those grants – which are short-term (5 years) – often fall short of enabling meaningful household adaptations. However, he also expressed hope that future (and potentially far more significant) adaptation funds will be attached to policies designed with a relatively long-term mandates.

Still, we have already witnessed some efforts aimed at restructuring the incentive system for evaluating international foreign aid (as well as the negative connotations associated with critical inquiry), and hopefully these can be extended to climate change adaptation initiatives. For example, the GEM initiative (http://appreciativeinquiry. case.edu/ gem/index.html) is an NGO evaluation initiative dedicated to "Appreciative Inquiry into Organizational Life." Essentially, this means that the initiative facilitates local institutional capacity development by identifying and propping up *best practices* and developing productive, good-natured partnerships among stakeholders. These efforts aim to generate respect for evaluations by highlighting positive experiences with specific aspects of daily life, and then soliciting ideas for a better future. The process is highly qualitative and participatory in nature, consistent with some of the most productive approaches I took in conducting my research—namely, holding several group interviews in the villages. The process avoids some of the ambiguity inherent to surveying people about long-term changes, and provides relatively more opportunities for triangulating results in order to connect accurately different inputs to long-term outcomes.

Is it possible that adaptation financing will be substantial enough to allow practitioners to take advantage of the multi-scalar nature of adaptations, or to initiate and maintain long-term monitoring programs and evaluations in order to help us learn about climate-related vulnerability and the proper role of aid in facilitating adaptations? As

international climate negotiations progress, we will learn much more about the nature of the funds coming down the line, and the preferred modes of delivering them to developing nations.

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Appendix

In this appendix, I document trends in REMP's workplans and annual reports (all obtained from unpublished grey literature located at the Rufiji district headquarters in Utete, Tanzania), and compare themes in these documents to the empirical results reported in this dissertation.

REMP: Original planning documents

An original motivating factor for the project was to preempt potential ecological damage due to an influx of economic interests if and when the main district road was improved. In the original planning documents, REMP technical officers commented:

> The inaccessibility of the floodplain has been a key factor in maintaining the integrity of the Rufiji wetland ecosystems. At the same time, however, the lack of access has been repeatedly identified as one of the most important development constraints in the Rufiji area.

The environmental management project that REMP envisioned would:

- involve local communities as much as possible
- train villagers in management techniques and participatory evaluations
- include traditional behaviors/rules in the design of more formal by-laws
- assign leadership roles, while maintaining a gender balance
- hold multi-sectoral technical workshops that involve local, zonal, district, regional, and central government officers; and focus on policy *cohesion*
    - focus on catchment-wide policies and upstream and downstream coordination

    - be headquartered at the district headquarters in order to integrate into district planning
    - review district laws and village by-laws and sectoral policies to establish better authority and clarity with respect to environmental governance
- facilitate traveling workshops to observe other similar projects

REMP would also identify potential "wise-use" livelihood activities, and facilitate their expansion and development. Initially, the project considered assisting in improved fish storage and marketing, improved bee-keeping, horticulture and agroforestry initiatives, improved wetland-based crops, chicken vaccinations, and small-scale improvements in communication technology throughout the district. A special note was made with respect to micro-credit initiatives:

> Credit facilities are to be avoided, even in the later stages of Phase I. The story of village-based credit schemes in Tanzania is rather catastrophic, so that it is advisable to make a thorough analysis first in case the project thinks to introduce a scheme (possible in Phase II only).

To initiate the project, REMP would hire consultants to deal with issues of gender, community development, monitoring and evaluation of village by-laws, communications, hydrology, and environmental awareness. It would also initially equip the project with three vehicles and three outboard engines, computers at the district headquarters, radio equipment, and equipment for extension into the pilot villages.

REMP: Further planning in Phase I, 2001-2003

After two years, the project self-evaluated with the participation of district and village leaders. They identified the following <u>achievements</u>:

- successful collection of socio-economic and environmental data to be used to construct land-use maps

- environmental awareness raised
- improved capacity for environmental management at the village and district levels
- developed the village environmental management plans and working towards implementation
- lessons in communications and conflict resolution learned through practice
- monitoring systems slowly implemented
- women represented in leadership roles
- wise-use activities identified—e.g., horticulture, chicken-keeping, bee-keeping—and groups established, and livelihood study tours completed
- natural resources business opportunities and limitations discussed with villages in legal training sessions run by some of Tanzania's top lawyers
- on-the-job training at the district level

They also identified several constraints:

- low and decreasing education levels causing a difficult transition to village-based planning and management
- expectations of outside "help" in the form of free equipment, etc., remained high
- low capacity for planning and implementation in district and near-absence of credible implementing partners (NGOs)
- low interest of developing partners and national institutions for working in Rufiji
- lack of incentives for implementing village environmental management plans
- lack of incentives for the district to move from unsustainable exploitation of natural resources to other sources of revenue
    - "The district council perceives the forest as a current account that can be overdrawn at will, instead of a saving account."
- difficulty integrating environmental management planning into general development planning

And finally, they identified priority areas of future effort:

- to build long-term incentives for short-term managers (money)

- to learn how to develop, pilot, and promote alternative methods and enterprises *without* adequate resources

- to facilitate the adoption of environmental rules and new livelihood activities without external support (there is low negotiating power at village level, and REMP only had resources for *some* demonstrations)

    - "wise-use" projects can't be expanded without more resources—from the government or other external support

Two key themes that emerged from the early planning and evaluation processes were (1) the importance of multi-level capacity development, and (2) the need for complementary resources to scale up initial pilot projects. Two years into REMP, project officers noted the following:

> From the outset it was appreciated by all partners that the achievement of the project goals requires the full implementation of an ambitious program over an extended period of time. In participatory processes, especially those requiring substantial changes in the perception and behavior of a highly diverse group of individuals and institutions, it is generally understood that 10-15 years of sustained effort are needed before the program can be fully taken over by the implementing partners.

REMP: Phasing out the project

When the project learned that it would be finishing after only the first phase, it conducted additional self-evaluations. It identified the following achievements in addition to those already reported in earlier evaluations:

- dozens of district staff trained on computers

- gender development strategy operationalized

- leadership courses at district and village levels progressing

- hand pumps delivered; organic farming training at agricultural university; scaling up traditional pesticide methods; marketing training; fruit and vegetable

production training; 4,000 chickens vaccinated and villagers trained to purchase, store, distribute and administer the vaccine; bee-keeping cooperative established and honey production up

- conflict-resolution platforms established
- district-wide communications improved

The evaluations also listed several persistent constraints:

- some villagers skeptical of chicken vaccine
- unreliable honey market
- slow progress on fish nets
- some claim bad relations developing between pilot and non-pilot villages due to the new rules about protected-area boundaries
- poor reviews of study tours (no knowledge-dissemination workshops held by those village representatives who participated in the tours)

Furthermore, the REMP chief technical officer exhibited frustration with the district leadership for not taking the environmental management plan seriously, not compromising, and being narrow minded about resource use in the district. However, while he claimed that, "In general, REMP staff has had to continuously coax, hassle, enthuse, push and pull to get things done," it was reported that there the project was making incremental progress in developing district-level capacity and facilitating networking across different levels of leadership in the district.

It was also observed that there was some interest by non-pilot villages in how to emulate the activities in the pilot village—a promising sign given that REMP was preparing its exit strategy at the time.

In planning to transfer ownership of the project to district officers, REMP lined up final investments in transportation and office equipment, and an expanded solar system to ensure reliable power supply into the future.

REMP evaluations and my dissertation results

The evaluations focused a lot on (1) the capacity of the district to coordinate policy across different levels of society, (2) the leadership potential of the village governments, and (3) the importance of complementary capital in order to ensure that initial project interventions would be scaled up and carried on into the future (this third focus became especially emphatic after the project became aware that it would be phased out prematurely).

I reported results that emphasized the importance of cross-scale policy coherence in order to foster positive synergies with respect to conservation and livelihood development processes. There were no glaring inconsistencies between what my empirical work demonstrated and what the project evaluation reported, but some areas of potential confusion.

The results of my research supported the initial positive reviews by the project of the effectiveness of the village environmental management plan in the Project Village.

I also found that one of the most lasting positive influences of REMP was something that it had begun to recognize, itself, only when it was planning its exit strategy: improved capacity at the district level and improved networks between district officers and village leaders. Less tangible than infrastructure improvements or scaled-up livelihood activities, improvements in social capital lay the potential for future cooperation in conservation and development initiatives. This outcome should be regarded highly.

The project was immediately aware of the need for long-term financial support in order to ensure the adoption of both the village environmental management plans and the "wise-use" livelihood activities. It would have been helpful to understand *how* such sustained resources would be put to use in the livelihood projects. REMP made it sound like *sustained* funding would be required to subsidize the adoption of new off-farm livelihood activities over the long-run, while I reported that the potential to scale up new off-farm livelihood options appeared to be limited by a lack of large-scale public infrastructure, not a lack of sustained subsidization. This is because I assumed that if the potential benefits of such activities were experienced by villagers (through, say, improved market activity), then positive feedbacks could be developed and the new activities would be perceived as profitable, instead of high-risk, investments. In this sense, long-term financial support wouldn't be necessary. The questions of large-scale public investments appeared to be lacking in the REMP reports—however, it is likely that they would have been proposed later into the life of the project (i.e., if it had been extended beyond the initial phase).