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DOI: 10.1111/j.1475-4959.2009.00343.x

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Double exposure in Mozambique's Limpopo River Basin

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This paper was accepted for publication in September 2009

This paper examines how double exposure to economic and environmental stressors – and the interaction between the two – affect smallholder farmers in Mozambique's Limpopo River Basin. Studying two case study villages we find that people, in general, are resilient to environmental stressors. However, most households show less resilience to the socioeconomic stressors and shocks that have been introduced or intensified by economic globalisation. Our findings indicate that economic change brought about by structural adjustment policies pressures rural people to alter their approach to farming, which makes it more difficult for them to respond to environmental change. For example, smallholder farmers find it difficult to make a transition to commercial farming within the Limpopo Basin, in part because farming techniques that are well adapted to managing environmental variability in the region – such as seeding many small plots – are not well suited to the economies of scale needed for profitable commercial agriculture. People use a variety of strategies to cope with interactive environmental and economic stressors and shocks, but many face considerable constraints to profitably exploiting market-based opportunities. We conclude that economic stressors and shocks may now be causing small-scale agriculture to be less well adapted to ecological and climate variability, making smallholders more vulnerable to future climate change. Some local level policy interventions, including those that support and build on local environmental knowledge, could assist rural agricultural societies in adapting to future environmental change in the context of economic globalisation.

KEY WORDS: Mozambique, economic globalisation, environmental change, risk, vulnerability

Introduction

Interactions between economic and environmental change shape local landscapes of vulnerability. The ways in which people in developing countries shift between different sources of food and income in response to environmental change are relatively well documented (Eakin 2005; Eriksen *et al.* 2005; Glantz 1994; Davies 1993; Corbett 1988). Geographers have also studied climate and other environmental conditions as possible factors influencing economic

development at the regional and national scales (Silva 2007; Escobal and Torero 2005; Moseley 2005; Bebbington and Perreault 1999; Diamond 1999; Dorsey 1999; Bloom and Sachs 1998; Liverman 1990). However, a major challenge to understanding vulnerability involves identifying how economic and environmental processes interact in particular places – what Leichenko and O'Brien (2008) refer to as double exposure – and how these interactions shape the effects of some global change processes and drive others.

Table 1 Environmental, economic, and political events in Mozambique (1977–2001)

Year	Extreme environmental event	Economic event	Political event
1977–8	Floods (worst floods in living memory prior to 2000)	Centrally planned economy implemented by socialist government (1975) calls for people to relocate from dispersed homesteads to communal villages. Prior to flood, move to communal villages is resisted by majority of rural people	People relocated from dispersed homesteads to socialist communal villages in order to access government relief services
1980–4	Severe drought	Faced with widespread crop failures and empty state-run shops, rural people increasingly turn to the black market to cope with drought	Socialist government is unable to enforce restrictions on informal economic activities. Fourth Frelimo Conference (1983) relaxed bans on informal market transactions
1986–7	Severe drought	Use of informal market activities increase as agricultural households struggle to cope with drought	Government of Mozambique shifts from centrally planned economy and embarks on structural adjustment programme to liberalise the economy (1987)
1991–2	Severe drought	Economic hardship in countryside limits the government's availability to put down rebel activity. Cattle stocks are extremely low. People are unable to farm due to drought and war	Peace accord signed in 1992 ending 17-year civil war. NGOs able to provide emergency relief to drought-stricken areas
2000–1	Floods (worst floods in 150 years)	Cattle numbers, which are recovering after the civil war's end, are decimated by floods. Widespread loss of household assets and many people are forced to evacuate their homesteads	Government appeals for international assistance. Emergency funds are used to rehabilitate transportation networks and other physical infrastructure

Sources: Hall and Young (1997) and INGC/UEM/FEWS NET/MIND (2003)

An examination of the dynamic interaction between environmental stress and economic change is particularly relevant for southern Africa as it (1) is characterised by high levels of both poverty and environmental variability, (2) is becoming increasingly integrated into the global economy via export-oriented development strategies, and (3) has been identified as one of the most vulnerable regions to climate change in the world (Boko *et al.* 2007; Dicken 2007; Alden 2007; Silva 2007 2008; Parry *et al.* 2007; O'Brien and Vogel 2003; Leichenko and O'Brien 2002; Mohan *et al.* 2000; O'Brien and Leichenko 2000). Examining the effects of environmental stress on farmers during periods of economic restructuring may lead to important insights on how individuals, households, and regions become more or less vulnerable over time.

As in many other countries in southern Africa, economic and political reforms in Mozambique are taking place during a period of consecutive floods and

droughts (see Table 1)¹. Arguably the most environmentally risk-prone region in Mozambique is its portion of the Limpopo River Basin. Environmental hazards such as flooding, droughts, and cyclones commonly affect this area of the country. Several factors also make the Basin highly exposed to risks associated with economic globalisation. The Basin has a long history of cash crop production due, in part, to a 30 km irrigation scheme built along the Limpopo River by the former Portuguese colonial government in the early 1950s. Cash crop farmers in the region face economic risks associated with structural adjustment, such as lack of access to agricultural inputs, inability to access regional and international markets, and changes in credit availability (Leichenko and O'Brien 2002; Sheldon 2002; Mittleman 2000).

This study expands on the work of Eriksen and Silva (2009), Leichenko and O'Brien (2002 2008), Eakin (2005), O'Brien and Leichenko (2000), and others by examining the effects and influences of simultaneous

and sequential processes of global change on farmers in southern Mozambique². Drawing from household survey data and ethnographic research, we examine the experiences of, and responses to, interacting processes of global change for inhabitants of Mozambique's Limpopo River Basin.

Literature review and conceptual framework

Within economic geography, studies that examine regional growth and uneven development draw on a wide base of economic theories and perspectives, such as neoclassical trade, export base, cumulative causation, and new economic geography, which suggest several possible interpretations for lagging regions and differential development between and within countries. However, most of these theories do not explicitly address the interactions between environmental risk and economic development. More recently, some empirical work has incorporated political ecological theories and applied the methodologies of economic geography to investigate the analytical significance of environmental phenomena for national and regional economies (Bridge 2002 2007; Gibbs 2006; Mansfield 2003).

Economic globalisation and uneven development

A growing body of literature within economic geography investigates the role of economic globalisation – and international trade in particular – in driving uneven development. Most of this work has been done on mature, post-industrial economies (Breau and Rigby 2008; Breau 2007; Leichenko and Silva 2004; Silva and Leichenko 2004; Edin *et al.* 2004; Galiani and Sanguinetti 2003). A growing body of literature looks at trade's effects on uneven development in transitional economies such as China (Amiti and Smarzynska Javorcik 2008; Lemoine and Unal-Kesenci 2004; Ying 1999; Fan 1992), India (Chamargwala 2006; Debaere 2004; Rajan and Sen 2002), Brazil (Reza Arabshabani *et al.* 2006; Haddad *et al.* 2002; Rodríguez-Pose and Arbix 2001; Ó Huallacháin and Wasserman 1999), and Mexico (Aguayo-Tellez 2006; Sánchez-Reaza and Rodríguez-Pose 2002; Feenstra and Hanson 1996). To a much lesser extent, economic globalisation's impact on differential growth has also been studied in sub-Saharan African countries (Silva 2007 2008; Murphy 2002 2003 2006; Moseley 2005 2008a 2008b; Katz 2004; Grant and Agnew 1996). In general, these studies find that social and economic inequality is increasing, but the magnitude of globalisation's contribution to regional uneven development is debated.

The work described above offers many insights on the relationship between economic globalisation – particularly as measured by international trade – and

uneven development. However, the inclusion of environmental issues in the debate has been somewhat limited (Dicken 2004). The agrarian change and political ecology literatures have noted that rural communities are increasingly under pressure from both biophysical and economic changes. Some research has addressed the effects of economic transition on resource access in emerging economies, investigating how the transition to predominantly commercial activities affects nonmonetary elements of life, including social structures, gender relations, and the environment (Katz 2004; Carney 2001; Schroeder 1999; Watts 1983). Other studies have examined the ways in which environmental factors can shape the political, social, and economic facets of life (Moseley 2008a; Schipper and Pelling 2006; Eakin 2005; Robbins 2004; Zimmerer and Bassett 2003; Wilbanks and Kates 1999; Blaikie and Brookfield 1987).

Bringing the environment into economic geography

The core of economic geography research has not really engaged with questions of environmental change and environmental policy nor has it investigated the environmental outcomes of economic processes (Bridge 2002). A recent body of work – environmental economic geography – has emerged which incorporates theories and methods used by economic geographers to investigate environmental questions. This growing body of literature, which draws on a wide range of theories including regulation theory, ecological modernisation, and mainstream economics, calls for more investigation into the environmental outcomes of economic processes and the analytical significance of environmental phenomena for economies (Bridge 2002 2007; Gibbs 2006). This work has been especially important in highlighting the environmentally embedded character of economic activity. However, few studies to date investigate the environmental constraints on, and impacts of, new development strategies (see Eakin and Luers 2006; Gibbs 2003).

In general, economic geographers examining globalisation and environmental change have not explicitly related their work to issues of vulnerability. Yet the concept of vulnerability has been increasingly used as a means of gauging the harm that negative shocks can have on communities, households, and individuals (Berkes 2007; O'Brien *et al.* 2004; Adger *et al.* 2003; Forsyth 2003; Adger 1999; Watts and Bohle 1993; Sen 1981). Vulnerability, in the context of this study, is a function of the characteristics of persons or groups that influence their capacity to anticipate, cope with, resist, and recover from the impacts of change (Vogel 1998). Much of the vulnerability literature has its roots in theories of political economy that attempt to explain how and why some individuals experience

negative outcomes from global change and shocks while others do not (Kirby 2006; Sen 1981 1999). The theoretical claim of Sen (1981) that vulnerability to environmental events can have non-environmental causes (e.g. poverty, social exclusion, etc.) has greatly shaped concepts of social vulnerability (Adger *et al.* 2003; Adger 1999).

Recent studies have noted that vulnerability can be the result of several stressors – including environmental and socioeconomic processes – operating together in an interactive manner (Füssel 2007; Tschakert 2007; Schipper and Pelling 2006; Eakin 2005; Leichenko and O'Brien 2002 2008; Reid and Vogel 2006; O'Brien *et al.* 2004; Turner *et al.* 2003; O'Brien and Leichenko 2000; Watts and Bohle 1993). Rural agriculturalists in developing countries tend to be exposed to high levels of both environmental and economic stressors and shocks, including climate variability, the lack of formal insurance mechanisms, poor transportation networks, and limited access to markets, price information, credit, and climate forecasts (Leichenko and O'Brien 2002; Scoones 1996). The complex relationship between economic and environmental processes has been shown to create risks for subsistence and small-scale farmers, for example in Mexico (Eakin 2005 2006) and in South Africa (Ziervogel *et al.* 2006). The synergies between global economic and political changes and environmental risk affect the resiliency of some populations in the developing world, and can contribute to their continued poverty.

The double exposure framework

The double exposure framework provides a useful way to examine the multiple and overlapping processes of global change and, in particular, the places and ways in which the economic and the non-economic interact. Double exposure acts as a metaphor for cases in which particular localities, social groups, or individuals are simultaneously and sequentially exposed to different processes of global change (O'Brien and Leichenko 2000 2008). However, double exposure is more than just the fact of multiple processes happening in the same place at the same time. It is rather that the processes interact and, in doing so, influence the exposure and capacity of people and places to respond to a wide array of stressors and shocks in a way that then creates new contexts for experiencing and responding to change. Pathways to increased vulnerability (or enhanced resilience) are multidirectional, so that socioeconomic conditions may mediate the impacts of environmental change, but changing environmental conditions may also alter socioeconomic capacities to maintain particular livelihood strategies.

The double exposure framework conceptualises the distributional effects of global change processes over different spatial scales and reveals feedbacks and synergies between different processes, including the socially constructed aspects of vulnerability (Leichenko and O'Brien 2008). Thus this framework offers a way of analysing the interactions between economic and environmental processes within a specific locality, while also accounting for other contextual factors that can shape rural vulnerability as well as impact ongoing processes of global change. By emphasising the importance of contextual conditions in understanding vulnerability, the double exposure framework facilitates an examination of the different ways vulnerability may accumulate or recede in certain places.

Research questions and design

Using a double exposure framework, this paper investigates how simultaneous exposure to economic and environmental stressors and shocks affects the livelihoods of rural households and farmers. Drawing on research in Mozambique's portion of the Limpopo River Basin, the article investigates two specific research questions: (1) What economic and environmental stressors and shocks interact in rural areas of the Limpopo River Basin? (2) How do these processes and their interactions affect individual and household vulnerability?

The selection of Mozambique's Limpopo River Basin (see Figure 1) as the area for this analysis involved the construction of physical and economic profiles of the region to identify areas with a high likelihood of exposure to environmental and economic stressors. Mozambique's National Directorate of Geography and Cadastre (DINAGECA) provided all base topographic and land use/land cover data (DINAGECA 1999). The Mozambican National Institute of Statistics (INE) and the Mozambican Ministry of Agriculture and Rural Development (MADER) provided the social, demographic and economic data used (INE 1998 1999; INE/MADER 2001; MADER 2002).

After identifying the Limpopo Basin as our case study region, we then selected two case study villages – Matidze and Massavasse – that face high exposure to environmental and economic stressors (see Figure 2). Interviews with Mozambican academic researchers, government policymakers, and other key informants guided the selection process. We also conducted preliminary research in potential case study sites to meet with district and village-level officials. This allowed us to select two sites that were appropriate case studies for our research (i.e. two areas that face high exposure to external stressors while demonstrating varying levels of market access and market

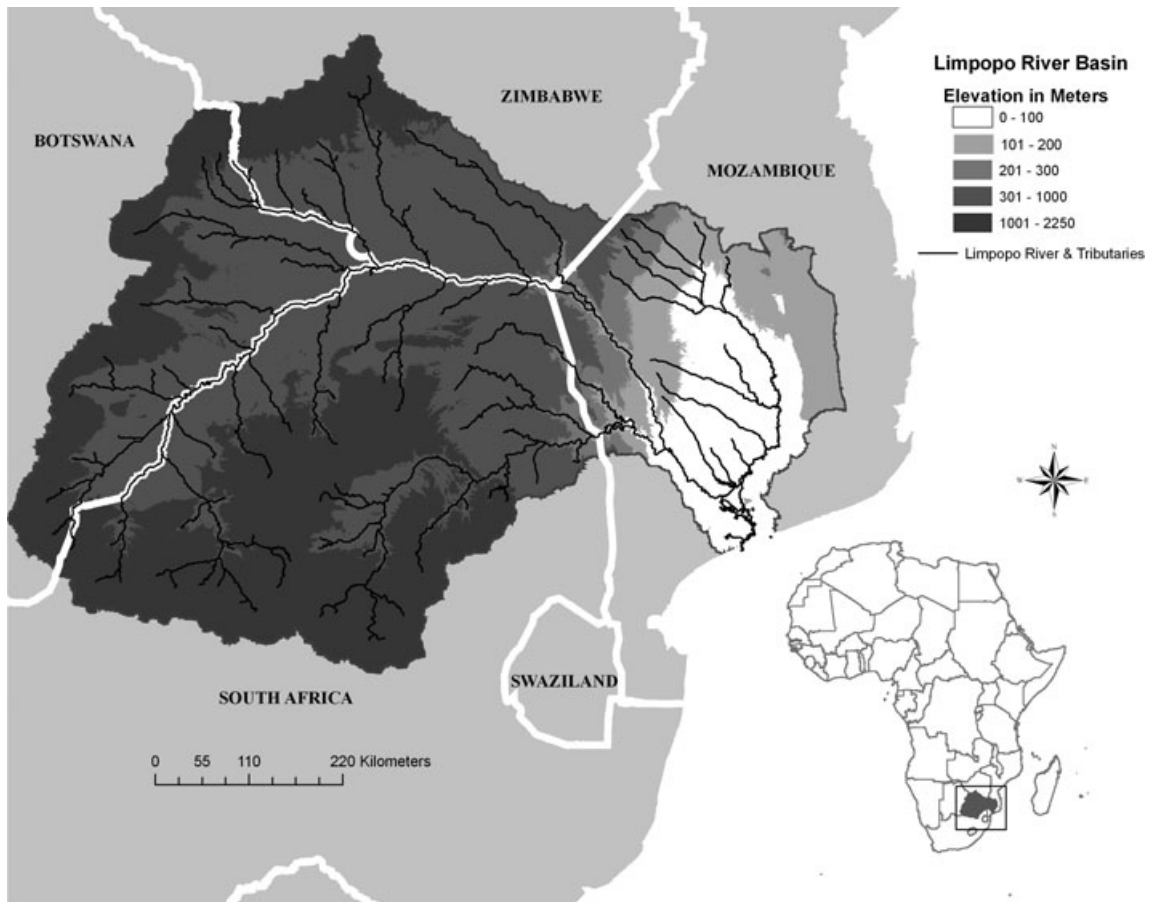


Figure 1 Map of Limpopo River Basin

connectivity) and that also showed the most interest in participating in the study. Studying these villages enabled a comparison between a community with relatively good market access (Massavasse) and another that is considerably more isolated (Matidze).

The first round of surveys and interviews was conducted in the summer of 2002. Using a random systematic procedure, the survey sample was selected from lists of households provided by the village authorities³. The male or female heads of 63 households were interviewed (30 in Matidze and 33 in Massavasse). The household questionnaire yielded quantitative and qualitative information which included household livelihood portfolios and risk-mitigating strategies. The survey included an open-ended qualitative component addressing perceptions of risk and household activity preferences. Respondents identified strategies used to smooth income and consumption in times of environmental stress (e.g.

floods and droughts), as well as types of market participation undertaken in response to economic restructuring (e.g. privatisation of state enterprises and the elimination of government subsidies for agricultural inputs). In addition to the household surveys, the authors also conducted three focus groups and 12 key informant interviews in the two villages to capture a broader spectrum of opinions on the effects of environmental and economic stressors on rural livelihoods.

In the final phase of the analysis, 20 follow-up interviews were carried out in June 2003 (10 in Matidze and 10 in Massavasse) in order to investigate in depth how people participated in certain livelihood activities, particularly commercial agriculture, petty trade, and charcoal production. These interviews allowed us to further investigate activities that were identified from the analysis of survey data as growing in popularity. We also conducted follow-ups with the

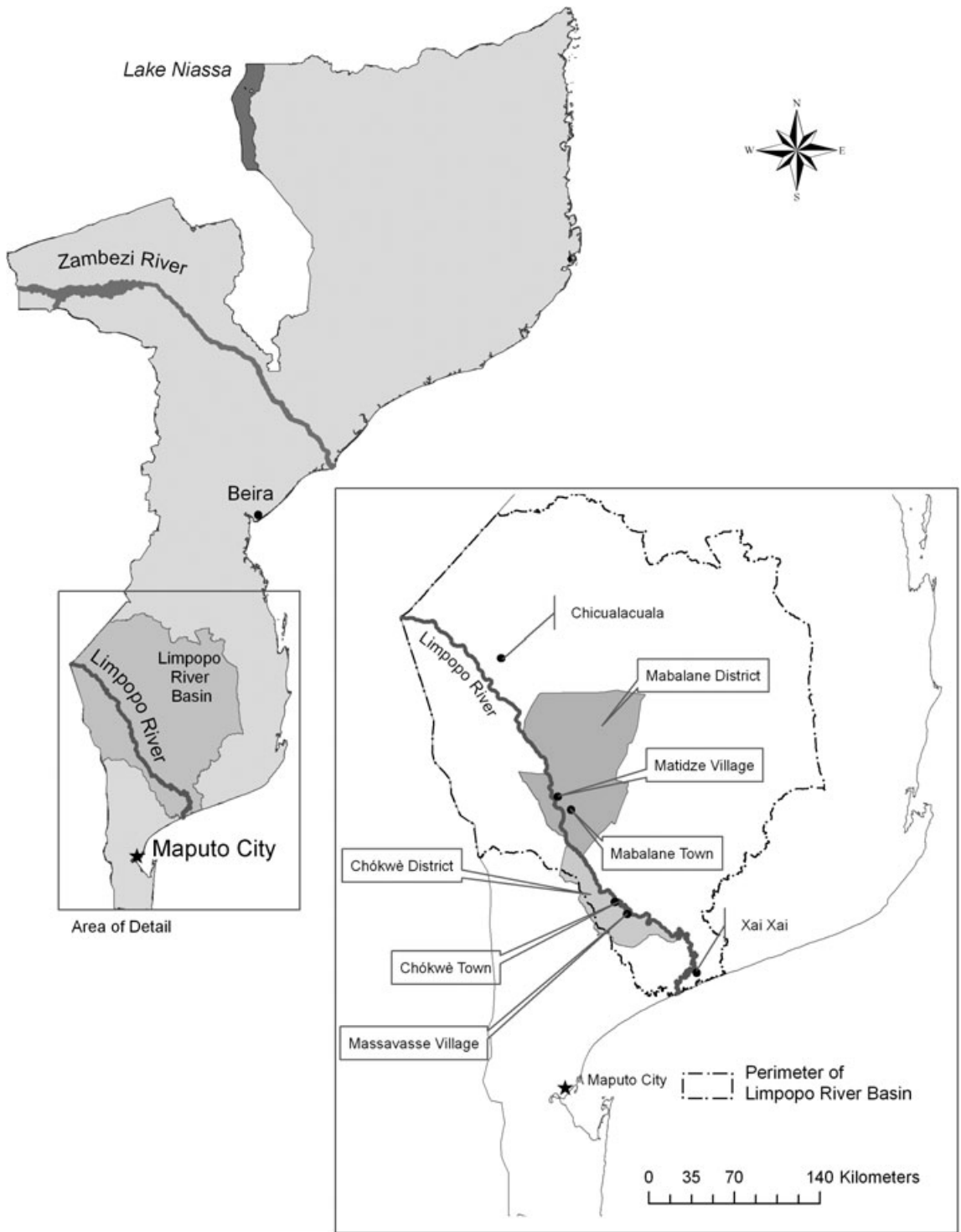


Figure 2 Map of case study villages

focus groups and key informants interviewed in the previous year.

The case study area

The Limpopo River Basin, located in southern Africa, covers 1.3% of the continent (over 400 000 km²). The Basin falls within South Africa, Botswana, Zimbabwe, and Mozambique (see Figure 1). The changes in elevation along the Limpopo River and its major tributary, the Elefantes River, make Mozambique's portion of the Basin particularly vulnerable to flooding. In South Africa, the river's headwaters start 1000 m above sea level, but the river drops sharply to 200 m before entering Mozambique. After another sharp descent just past the Mozambican border, the river flows the final 400 km to the Indian Ocean at elevations of less than 100 m. From Chókwe to the river mouth (a distance of 175 km), the river is less than 7 m above sea level. The Elefantes River also has a very steep drop in elevation over its course (from 1500 m in South Africa to 80 m just past the Mozambican border). The tributaries feeding the Limpopo and Elefantes Rivers have been extensively dammed within South Africa, and the opening of these dams during heavy rains has contributed to devastating floods in Mozambique (Christie and Hanlon 2001). In addition, tropical cyclones originating from the Southwest Indian Ocean Basin hit Mozambique at an average of once a year, and lesser magnitude tropical disturbances typically hit three or four times a year (INGC/UEM/FEWS NET/MIND 2003).

The rainfall regime in southern Africa, including Mozambique, is characterised by high variability both within seasons and from year to year, making it one of the most drought-prone regions in the world (Hulme *et al.* 2001; Dilley 2000). The average annual rainfall in the Limpopo Basin in Mozambique is less than 500 mm each year, but year to year variability is high (INGC/UEM/FEWS NET/MIND 2003). For the Massavasse study area, based on rainfall data for a 0.5 × 0.5 degree grid covering Massavasse, the mean rainy season rainfall between 1961 and 1990 was 574 mm. For the Matidze study area, based on rainfall data for a 0.5 × 0.5 degree grid covering Matidze, the mean rainy season rainfall in that period was 487 mm (Eriksen and Silva 2009), but there is great variation in rainfall from year to year in both sites. The Basin experienced devastating floods in 2000. Severe droughts appear to occur about every 7–11 years, and there is some evidence that a relationship exists between the El Niño-Southern Oscillation signal and drought in southern Africa (Nicholson and Selato 2000; Nicholson 2001). Less severe droughts also occur often across the region.

In Mozambique, the Basin is among the most chronically food-deficient parts of the country, as well

as the most prone to floods and droughts (INGC/UEM/FEWS NET/MIND 2003). The medium to high soil water holding capacity contributes to poor drainage that can lead to low crop yields and increased susceptibility of crops to diseases. In addition, the poor water quality of the Basin aquifers (due to minerals and salts eroded from the upper reaches of the Basin) limit the degree to which they can be exploited for human development. Disease burdens also pose a serious problem for the region. For example, HIV/AIDS infection rates in the Limpopo Basin are among the highest in Mozambique (INE/MISAU/DHS 2005).

According to the 2007 Population and Housing Census, over 1.1 million people live in Mozambique's Limpopo Basin (INE 2008). Much of the population is concentrated in the south of the Basin, where the transportation network and accessibility to Maputo and other major markets are highest. The Changana people are the dominant ethnic group living in the region and account for the majority of the population and Xichangana is the most spoken language. Changana settlement in the area dates back to the late 1700s, when the Zulu Empire expanded beyond the borders of South Africa and Bantu people migrated from other parts of southern Africa to escape severe drought (Liesegang 1986). Changana society is patrilineal (i.e. inheritance and land tenure moves through the male line) and patrilocal (i.e. a wife moves to her husband's village). Decision making is mainly done by men, although widespread male migration has led to high levels of female economic and political participation in the public realm (Ombe 2006; Waterhouse and Vijfhuizen 2001; Feliciano 1998). In the nineteenth century, migration started from southern Mozambique to the mines of South Africa and Rhodesia (Rita-Ferreira 1963). Migrant workers would often transport goods with them when they returned home, thus southern households were linked to the cash economy earlier than rural households in the north and central regions of Mozambique.

Rapid economic change in Mozambique has affected the region's inhabitants. During the period of 1975–2003, the country went from being governed by a colonialist government, to being a centrally planned economy, to adopting a capitalist economic system, enduring a 17-year civil war along the way⁴. The liberalisation of the economy had many effects on rural livelihoods in the Limpopo Basin (Eriksen *et al.* 2002; Sheldon 2002; Mittleman 2000). First, the government lost the ability to subsidise agricultural production, leading to higher costs for farmers. Second, reductions in government jobs led to high unemployment, which decreased the ability of urban people to send support to their relatives in the countryside. Formal sector employment was particularly reduced by structural adjustment. A recent study by the Mozambican National Statistics Institute estimates

that 87% of the economically active population (approximately 14 million people) is employed in the informal sector (INE 2008). Third, high inflation eroded rural incomes. Finally, farmers had difficulty buying sufficient quantities of seeds, both due to lowered incomes and lack of supply to rural areas. Thus, the implementation of economic reforms in Mozambique was followed by a decrease in living standards for many rural people (Sheldon 2002; Abrahamsson and Nilsson 1995).

As previously mentioned, research for the study took place in Matidze in Mabalane District and Massavasse in Chókwè District. Massavasse is located 14 km from Chókwè, the capital city of Chókwè District, which functions as the economic capital of the Basin and is linked via a paved road to Maputo. The majority of the distance between Massavasse and Chókwè can also be covered on the paved road. Matidze is located approximately 25 km from Mabalane, the capital city of Mabalane District, via a dirt road that can only be used by vehicles during the dry season.

Both villages are located close to the Limpopo River: Matidze is 0.5 km away and Massavasse is 4 km away. Matidze was created in 1977 when the government relocated rural households into communal villages in response to flooding, as well as an attempt to provide better security to rural inhabitants during the country's civil war. The government also pursued the policy of creating villages because they believed it would be easier to supply rural people with education and health services if they were living together in communities (Bowen 2000). At the time that this research was conducted, Matidze had 192 households. Massavasse village dates back to the Portuguese colonial period when the Portuguese constructed the Chókwè irrigation scheme in the 1950s. Mozambicans moved into the cement houses abandoned by the Portuguese settlers after the country gained its independence in 1975. The town quickly expanded to include houses made of traditional materials (e.g. wood, reeds, and mud). Massavasse had 795 households in 2002.

Figures 3 and 4 illustrate the village settings of Matidze and Massavasse, respectively. Three key dis-



Figure 3 Illustration of Matidze Village

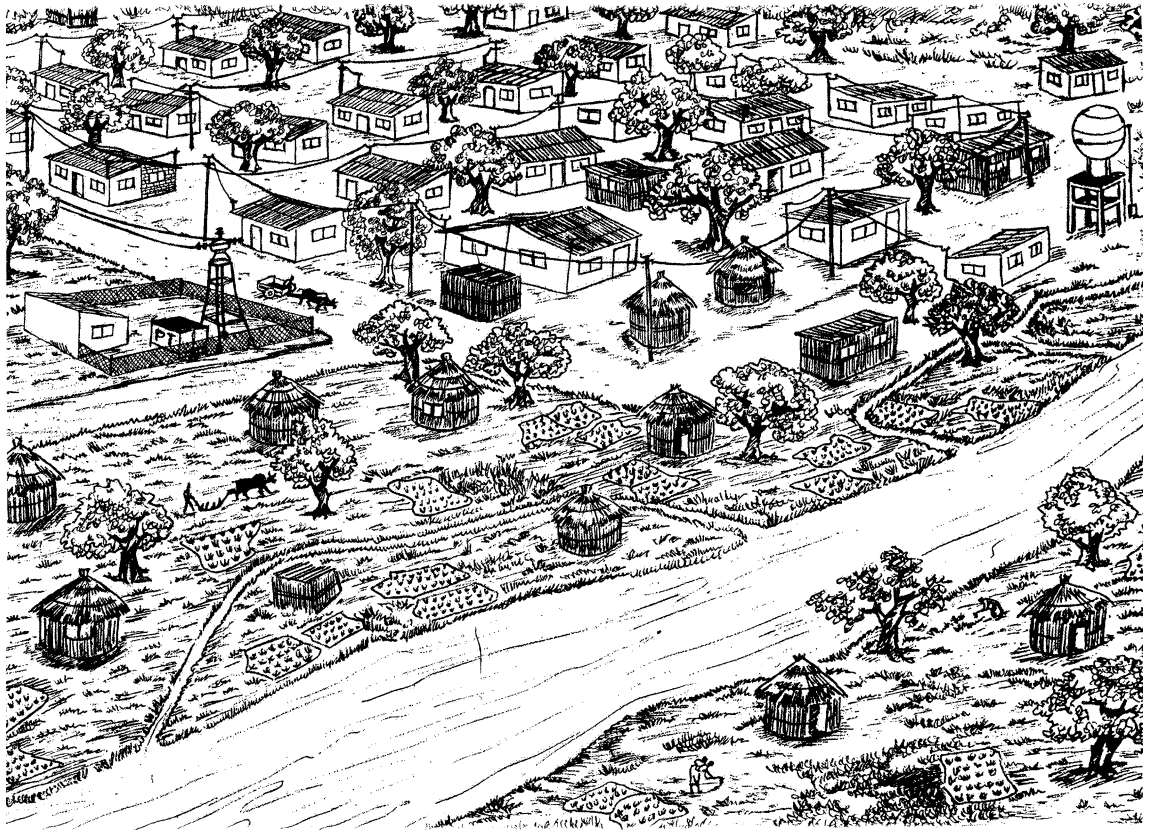


Figure 4 Illustration of Massavasse Village

inctions are easily apparent between the two villages. First, Massavasse is located near an irrigation canal and some agricultural plots are located close to houses. In Matidze, livestock (and pasture for grazing) is more abundant and there is closer access to the river. Second, the level of physical infrastructure – including roads, electricity pylons and cables, and conventionally built housing with brick walls and tin roofs – is much higher in Massavasse. Third, inequality of households – in terms of construction materials and the condition of housing structures – is visually apparent in Massavasse but absent in Matidze. The differences between the two villages seen in the illustrations may be a function of varying levels of economic connectivity, with Massavasse having much better access to markets. But as the following section will show, residents of both communities are integrating into the cash economy (albeit at different speeds) and changing the way they use their environment as a response to economic shocks and stressors.

Study results

Rural livelihoods and differential vulnerability

The majority of people surveyed for this study could be classified as small-scale farmers⁵. Out of 63 surveyed households only two did not fall into the small-scale category; one farmed more than 5 ha and another household did not farm any land at all. In rural areas of Mozambique farm size averages 2.4 ha per household (INGC/UEM/FEWS NET/MIND 2003). In Massavasse that figure was 2.2 ha per household. Although exact figures for area under cultivation were not available for Matidze, Mabalane District (where Matidze is located) averages 2.3 ha per household. However, it is important to note that the area under cultivation in some regions is often not continuous, but rather consists of several plots, sometimes located several kilometres apart. For example, Matidze households farmed an average of 3.2 plots, and all survey respondents reporting that they farmed in both upland

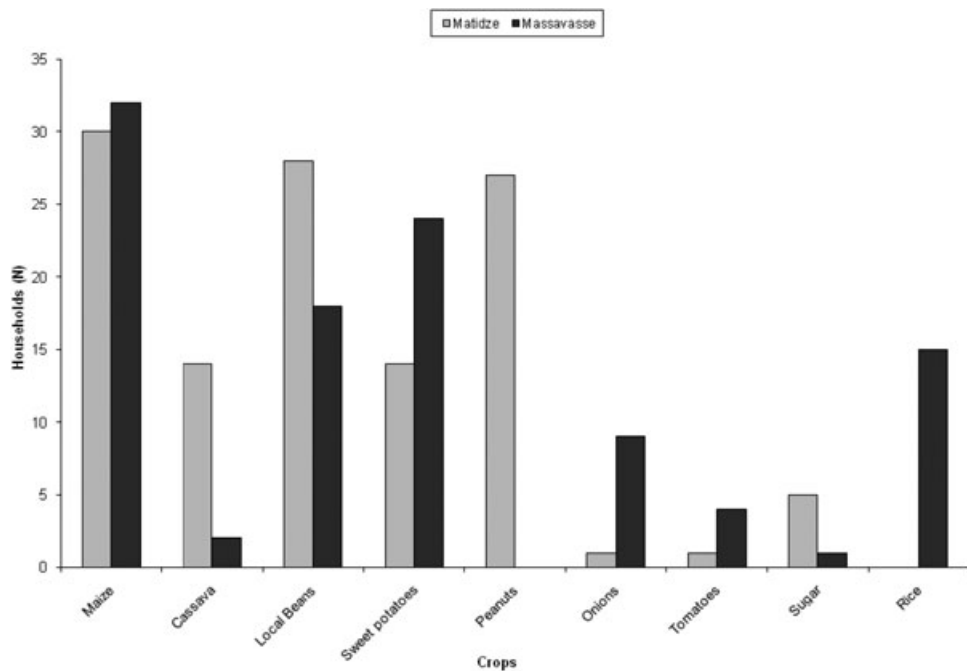


Figure 5 Crops grown in case study villages (2002)

and lowland areas. In contrast, Massavasse households averaged 1.3 plots per household and none reported farming an upland area (although eight households had multiple low-lying plots). Over 80% of Massavasse households surveyed had land in the irrigation scheme. The majority of these farmers (60%) did not cultivate any unirrigated land.

Survey results show that the inhabitants of Matidze and Massavasse have primarily agricultural livelihoods. According to survey results, the most important source of food was subsistence agriculture (98%). However, all farming households surveyed could be defined as capital poor, in that they farmed using very labour-intensive techniques because they lacked equipment and technology to do otherwise. For the most part, the people living in our case study sites did not have access to sufficient infrastructure, credit, farming inputs, or other factors that would help them increase the scale of their farming enterprise. Although over half of those interviewed said that they could get access to more farm land if they wished (57% and 46% for Matidze and Massavasse, respectively), almost 80% of respondents said they lacked the labour as well as the financial and/or physical capital to farm more land.

The majority of households in each village grew maize, the staple food of the area (100% and 97% in Matidze and Massavasse, respectively). Still, local

variations in soil conditions and water availability account for different types of crop specialisation in villages, particularly among cash crops. As shown in Figure 5, peanuts were a popular cash crop in Matidze, but no households in Massavasse grew them. Meanwhile rice was a popular cash crop in Massavasse, where farmers had access to irrigation, but not in Matidze. A few households in each village reported growing vegetable crops, which they reported selling in domestic markets.

The production of rice versus peanuts was a key distinction between Massavasse and Matidze with regards to market participation. Most households that produced rice did so under contract with private sector exporting firms. They reported buying seeds on credit and allocated less family labour to the production of other food crops. In contrast, peanut farmers in Matidze used saved seed or seed sourced through informal networks. Peanuts were not exported, but rather sold at local and regional markets. Since peanuts do not require sophisticated processing, people reported that they would eat or gift what they could not sell. Rice farming offers higher possible returns than peanut farming, but also higher risks (due to the need to repay the cost of seeds even if the crop fails). Rice farming also revealed household differentiation within Massavasse. Access to the irrigation scheme makes rice possible for some farmers in

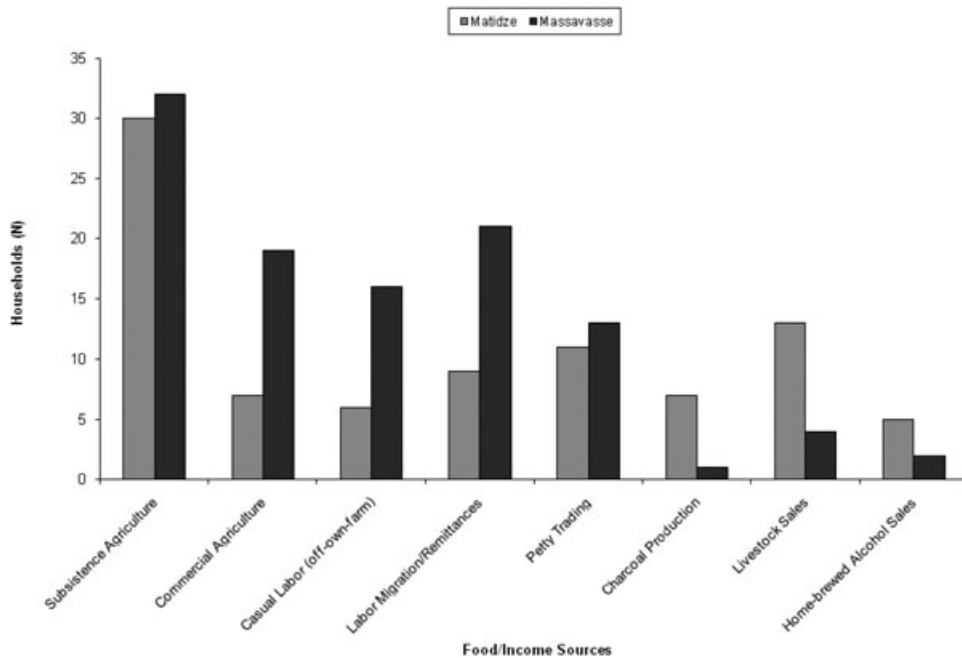


Figure 6 Food and income sources in case study villages (2002)

Massavasse, but not all. Some farmers who did not produce rice said they were unable to get credit from private firms because they had defaulted in a previous year. Another farmer said she was unable to negotiate a contract because she was a woman, and the private companies did not like to give female-headed households credit.

Despite the strong focus on subsistence farming, the survey results also show that households in both communities use a range of other income sources. Figure 6 illustrates that some sources were more popular than others, and there were notable differences between the villages. For example, livestock sales were a popular income-generating strategy in Matidze in September 2002, with 43% of households participating in this strategy. In contrast, only 6% of surveyed households in Massavasse reported selling livestock during this time period. Casual labour on commercial farms was a common market-based coping mechanism in Massavasse where 49% of survey respondents said a member of their household participated in this activity. Survey respondents and key informants said most casual labourers were hired at very low rates on commercial farms on a first-come first-served basis every morning. Working as a casual farm labourer was rarer in Matidze, with only 20% of surveyed households reported engaging in this activity. Several Matidze respondents who did not

perform casual labour said there were very limited opportunities to get this type of employment since there were only a few, relatively small, commercial farms in the area. Remittances played an important role in both villages. In Matidze, 14% of households reported that a male family member had migrated in order to look for casual or permanent work. In Massavasse too, 24% of households had male family members working abroad – mainly in South Africa – and sending back remittances to their families more or less regularly⁶.

Our fieldwork results suggest that the majority of households in both villages had managed to engage in some type of commercial activity and 55% of survey respondents said they received some type of economic benefit. Certain types of smallholder farmers – in addition to some of the larger-scale commercial farmers operating in Massavasse – had been able to succeed in the new and changing environments. For example, one older farmer in Matidze described himself as doing well under the new economic system. While this farmer uses mostly traditional methods, he had begun using a cell phone to help him set prices on his surplus produce. He described cell phones as a technology that is appropriate to his local circumstances. Another successful farmer had adapted to economic circumstances by raising small livestock like guinea fowl. He explained that these

animals are easier to raise than large livestock in times of drought because they eat less. They also produce meat that is affordable to the working poor.

But even among people who said they benefited economically, the results of market engagement were complex. For example, one survey respondent – physically disabled because of a land mine explosion – had traded hand woven reed mats in exchange for help in farming his fields prior to market liberalisation. He said that although the river reeds necessary for making these mats were freely available to everyone in the village, people would get some of their mats from him so their help on his farm was not just a matter of charity. After market liberalisation the survey respondent was able to sell as many hand woven mats as he could make to regional traders who then resold these mats in urban centres where people do not have access to river weeds. The mat maker said his income had increased. But he said people were no longer willing to help him in exchange for mats since they saw he had a cash income. He now had to pay farmhands for assistance, which left him with little money left over. He said he now had to make many more mats to get the same level of farming assistance than when he was simply trading mats individually with local villagers.

Shocks, stressors, and risk

Farmers identified various stressors and shocks that affected their day-to-day livelihoods. With regards to the environment, all survey respondents reported that these villages frequently experience adverse and severe weather events, such as droughts and floods. All survey respondents identified the 2002–3 drought (ongoing at the time of the study) as a stressor but many households also described the drought as 'typical' or 'moderate', as opposed to severe droughts that occurred in the 1980s and early 1990s. This is consistent with observations of the variations in rainy season rainfall over the past century (Eriksen and Silva 2009). Effects of the 2002–3 drought included crop damage (particularly for maize) and low stream flows in the Limpopo and Elefantes Rivers. Even farmers who had land in the Chókwe irrigation scheme reported that the below-average rainfall and low river levels in Gaza Province caused a shortage of water in the irrigation canals, leading to some crop failure even on irrigated land.

Many surveyed households said they were still recovering from the devastating floods of 2000. Both villages were impacted by the severe floods. However, the vulnerability to extreme weather is not equal along the Limpopo River (Brouwer and Nhassengo 2006; Christie and Hanlon 2001). For example, the different physical geography and political economies of the Matidze and Massavasse led to

differential effects of the 2000 flood. Matidze, which is 142 m above sea level, experienced fewer negative impacts from the floods than Massavasse, which is 29 m above sea level. Over 75% of Massavasse residents who were surveyed reported severe and widespread losses in terms of houses, livestock, and agricultural land. Although survey respondents could not give an exact number, they said many people from Massavasse were evacuated to emergency camps. In addition, many people from other areas who lost their homes and livestock were relocated to Massavasse in the aftermath of the floods. In contrast, no houses were reported lost by Matidze residents and they were never evacuated, although the floods did destroy some agricultural land and tools. On the other hand, Massavasse had benefited from post-flood reconstruction efforts, but Matidze had received no non-governmental or governmental assistance as of the time this research was conducted.

Climate change may also exacerbate current climatic stressors. Evidence suggests that variability and the intensity of extremes may be increasing in the region and projected changes in precipitation due to climate change will lead to a drying in the southern African region as well as possible increased risk of intense rainfall events and associated flooding (Parry *et al.* 2007; Tyson *et al.* 2002; Mason and Joubert 1997). Greater rainfall variability has the potential to affect rural inhabitants of the Basin severely because of the other environmental stressors present in the region. People in the region have also noted environmental changes and the increasing unpredictability of rains. For example, in interviews with the authors, inhabitants of Matidze mentioned the strange behaviour of fruit trees, saying that the flowering and fruiting of these trees are not following traditional cycles. Another key informant from one of the case study villages noted that wind patterns could no longer be reliably used to predict the coming of rain as they once had.

Economic shocks and stressors also affected households in both villages. Approximately 95% of those surveyed identified some aspect of economic restructuring policies as an ongoing problem for attaining food security and sustainable livelihoods.

The key issues named were: the elimination of government subsidies for social services and agricultural inputs; the elimination of state marketing boards; restrictions of livestock sales due to foot and mouth disease; the closure of state-run shops and other enterprises during privatisation (and the subsequent failure of the private sector to replace them); and the increasing difficulty in acquiring employment in Mozambique and South Africa.

All of the economic stressors and shocks associated with economic restructuring have made the produc-

tion of food crops for home consumption more difficult. For example, the lack of agricultural subsidies and local shops has resulted in scarcity of seeds and fertiliser for farmers. Thus households reported relying more on markets to acquire food since economic restructuring began in 1987. In addition, marketing boards had set minimum prices for products and often helped farmers get their products to market. Now farmers said they bore the entire cost of transporting goods to market, and that this considerably reduced their profits. Meanwhile, restrictions on the movement and sale of cattle due to outbreaks of foot and mouth disease have limited people's ability to trade and earn money. In particular, several Matidze households said the laws had dramatically decreased their food security during droughts.

Economic change has pushed people towards informal economic activities as privatisation policies have led to widespread job losses within state sector enterprises. One key informant noted that these jobs had not been replaced by the private sector, even though many state enterprises closed over 15 years ago. Research results indicated that formal employment is largely unavailable to rural households. For example, none of the households surveyed reporting having a member employed in the formal sector. Several people interviewed had previously been employed in state enterprises, such as the railroad or the irrigation management body. These individuals stated that they lost this employment in the late 1980s after Mozambique adopted its structural adjustment programme. In addition, people said that it was becoming rarer to have relatives working in cities such as Maputo. Traditionally, even having one family member formally employed in a city would mean enhanced food security for rural households. Remittance income has also become less secure mostly due to stricter South African immigration laws and decreasing job opportunities in the South African mines (Rolim *et al.* 2002; Feliciano 1998)⁷. The high cost of living in South Africa also affects the amount of remittances sent back to families in Mozambique.

A social element of market risk also exists. There is a cultural tendency among the Changana for people not to want to be different from others, in terms of livelihood practices and behaviour (Feliciano 1998). Moreover, in interviews with the authors, several Changana farmers described selling goods as cheating (i.e. making profit by charging others higher prices than you paid to grow or acquire the goods). Therefore early adopters of new market-based activities suffer. Many people who now make their living by growing and collecting things expressed the sentiment that market vendors are often socially stigmatised. One recurring complaint was the lack of respect given to them in the public market place. As one woman who

had recently begun selling vegetables in a small stall in Chókwè's informal market explained, 'people can treat you however they want'.

Economic restructuring and environmental vulnerability

Local-level evidence suggests that people, driven by economic needs in the aftermath of restructuring, have changed their approach to farming. Approximately 76% of all households said they had altered the way they farm (73% and 79% in Matidze and Massavasse, respectively) in order to try and increase their income. The two most common changes were to look for non-own-farm sources of income (76%) or to increase the production of crops to sell (24%). Almost all survey respondents said that turning to non-own-farm activities generally resulted in families having to decrease household agricultural production since there were fewer people or there was less time available to work on family plots. Among those households who switched focus to commercial crops, 100% said they had to decrease the number of crops previously cultivated by the household.

One effect of the income-generating strategies being employed by households in Massavasse and Matidze was that they often required farmers and farming households to alter or abandon traditional methods of environmental risk mitigation. The farming techniques that are well adapted to minimising environmental vulnerability are not well suited to commercial agriculture. For example, the common strategy of farmers in the Basin to seed several different small plots among high- and low-lying areas allows them to exploit different microclimates. This system is labour intensive but compatible with subsistence farming systems. However, the strategy is incompatible with commercial agriculture since it does not allow people to exploit economies of scale and produce goods for export. Thus commercial farmers, who farm fewer crops on larger plots, are more vulnerable to climate variability. This finding is consistent with observations of reduced flexibility and increased vulnerability to climatic stress among commercial farmers relative to small-scale farmers in both Mexico and South Africa (Eakin 2006; Ziervogel *et al.* 2006).

All rice farmers in Massavasse – 45% of all households surveyed in the village – told a similar story. They get their seeds on credit via contracts with private export firms who do not want to advance farmers' seeds in small quantities. Rather, the organisations push for high levels of production. So the rice farmers who participate in these contracts must cultivate larger tracts of land in order to plant all the seeds and maximise yields. In order to be efficient in terms of labour power and agricultural inputs, farmers said

they cannot use small, dispersed plots like subsistence farmers do. So, these commercial farmers said that they are more at risk of losing their crop if the rains do not come or if they are insufficient. If this happens, as it did during the 2002–3 drought, farmers risk becoming indebted to the organisation that provided them with seeds. This locks them into a cycle where they have to try and farm commercially again the following year, because they owe the organisation money. The constraints placed on agricultural practices by contract farming have also been noted elsewhere in Mozambique by Bowen *et al.* (2003).

While commercial activity among rural households is not new (Rolim *et al.* 2002), certain activities, like vegetable trading, were reportedly more common since the late 1980s. For example, 38% of surveyed households engaged in some form of petty trading, mainly of vegetables (37% and 39% in Matidze and Massavasse, respectively). Of those households, over three quarters of the survey respondents said this was a relatively new activity. One woman who lived in Massavasse said that the recent growth of Chókwe village since the 2000 floods had increased the market for vegetables. Thus she had decided to increase her household's production of tomatoes and sell them. In Matidze, many survey respondents and key informants spoke of the existence of intermediate traders – mainly women – who bartered maize for vegetables and would then resell the vegetables at regional markets. This gave households who could not afford to get their own products to market a way to sell vegetables.

Several issues hindered peoples' ability to earn cash income. The majority of survey respondents (87%) said they faced considerable constraints to engaging in market-based activities. Access to capital was one of the most important factors determining whether or not a household was able to engage in market-based activities. The two most successful farmers interviewed had both worked in the government sector prior to privatisation. They had used the money they received from their formal wages to invest in agriculture.

Access to capital was a critical influence on the choices of alternative sources of income made by the small- and medium-scale farmers during the drought. Several women described using remittances from husbands or sons as seed money to begin commercial vegetable trading, while others sold livestock or borrowed money from family members or other informal channels. While credit schemes had been in place for agricultural production in the past, only 18% of respondents reported having access to credit, and these were members of wealthier households.

Interestingly, the small-scale nature of production among most farmers in the Basin makes some common risks of trade liberalisation on developing

countries, such as fluctuations in world commodity markets and unfavourable terms of trade, not directly relevant to the livelihoods in the area since the majority of farmers did not produce for export markets⁸. However, there is some evidence of import competition. For example, vegetable growers reported having to compete with produce from capital-intensive commercial farms in South Africa. Several of the rice producers interviewed said they must compete with cheap Chinese imports of rice.

Conclusions

In Mozambique's Limpopo Basin, farmers operate under a great degree of environmental risk (e.g. exposure to floods, droughts, heavy winds, and soil erosion). In addition, economic reforms that encourage farmers to move from subsistence-based farming to commercial production have in some ways exacerbated the common environmental risks faced by farmers (e.g. climate variability) and have added a new element of risk as well (e.g. removal of agricultural subsidies and the difficulty or inability to gain access to regional or international markets). In particular, the need for cash income pushes farmers away from more resilient (but less profitable) agricultural strategies towards others that carry a greater degree of risk for capital-poor, small-scale farmers.

The overall environmental risks facing the two communities investigated in this study appears to be constant or, possibly, increasing, although evidence from this study suggests the nature of these risks is changing over time. Yet our findings agree with those of Brouwer and Nhasengo (2006) and Bowen *et al.* (2003) who find that people are resilient to climatic stressors (except the extreme events like the floods of 2000) in terms of adapting their land use strategies to manage climate variability. Those interviewed expressed intimate knowledge of their physical environment, and the mixed farming systems they use are particularly resistant to climate shocks. But the agricultural techniques they use to mitigate climate risk are neither compatible with commercial production nor sufficient, with increasing cash needs, to ensure material basic wellbeing, such as food, health and education. Thus people's economic responses to risk contribute to their increasing vulnerability to climate variability. Rural people now need cash income in order to access goods and services (Sheldon 2002). Greater exposure to consumer societies (via televised media as well as more linkages with commercial trading centres) has also increased the desire for more manufactured goods. In addition, government policies strongly encourage rural farmers to produce for the commercial market (Government of Mozambique 2001).

In contrast to their resiliency to environmental risk, people appear to be much less resilient to the socio-economic stressors that have been introduced or intensified by economic globalisation. The speed of change from a colonial economy, to a centrally planned economy, and finally to a capitalist market economy has made it difficult for rural people to develop coping strategies and successful adaptations to maintain their livelihoods. In many ways, the economic risks faced by rural people in the Basin stem from how the new liberalised economy forces them to alter their approach to farming, often making it difficult to respond to environmental change and variability, and making them more vulnerable to climate hazards in the process. This finding echoes that of Eakin (2005) who finds that the ability of Mexican smallholders to respond to climate risk is circumscribed by economic uncertainty.

In terms of policy implications, the findings of this study suggest that some local level interventions have considerable potential for assisting rural people to improve their quality of life. Such interventions must focus on bridging the gap between strategies well adapted to environmental variability and the financial and technical requirements of a commercialising economy. One possibility is to build on the policy recommendations of Chambers (1983 2005) to incorporate indigenous knowledge into rural development programmes by learning from local best practices. One strategy would be to foster more integration between schools and successful farmers from the local area. Further analysis of the role which indigenous knowledge can play in shaping policy should be coupled with an analysis of the state institutions responsible for agriculture and rural development. As pointed out by Eriksen *et al.* (2008), assessments and policies aimed at reducing vulnerability need to be nuanced and designed to capture the multiple stressors that create vulnerability in a specific place, including the effects of economic liberalisation on agricultural practices and livelihood patterns.

This research has examined economic and environmental change at the local level within a regional context, enabling a better understanding of how multiple stressors operate on farming households. Studying global change processes using a double exposure framework is an important first step in identifying the ways environmental and economic changes interact. The findings of this study suggest that environmental crises may be an important driver of how people construct their economic livelihoods, and that economic change can increase the environmental vulnerability of rural societies in less developed countries. The findings show how adaptation to new opportunities and risks associated with economic liberalisation – in particular the commercialisation of agriculture –

can also increase vulnerability to climate change since practices that are well adapted to ecological and climatic variability are incompatible with the type of commercial agriculture favoured under economic liberalisation. Future work needs to consider how the scope and use of strategies to cope with multiple stressors influence political and economic outcomes, which in turn shape the vulnerability and resilience of many rural people in the developing world. Research of this type is particularly relevant, given growing evidence that climate change is likely to increase the magnitude and frequency of extreme events (IPCC 2007a 2007b) at the same time that economic globalisation continues to present new challenges and opportunities for rural farming communities around the world.

Acknowledgements

This study was funded by the World Bank, AFTES program. Special thanks to Wendy Jepson, Christian Brannstrom, Mike Binford and two anonymous reviewers for their comments on earlier drafts of this paper. The authors would also like to thank the Mabalane and Chókwé District administrations for facilitating the research, and to the leaders and people of Matidze and Massavasse villages for welcoming us and helping in every possible way.

Notes

- 1 The intent of Table 1 is not to imply that environmental events are the sole triggers of specific economic changes and political outcomes (e.g. environmental determinism). Rather Table 1 illustrates that environmental events can be contributors to or help create the conditions for certain economic and political outcomes. For more on these types of relationship, see Binford *et al.* (1997) and Kolata *et al.* (2000).
- 2 This paper builds on the analysis by Eriksen and Silva (2009) on the same study sites. Their paper discusses drought coping strategies and how these strategies change over time as drought intensifies.
- 3 We alternated interviewing male and female heads of households in order to try and speak with an equal number of men and women. Sometimes our alternating sequence of male and female interviewees was broken, maybe because the male we had intended to interview was working in South Africa. In such a case, we interviewed the female head of household and then interviewed the male head in the following household. In one case, the female head of household declined to be interviewed because she preferred we speak to her husband who was present. Overall, we interviewed 29 women and 34 men.
- 4 For more information on the role of South Africa's active destablization programme throughout rural Mozambique during the civil war, see Hall and Young (1997).

- 5 The Mozambican government defines small-scale farming as farming less than 5 ha of land.
- 6 In no case did a household report that a female household member had migrated for employment.
- 7 Recent (2008) attacks on immigrants in South Africa will presumably only decrease the flow of remittances into Mozambique.
- 8 An important exception is the restrictions on cattle sales in Gaza Province in order to comply with international trade regulations to limit the spread of foot and mouth disease.

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