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Perceptions of Environmental Risks in Mozambique:

Implications for the Success of Adaptation and Coping Strategies

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Abstract

Policies to promote adaptation climate risks often rely on the willing cooperation of the intended beneficiaries. If these beneficiaries disagree with policy makers and programme managers about the need for adaptation, or the effectiveness of the measures they are being asked to undertake, then implementation of the policies will fail. A case study of a reset¬tlement programme in Mozambique shows this to be the case. Farmers and policy-maker disagreed about the serious¬ness of climate risks, and the potential negative consequences of proposed adaptive measures. A project to provide more information about climate change to farmers did not change their beliefs. The results highlight the need for active dialog across stakeholder groups, as a necessary condition for formulating policies that can then be successfully imple¬mented.

This paper—a product of the Sustainable Rural and Urban Development Team, Development Research Group—is part of a larger effort in the department toto study the implications of climate change. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The authors may be contacted at through alotsch@worldbank.org.

Perceptions of environmental risks in Mozambique: implications for the success of adaptation and coping strategies

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1 Introduction

In early February 2000, heavy rains started to fall across much of southern Africa, hitting southern Mozambique the hardest. On 9 February the capital of Mozambique, Maputo, was flooded, with slums in the peri-urban areas hardest hit, and the road north to Beira underwater. The rains continued, and on 11 February the Limpopo River, north of Maputo, broke its banks, contaminating the water supply and bringing dysentery to the local population. The worst came on 22 February when Cyclone Eline hit the Mozambique coast near Beira, with winds of 260 km/h and torrential rains. Eline worked its way inland, dropping huge quantities of water on the Limpopo River catchment area. That water followed its way down the Limpopo River valley, and on 27 February flash floods occurred in the Gaza Province of Mozambique, arriving suddenly and burying the low-lying farmlands in the Chókwe and Xai Xai Districts under four to eight meters of water. Residents climbed trees and rooftops, but with only a few boats and less than a dozen helicopters available to evacuate over 100,000 people, over 7,000 of them were stranded in trees for several days. Eight hundred people died, hundreds of thousands were left homeless, and two million were affected. Over 90% of the irrigation systems in Mozambique were lost. In the immediate aftermath of the floods, losses were estimated at $273 million in direct costs, and $428 million in optimal standard reconstruction costs (World Bank, 2000).

In the months following, after the waters receded, the government and the aid community began to ponder how to prevent such a disaster from recurring. It had been the worst flood in 50 years, but there was concern that climate change could have contributed to it, meaning that the time until the next flood would be less. It was clear that something needed to be done to reduce the vulnerability of the farmers living in the fertile Limpopo River floodplain from Chókwe to Xai Xai, who were hardest hit. In addition to emergency assistance to help most farmers move back to their houses and begin farming again (USAID, 2002), policy makers began working on several longer-term ideas. First, they decided to distribute hand-crank radios to farmers, through which they could hear early warning information, such as a new color code system for cyclones. Second, they provided technical assistance to farmers to help them make their dwellings more resilient, such as by constructing granaries in the treetops, so that they would not lose all of their food and their seed from the next flood. Most ambitious was a voluntary resettlement program, planned and executed by the Ministry of Environmental Affairs (MICOA) and the Ministry of Public Work and Housing (MOPH) at an estimated cost of $13 million (World Bank, 2000). The government built entire villages, equipped with modern services such as electricity, in the hills overlooking the floodplain, for those living in the areas most prone to future flooding (Government of Mozambique, 2000; Mozambique News Agency, 2001). Farmers could farm in the scrubby land around the villages, or else walk or bicycle to their fields in the floodplain. At the time, the government admitted that the success of such a voluntary program was “hard to project”, since the fertile deposits in the floodplain would attract people back to the low-lying areas, though they hoped that people would indeed choose the “risk-reducing” option of the resettlement areas (World Bank, 2000).

Since there has not been a catastrophic flood in the Limpopo River valley since then (FEWS-NET, 2007), it is too early to tell whether the radio and resilient housing programs have succeeded.[3] The resettlement program, however, has failed. After a few months living in the new houses, farmers began to return to the floodplain to farm, and rebuilt their dwellings in their old villages. The government then encouraged them to maintain two homes: temporary ones near the fields, where they could live for several days at a time, and permanent ones on higher ground, where their families would stay, and where they would keep their possessions. But that too failed. The farmers wanted to live in the floodplain, and very few of them maintain households in the new dwellings that had been built for them.

This was not the first floodplain resettlement program to have failed. There have been many such schemes in Asia, and while a few success stories exist, in general "this mitigation measure has proven to be less successful, costly, and economically, politically, and socially insensitive" (ADPC, 2005, 100). It is also not the only type of policy to help people adapt to the threat of climate change, and climate variability, for which the implementation has been poor. Ironically in the Limpopo Valley a threat at least as big as flooding is of drought, especially in El Niño years (Arndt et al., 2003). There, as in many parts of southern Africa, the government and civil society have developed policies and practices to develop timely seasonal forecasts, to communicate these forecasts to potential "users", and to recommend a shift away from water intensive maize toward more drought tolerant seeds (International Research Institute for Climate Prediction, 2000; NOAA, 1999; O'Brien and Vogel, 2003; Unganai, 1998). But these policies rely on the assumption that farmers will actually use the forecasts. Again, while there have been some success stories, in general few subsistence farmers have made use of the forecasts, and most continue to plant maize, which requires more water than alternatives such as millet or sorghum (Suarez and Patt, 2004), but which also can be more productive when the rains are good, and which commands a higher market price.

A common factor in these difficulties implementing policies is the failure of the people who are most vulnerable to change their behavior in ways that policy makers think they should. There are three questions that arise. First, to what extent is it important that citizens support adaptation policies? Second, why might people not support such policies? Third, what can be done to increase the willing participation of people in adaptation policies? In this paper we examine these three questions in general, but focus our attention on the second. We report on an empirical case study in the Chókwe District of Mozambique to support the conclusion that different perceptions of relative risk can account for the lack of popular support for adaptation policies. There are good reasons, based in behavioral economic theory, to suspect differential risk perception.

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3 Based on evidence from the Zambezi River valley, however, there is reason to believe that new programs are helping. In early 2007, the worst floods since 2000 hit central Mozambique. While over 130,000 have been left homeless, there have not been reports of widespread loss of life, suggesting that early warning efforts have been successful (FEWSNET, 2007).

2 Background

2.1 Adaptation and coping

Climate change adaptation is increasingly viewed as an issue of risk management (Hellmuth et al., 2007). Risk is the product of the seriousness and probability of negative outcomes that might occur. Adaptation then is the process of taking actions to improve expected welfare by reducing the likelihood or severity of future risks. Adaptation is closely related to coping, which is the process of minimizing the long-term harm suffered as a consequence of negative events, without engaging reducing the likelihood or magnitude of the negative events themselves (Turner et al., 2003). If, for example, a community faces a risk of flooding, then an adaptation would be to construct a levy to reduce the likelihood of flooding, and coping would be to live in less valuable housing, that will be easier to rebuild to the same state should it be destroyed. Coping is seen as a process carried out by individuals, which policy-makers can, at best, observe (Roncoli et al., 2001). Adaptation, by contrast, is a process that can be both initiated and undertaken either by individuals or by the state, depending on the specific measures. Building a floodwall is an activity for the state, for example. In many cases, such as the resettlement program in Mozambique, the state initiates the adaptation policy, but it is citizens who much change their behavior in order to implement the policy.

Figure 1 presents two alternative models of the relationship between adaptation and coping. In Model A, policy-makers develop adaptation strategies in response to observed events independent of citizens' coping. The policies are then

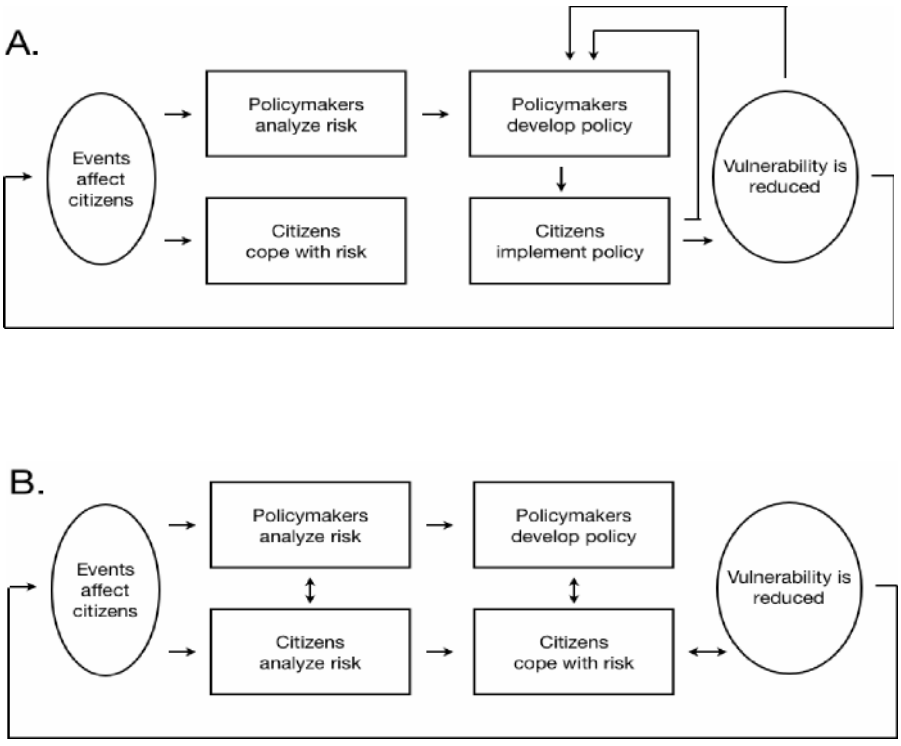

Figure 1—Alternative models of adaptation and coping. In Model A, adaptation policies and coping strategies operate independently. In Model B, there is a close relationship between adaptation and coping, and a greater need for communication at the risk analysis and policy-development stages.

given to citizens to implement. Policy-makers can observe how well citizens are able to implement their policies, and conduct a vulnerability assessment to identify whether the policies have reduced vulnerability, using this information to improve the policy before the next event strikes, such that the likelihood or magnitude of the event is in fact reduced. In Model B, there is a close link between citizens' coping and the development of adaptation policies. Coping here is understood not to be an autonomous process, as it is in Model A, but one that, like adaptation, requires risk analysis. In order for adaptation policies to be effective, they have to work synergistically with coping, rather than in opposition. In order to ensure this occurs, it is necessary to have two-way communication between policy-makers and citizens both at the stage of risk analysis, and at the stage of developing both adaptations and coping strategies. Feedback reaches policy-makers via the latter communication channel, relying on citizens' observations of their changing vulnerability.

Which model is the more accurate representation of the relationship between coping and adaptation is an empirical question, which can be answered by observing whether the existence of two-way communication linkages at the stages of risk analysis and response formation improves the outcome of policies. There is in fact a growing empirically based literature suggesting that they do (Verweij and Thompson, 2006). In a five-year study in Zimbabwe, for example, Patt et al. (2005) found that farmers were more than five times as likely to make changes to their established practices on the basis of new information when they participated in the process of formulating the list of changes, compared to when the changes were developed by expert analysts, and communicated to the farmers via radio and other media. One of the few projects that has successfully promoted widespread use of climate information to assist decision-making, in Mali, has worked because it has spanned 25 years, with a gradual process of involving more and more farmers in a process of social discourse at both the risk analysis and implementation stages (Diarra and Kangah, 2007).

If indeed Model B is the more accurate, but policy makers proceed according to Model A, then it is likely that they will not establish the communication linkages that are necessary for policy success. The absence of communication can lead to the greatest problems—the development of adaptation policies that conflict with citizens' coping strategies—when there are significant differences of opinion at the risk analysis stage.

2.2 Behavioral factors influencing risk management behavior

A schism in opinion at the risk analysis stage can occur if policy makers and citizens perceive risks, and what to do about those risks, differently. Why this could happen is the subject of behavioral economic and environmental psychology research. Grothmann and Patt (2005) examined the role of behavioral factors in people's decisions to take precautionary action against the risks of flooding and drought. In one part of their empirical study, they interviewed residents of Germany facing the risk of flooding from nearby rivers. From these interviews, they were able to assign values to a list of socio-economic and psychological variables associated with each individual, as well as to identify the self-protective behavior each individual had engaged in, activities such as moving electrical appliances to upper-level floors. Using regression analysis, they found that the psychological variables—factors such as feelings of control, optimism, and fatal-

ism—were able to predict self-protective behavior with significantly greater accuracy than were the socio-economic variables, consistent with previous findings of self-protective health behavior (Prentice-Dunn and Rogers, 1986; Weinstein, 1993). This suggests that a model of adaptation to changing environmental conditions based purely on the financial or economic ability to adapt, but ignoring the psychological factors that provide motivation to adapt, is incomplete, and potentially misleading.

Other work has examined how behavioral factors influence the perception of information that may be relevant for adaptation and development. Weber (1997) examined the conditions under which farmers in the United States were more likely to believe in climate change, and hence be likely to incorporate information about climate change into their decisions. She found that not just the type of information that they received, but also the number of sources from which they received it, influenced the extent to which they believed it. Additionally, whether a given farmers had a subscription to a daily newspaper or a farm journal made a large difference, with those people subscribing to a news source (rather than purchasing one irregularly) being more receptive to information about climate change.

Others have called for greater research on the role of behavioral factors in development and adaptation. Nicholls (1999), for example, has argued that cognitive illusions play an important role in how people interpret environmental information, such as weather and climate forecasts. Similarly, Podestá et al. (2002) have suggested that mental models of climate and El Niño can highly influence whether farmers in Argentina use seasonal climate forecasts to guide their decision-making. Grether (1994) has argued that behavioral factors can play a strong role in the performance of agricultural commodities markets, a central institution of development. Bertrand et al. (2004) have argued that behavioral factors can help us to understand poverty and underdevelopment. Some have argued that a behaviorally-grounded reluctance to use new information creates a need for more effective practices of science communication (Klopper et al., 2006). Patt (2001) showed that farmers in Zimbabwe applied a common behavioral heuristic, probability matching, when interpreting probabilistic information about seasonal climate. Johnson et al. (1993) showed how biased perceptions of flood risk in the United States can destroy insurance markets; except in the immediate aftermath of a flood, people rate the likelihood of flooding as low, and do not purchase insurance even when offered at subsidized prices.

Returning to the issue of adaptation as risk management, it is important to examine how both the seriousness and the likelihood of outcomes are perceived. Two factors may influence the perception of the former. The first factor is perceived ownership. The *endowment effect* describes the additional worth people place in items that they currently possess, compared to items that they do not yet possess (Kahneman et al., 1990; Thaler, 1991). When taking an action will lead to both gains (acquiring something new) and losses (giving up something already possessed), people's decisions will be dominated by the potential losses, and they have a propensity to do nothing. The second factor is perceived responsibility. The *omission bias* describes people's unwillingness to take an action with potentially negative consequences, even when taking that action will eliminate another risk that is at least as severe, out of a desire to avoid per-

sonal responsibility for the losses (Baron and Ritov, 1994; Baron and Ritov, 2004; Ritov and Baron, 1990; Ritov and Baron, 1992). People may choose not to vaccinate against a deadly illness when there is the possibility of the vaccine itself having negative consequences, even when the risks associated with the vaccine are far less than the risks associated with the illness it will prevent, because they assign more personal responsibility to the consequences of actions than they do of omission, and want to avoid that personal responsibility for negative outcomes.

When decisions are framed in terms of negative outcomes, or a mix of positive and negative outcomes, the most obvious effect of the endowment effect and omission bias is *status quo bias* (Samuelson and Zeckhauser, 1988). Status quo bias describes a propensity to take no action that will lead to a change in the current condition or set of risks. When the salient effects of an action are viewed as almost entirely positive, *action bias* has been observed (Patt and Zeckhauser, 2000). When demonstrating action bias, people want to take an action that will lead to a demonstrably good outcome, even when doing so will prevent an equally good outcome from occurring, or will indirectly allow an equally bad negative effect to occur.

The second issue is the estimation of probabilities. People do not use mathematical formulae such as Bayes' Rule to estimate probabilities, but rather use a variety of heuristics, or mental shortcuts (Tversky and Kahneman, 1974). One of these, the *availability* heuristic, is particularly important for estimating the likelihood of suffering future harm: people search their memories for instances of this kind of event occurring, and to the extent vivid memories are readily available, they will estimate the probability to be high (Tversky and Kahneman, 1973). This can mean that both recent events, and those creating a more vivid emotional impact, will have a greater effect on probability estimation. Indeed, researchers have shown how particular emotional responses to events can lead to very high—and inaccurate—estimates of likelihood (Covello, 1990). Another important heuristic is *representativeness:* people evaluate the likelihood of an event occurring in a given place based on how representative the place is of places where that kind of event normally occurs (Tversky and Kahneman, 1974). Hence, one might judge it more likely that San Francisco will suffer an earthquake than a landslide, because San Francisco is very representative of the kind of place that suffers earthquakes, and less so of the kind of place that suffers landslides. Finally, it has also been observed that people overestimate the likelihood of low probability events occurring, and under-estimate the likelihood of high probability events occurring (Kahneman and Tversky, 1979).

2.3 Hypothesized effects of behavioral factors on climate risk management

The behavior patterns described above could lead to the type of policy failure seen in the Mozambique resettlement program. First, we suspect that farmers (relative to policy makers) may exhibit status quo bias. This is because, from the perspective of a farmer, any action taken to adapt to climatic factors entails some sort of risk of negative outcome. The decision to move to a safe area on higher ground, for example, entails the risk of losing one's livelihood or community. The decision to plant a drought tolerant crop entails the risk of having a lower harvest, if the rains are plentiful. Farmers

wanting to avoid personal responsibility for negative outcomes will avoid making new choices. By contrast, policy makers can gain personal credit for avoiding a negative outcome, but only if they take action. If farmers survive the next flood because they were resettled, then the policy maker can claim credit. The policy maker who decides not to resettle people will be criticized in years of flood, and yet will get no credit for helping farmers in years where no flood occurred. They will be most sensitive to the negative consequences of doing nothing.

Second, we hypothesize that farmers and policy makers will view probabilities differently. Policy makers will likely have seen gripping images in the media, especially on television, of people suffering from catastrophes. They will focus on these images of farmers stranded in treetops. Most farmers were not personally stranded in a treetop; they were left homeless, but managed to escape the floodplain before their own lives were threatened. The representativeness heuristic could also play a role. For many policy makers, the Limpopo River floodplain is a place defined by flood risk, and flood risk alone, just as San Francisco is for many people defined by earthquake risks. For the people living there, however, life in the floodplain is defined by many more factors than climate risks, and the floodplain less representative of the kind of place where climate risks are paramount. Relative to farmers, policy makers will have a propensity to overestimate climate related risks.

3 Case study: adaptation to risks of flooding and drought in Mozambique

We tested these hypotheses using qualitative and quantitative research methods. From a set of workshops held in May 2006, we qualitatively observed differences in farmers and policy makers' perceptions of climate risks. From a questionnaire administered in September 2006, we gained quantitative evidence of the hypothesized biases. From a household survey conducted in December 2006, we obtained data suggesting that a recent information campaign had not led to an observed change in perceptions of climate risks among farmers.

3.1 Farmer and policy maker workshops

In May 2006, we held a workshop with a group of 20 farmers in the village of Chiguidela, within a few hundred meters of the banks of the Limpopo River. The farmers told their stories of the floods as if they had just happened. They had to climb trees to avoid the floodwater, and then be evacuated by boat to higher ground. Those who did not do this died. Everything had been lost; the only way to identify where their houses had been, and what land was theirs, was by identifying particular trees. A woman said that she had stayed in resettlement village for two months, but that it was 16 km from her fields, and there was nowhere to farm on the high ground. She had no choice but to move back if she was to continue to farm. She didn't know if the floods would return, and she feared that if they did, she would not be strong enough to survive them a second time. But she had no choice but to continue farming her fields, and facing the risk. A man said that evacuating from the floods was not hard, but then upon return they faced a lack of food, and that was the hard part. He didn't think that the floods would return within his lifetime, but if they did, he felt confident that he could

survive them, as he had survived before. His main concern was with growing more food, coping with the threat of drought. Several farmers said that they were concerned about a coming shortage of draft animals. They had lost all of their animals in the floods, and had been given new ones—oxen—to begin farming again. But oxen can't reproduce on their own, and they needed breeding stock to replace the oxen as they grew old and died.

Overall, the farmers seemed unconcerned about the risks imposed by future flooding, and more concerned about the problems they continued to face as a result of the policy responses to the floods. Moreover, the farmers seemed more concerned with less significant, but more constant, threats to their livelihood. Compared to our concurrent discussions with policy-makers, the farmers talked much more about the trend towards drier conditions combined with the inability to irrigate properly. The farmers were far more concerned about taking practical steps to address current problems, which included recurring drought, rather than reduce their risk from flooding. They did address the likelihood of a flood occurring again, saying that it was very unlikely. To the extent they wanted to take actions, such as to improve the irrigation system, it was in cases where there were gains to be had, rather than losses to avoid.

Later during the same week we conducted a workshop with 25 representatives from disaster management and climate change organizations in Maputo. This group was made up of representatives from the national meteorological institute, the Mozambique Red Cross, the national disaster management planning agency, and international development organizations. After introductory talks, we split participants into four breakout groups of six to seven people. Three of the groups were composed of stakeholders with experience in climate risk management: high-level officials charged with promoting adaptation, such as the head of the Red Cross climate program, the head of the national program to map and respond to environmental risks, and the climate program manager within the Ministry of the Environment. The fourth group, on the other hand, did not contain any such people. It was composed mainly of program managers in the area of HIV-AIDS and logistical support. These people were familiar with the issue of climate and disasters, but did not have any policy-making responsibilities in this area. We asked each breakout group to answer three questions: (a) what are the climate-related risks that they consider to be most important; (b) what are the adaptation strategies that they can envision for each of those risks; and, (c) what are the potential risks or negative aspects that those adaptation strategies themselves might cause. The last of these questions was for us the most interesting, and we were specific about what we were asking, namely the "side-effects" of the adaptations if successfully implemented, rather than simply the difficulties that government agencies might have in implementing them, or the potential that the adaptations might not be as effective as hoped. While we were confident that these stakeholders had been considering the first two questions for some time, and their answers were not likely to be surprising, we were interested in observing whether their answers to the last question demonstrated as much prior thought. Furthermore, we wanted to observe whether there was a difference between the groups with topical expertise, and those without.

Table 1 shows the top ranked answers provided by each group. The answers to the first question were the same across all groups, expect for the fact that the fourth group—composed of people non-expert in the field—only list two climate-related risks, and did not consider the problem of cyclones. The answers to the second question contained greater variation, with different groups focusing either on improved analysis (e.g. risk mapping), top-down structural measures (e.g. improved irrigation canals), or efforts to promote bottom-up adaptation (e.g. education). No single group stood out from the other three in its answers to the second question. On the third question, however, the fourth group clearly did stand out. The first three groups, when asked to consider the possible negative consequences of their proposed adaptation policies, listed only the reasons why the adaptation measures might not be fully effective, i.e. challenges to overcome in

Table 1—First three responses to breakout group questions

	What are the main climate related risks?	*What are the main adaptation strategies?*	*What are the potential negative side-effects?*
Group 1: Experts	Floods Drought Tropical Cyclones	Risk/Vulnerability evaluation Risk Mapping Education/Sensitization	Poor quality of the evaluation Lack of adequate data for mapping Lack of stakeholder participation in education
Group 2: Experts	Droughts Floods Cyclones	Education Improve information on risks by communicating in local language Improve irrigation and water management systems	Information may not be reliable Farmers may not believe the information Farmers may not understand the information
Group 3: Experts	Floods Cyclones Droughts	Building dams Planting trees Development of early warning systems and communication systems	High cost of building dams Community resistance to change as a result of cultural issues High cost and resistance of communities to move to *zonas siguras*
Group 4: Non-experts	Droughts Floods	For droughts: increased storage of food surplus, and growing drought resistant crops For floods: population resettlement in *zonas siguras,* and construction of elevated granaries	Stored food surplus might be lost due to pests, drought tolerant crops provide lower average yields. Lack of adequate farmland and social institutions around the *zonas siguras,* elevated granaries might be damaged from extreme climate events.

implementation. These fall into roughly three types of challenges. First, these groups considered the challenges for policy

makers and analysts of conducting their job successfully, such as by providing accurate information. Second, these groups considered the potential unwillingness of farmers to implement proposed changes, such as moving to resettlement villages, either because of cultural issues, a lack of trust, or poor understanding of the information. Third, these groups considered the high cost of some of the proposed changes, and hence that the government may not actually be able to carry them out. What none of the first three groups considered—as if they had a blind spot—was the potential for negative consequences arising out of the adaptations themselves. This was something that the fourth group—the group with less experience in climate risk management—had no trouble examining, and all of their answers reflected this ease. If farmers actually did store more food in order to cope with recurrent drought, then that food might be lost to pests, making the farmers worse off than if they had sold their surplus. If the farmers actually did grow more drought tolerant crops, then they might get lower average yields than from growing the more water intensive varieties. If farmers did resettle, they would suffer from the lack of farmland and social institutions in the new villages. If they constructed elevated granaries to protect against flood, it might be that those granaries would be more vulnerable to high winds.

The two workshops lend support primarily to the hypothesis that farmers demonstrate omission bias, while policy makers demonstrate action bias. Farmers were much more likely to draw attention to the risks and drawbacks associated with policy interventions, while policy makers—especially those policy-makers with specific expertise in this subject—were largely oblivious to them. This supports the hypothesis that omission and action biases play a role in creating different perceptions. The workshops provided less clear guidance on probability perceptions, our second hypothesis: farmers did indicate that they thought that the risk of flooding was low, in comparison with other threats that they faced, but from the workshop format it was difficult to draw any conclusions about the relative probability perceptions of the two groups of people.

3.2 Questionnaire

In September 2006, we administered a questionnaire where we examined probability and risk perceptions among farmers and policy makers. The questionnaire included three sets of questions. The first set asked participants to indicate the likelihood of ten different events occurring within their lifetimes. Some of these events were climate related, such as flooding and drought, and others were non-climate related, such as the likelihood of an African country winning the Football World Cup, or civil unrest occurring in a neighboring country. The purpose was to see how likely people thought climate related risks were, not by talking about them in the abstract, but by comparing them with non-climate risks. The second set asked participants to indicate the likelihood of several different events affecting farmers in the Limpopo River valley within the next five years, and over a five year period beginning 20 years from now. Again, these included climate events (flooding, drought, and cyclones) and non-climate events (e.g. losing a family member to HIV-AIDS). The purpose was to see whether participants expected particular risks to grow worse in the future than they are today. The third

set of questions asked farmers to indicate whether these same types events are, in the present, becoming more or less likely. The purpose was to compare perceptions of the present with expectations of the future, and see if they agreed qualitatively.

On all questions, participants indicated their answer on a horizontal scale. For the likelihood estimations, the scale ranged from 0 (will not occur) to 100 (will certainly occur). On the change questions, the scale ranged from –100 (becoming much less frequent) to 100 (becoming much more frequent). Seventy-five farmers from the village of Chiguidela completed the questionnaire, which took place in a three-hour sitting, with the farmers dividing into groups of 6 to 8 people, each being led by a facilitator who explained each question and helped illiterate farmers to answer them. The farmers filled out a paper copy of the questionnaire, written in Portuguese but verbally translated into the local language by the facilitators, and indicated their estimate by drawing an arrow to point to some place on the scale. Sixty-nine policy makers completed the questionnaire, and represented a diverse group of high-level decision-makers, program managers, and technicians. Many of these did so as part of training sessions organized by the Mozambique Meteorological Department and Mozambique Red Cross, completing the same paper survey as the farmers, while the remainder responded to an email invitation. The latter filled out the survey online, choosing English or Portuguese, and moving an onscreen slider bar to indicate their answers.

The results supported the second hypothesis, namely differences in probability perception between the two groups. As seen in Figure 2, on the first set of question farmers indicated the likelihood of the non-climate events (69.1% on average) being higher than the climate related events (65.6%), although the difference was not significant (*student's t* = 1.58, *p* = 0.12). Policy makers indicated the likelihood of a non-climate event being lower (55.9%) than the climate related events (60.3%), although the difference between the two types of events was only marginally significant (*student's t* = 1.96, *p* = 0.054) significant. When the difference between the climate related events and the non-climate related events is compared, the difference between farmers and policy makers does become significant (*student's t* = 2.51, *p* = 0.01; *Mann-Whitney z* = 2.62, *p* = 0.009). Farmers indicated that the non-climate related events were on average 3.4% more likely than the climate related event, while policy makers indicated the non-climate related events being on average 4.4% *less* likely than the climate related events.

On the second set of questions, farmers thought that the climate related risks would be less likely in the future than they are now, by an average of 5.8% (*student's t* = 1.66, *p* = 0.10), as Figure 3 shows. Most of the drop resulted from the assessed likelihood of losing their crop to droughts, which farmers assessed at 70% likely today, and only 49% likely in the future. Farmers thought that the non-climate related risks would be more likely in the future than they are now by an average of 1.9%, although the change was not significant (*student's t* = 0.94, *p* = 0.35). Policy makers, by contrast, thought that climate related events would be on average 7.7% more likely in the future than today (*student's t* = 3.19, *p* = 0.002), and non-climate related events would be 3.3% more likely in the future than today (*student's t* = 1.68, *p* = 0.099).

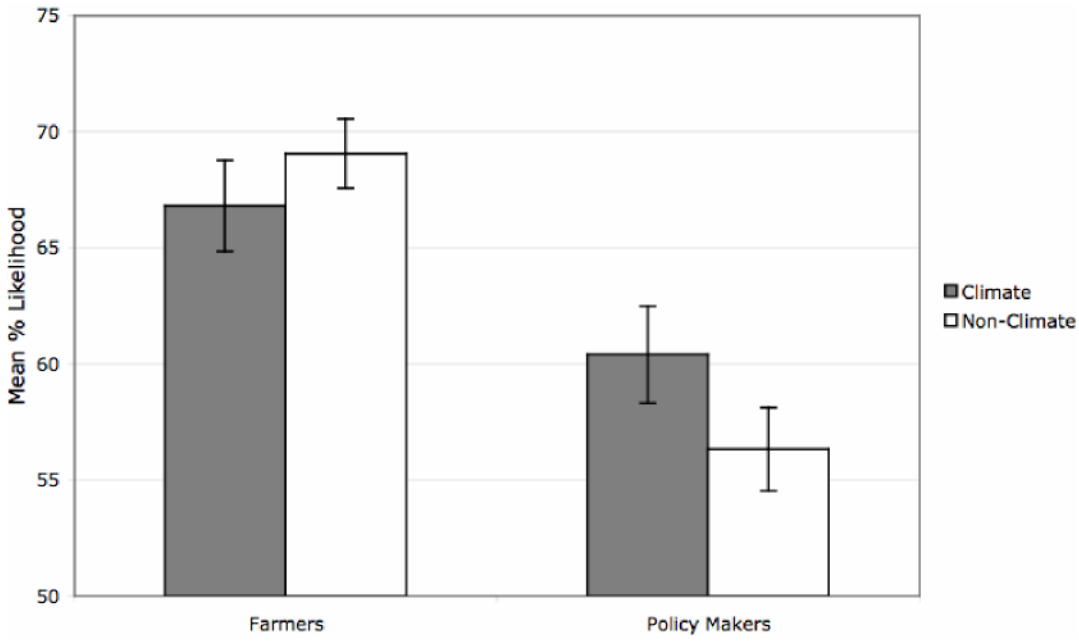

Figure 2—Average assessed likelihoods of climate and non-climate events, among farmers and policy makers. Error bars represent one standard error. Farmers on average thought that the non-climate events were more likely, while policy makers thought that climate events were more likely, and the difference between the two groups is significant.

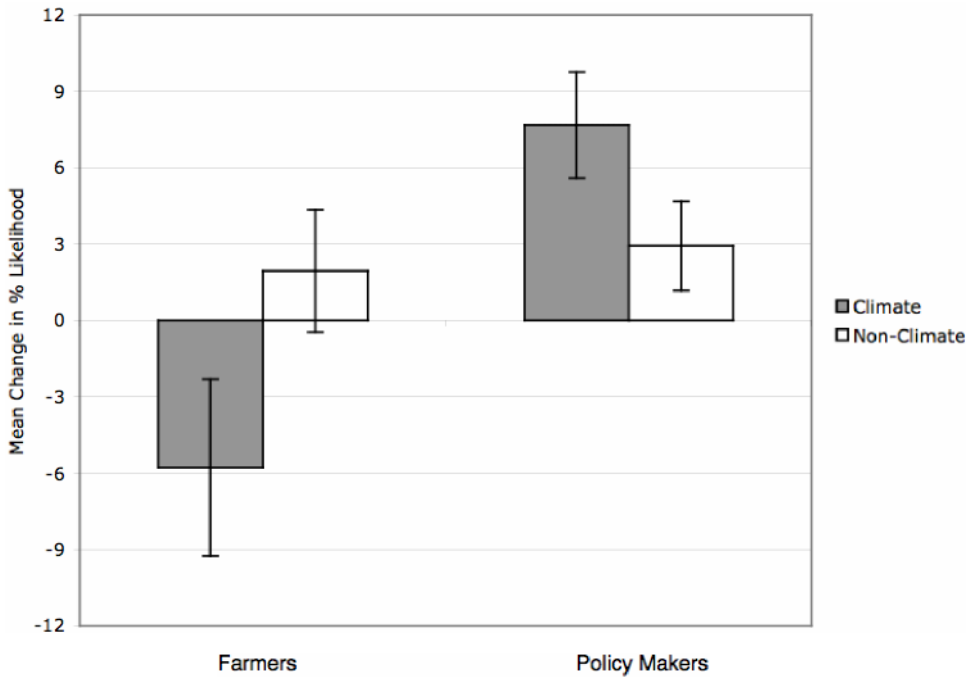

Figure 3—Average assessed change in likelihood of climate and non-climate events, among farmers and policy makers. The error bars represent one standard error. Farmers anticipate that climate events will be less likely twenty years in the future than they are today, while policy makers believe that they will be more likely.

While there was no significant difference between the farmers and policy makers for the changes in likelihoods for the non-climate events (*student's t* = 0.36, *p* = 0.72), there was a significant different between the two groups for the changes in likelihoods for climate related events (*student's t* = 3.29, *p* = 0.001 4). In short, farmers think that climate related risks will decline, while policy makers think that climate related risks will increase, and the difference between the two groups is significant.

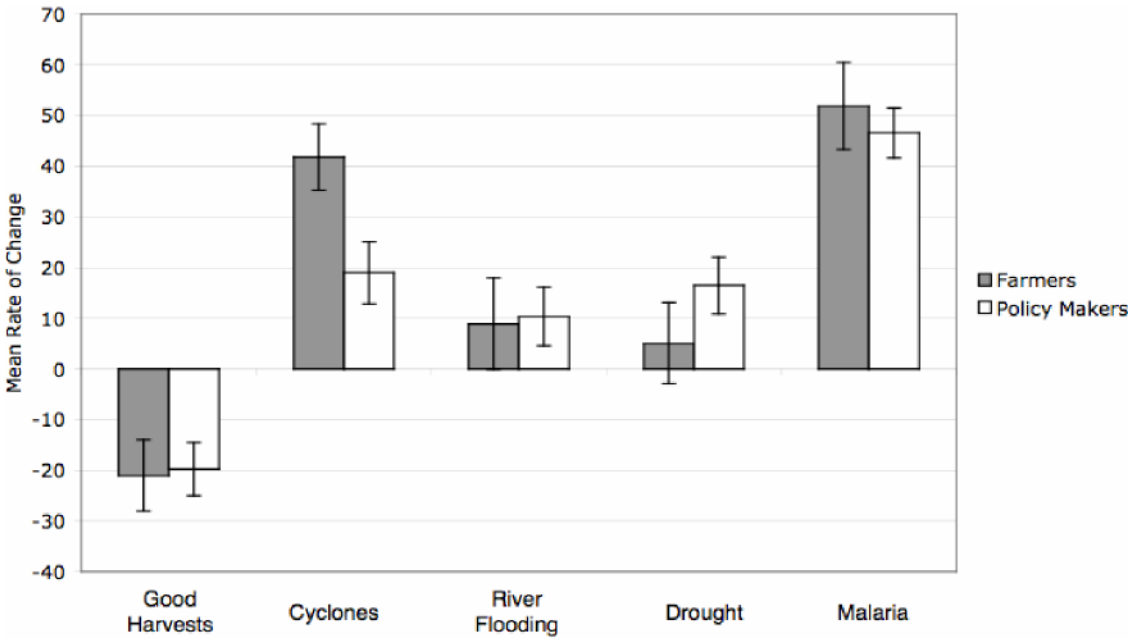

Figure 4—Average assessed rates of change in likelihood of climate and non-climate events, among farmers and policy makers. Error bars represent one standard error. Both farmers and policy makers believe that the risk of cyclones and malaria is increasing, while good harvests are becoming less frequent.

We show results from the third set of questions in Figure 4. Both farmers and policy makers felt that cyclones were becoming more frequent (*p* < 0.01 for both groups), farmers felt they were becoming more frequent significantly faster than did policy makers (*student's t* = 2.54, *p* = 0.012). While farmers on average thought that the risk of river flooding was increasing, it was not significantly different from an estimate of *no change* (zero on the scale) (*student's t* = 0.99, *p* = 0.33), whereas policy makers' responses were marginally significant (*student's t* = 1.80, *p* = 0.077). The same story existed for drought: farmers' responses were not significantly different from no change (*student's t* = 0.64, *p* = 0.53), whereas policy makers' responses were significantly different from no change (*student's t* = 2.93, *p* = 0.005). Both farmers and policy makers thought that the rate of good harvests was declining (*p* < 0.01 for both groups), and both groups thought that the risk of malaria was increasing (*p* < 0.001 for both groups). For both farmers and policy makers the answers to the third set of questions were consistent with the answers to the second set: the risks that are becoming more problematic most quickly in the present are also the ones for which the future is most worrisome. But the difference be-

tween the two sets is revealing. Policy makers see events changing in the present, and expect those changes to continue into the future, while farmers, at least for the climate-related events, do not extrapolate current trends into the future nearly as much.

3.3 Household survey

The third element of our empirical study was the analysis of a survey that was administered to gather baseline data for a Red Cross climate change program, and to evaluate the effectiveness of a first set of workshops that were designed to promote climate change adaptation. The workshops, which had taken place in the communities of Chiguidela and nearby Malhazene, had been motivated by the qualitative observation that many farmers attributed observed climate changes to supernatural causes, and that their efforts to adapt to the observed changes could in fact make them worse.

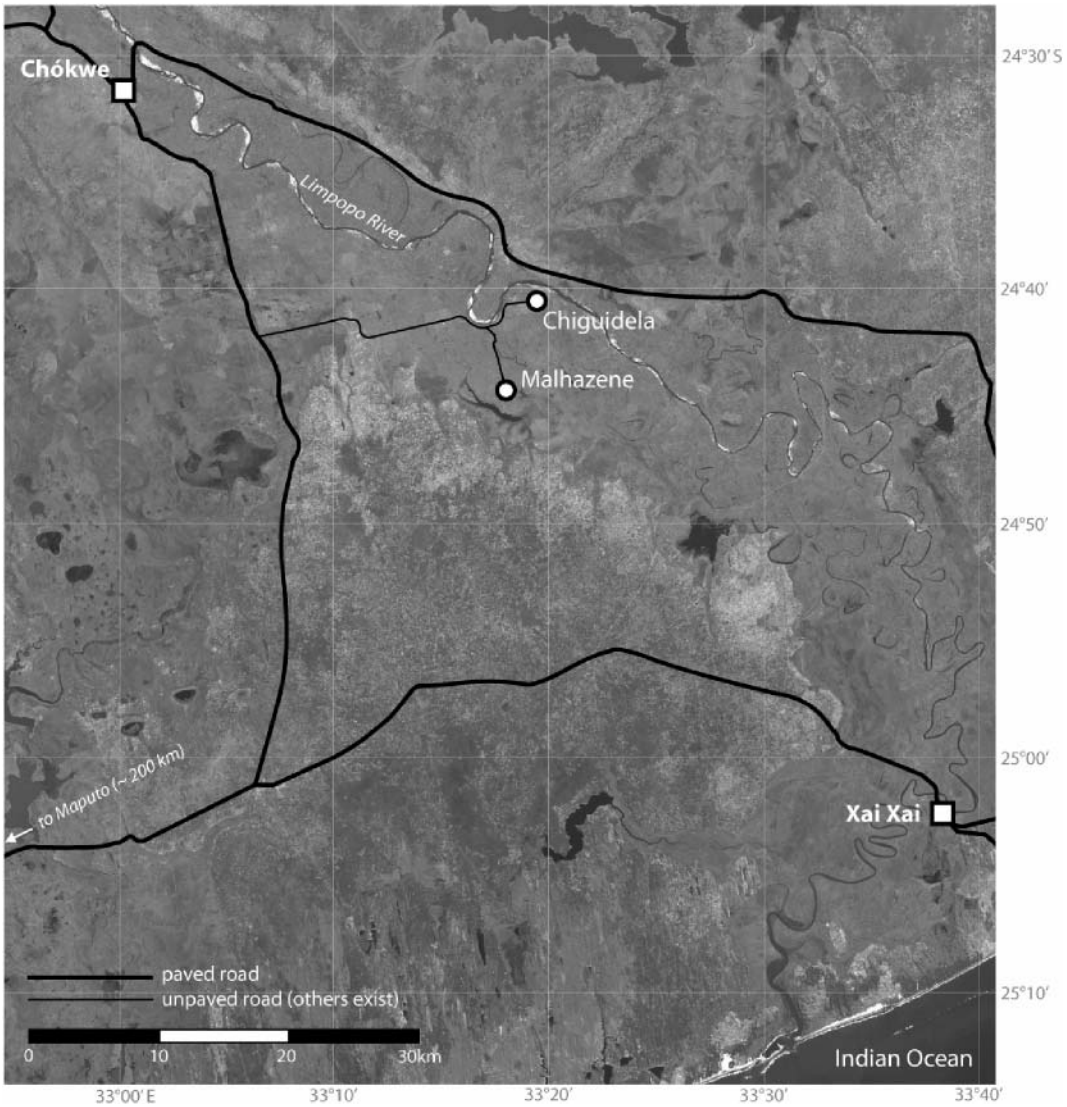

Figure 5—Map showing the study area, including the two survey villages Chiguidela and Malhazene, the district seat Ch—kwe, the provincial capital, Xai Xai, roadways, and the Limpopo River. Image Source: Global Land Cover Facility, http://glcf.umiacs.umd.edu.

It was believed that by explaining to farmers the scientific underpinnings of climate change, their perceptions both of the problem and the effectiveness of their responses to it would change. A survey was administered in the two communities, with randomly selected participants who included both workshop attendees and those who had not attended the workshops. The study area appears in Figure 5.

Of the 84 farmers surveyed, 90% said that they had noticed major changes in the climate during their lifetime, including changes in temperature (80%), cyclones (80%), rainfall (73%), soil moisture (69%), and flooding (64%). Only 16% of the farmers thought that the changes would go away, with 45% thinking the changes would definitely continue, and 39% thinking they might continue. While none of these data about observed changes or expectations for the future are particularly noteworthy, what is interesting is farmers' beliefs about what had been causing the changes. As can be seen in Figure 6, farmers were much more likely to list the gods' and ancestors' being unhappy as the cause of climate change than pollution from outside the community.

The motivation for the workshops had been qualitative evidence of the results seen in Figure 6, namely that people were more likely to attribute climate change to the gods and ancestors than to global carbon dioxide levels. Of the survey respondents, nineteen had attended one of the two workshops, during which it had appeared that the farmers understood the information presented. Nevertheless, in the survey itself, a greater percentage of workshop attendees than non-

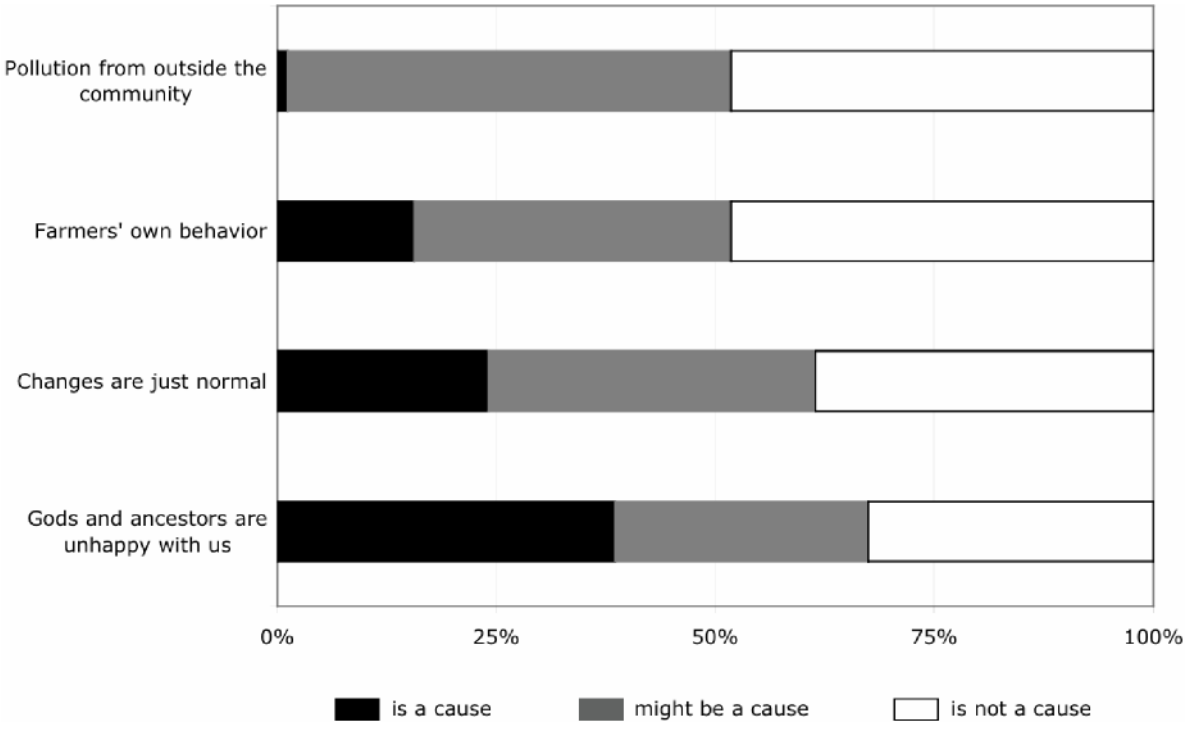

Figure 6—Beliefs about causes of climate change. While about half of survey respondents thought that pollution from outside the community might be a cause of climate change, only 1 of the 83 respondents was confident in this. Many more identified their own behavior, the normality of change, and supernatural factors as being causes of climate change.

attendees believed climate change being caused by the gods and ancestors being upset (63% compared to 31%), by farming practices within the community (32% compared to 11%), or by the naturalness of the changes (32% compared to 22%). Indeed, the *one* respondent who identified climate change as definitely resulting from pollution from outside the community had not attended either of the workshops. Of the workshop attendees, 47% thought that climate changes would continue, while 44% of non-attendees thought it would continue, an insignificant difference $(^2 [2] = 0.49, p = 0.782)$.

The household survey results are relevant for this paper for two reasons. First, they suggest that there likely are important differences in how farmers and policy-makers perceive the causes of climate change, which in turn could influence the perception of future risk, and of the effectiveness of adaptation strategies. Second, it suggests that a strategy to "fix" these perceptions by providing accurate information will not necessarily be immediately effective. It has long been observed that where any ambiguity makes it possible, people use new information to confirm, rather that disprove, their pre-existing beliefs (Lord et al., 1979), a pattern known as "confirmation bias." The farmers who had participated in the workshops did not assimilate the workshop content—which included the information that pollution from outside the community was causing climate change—in such a way as to be increasingly skeptical of alternative explanations, but rather, apparently, to believe in their pre-existing beliefs more strongly.

4 Discussion

Both the qualitative results from the workshops and the quantitative results from the questionnaire and household survey suggest that there are differences in perception between farmers and policy makers, of a type that could lead to policy failure such as that observed in Mozambique following the 2000 floods. The workshops suggest that farmers and policy makers differ in their desire to take action, versus staying with the status quo, related to how each group views the potential for negative consequences flowing from action. The questionnaire results suggest that there are differences in the perception of relative likelihoods. Farmers view climate related events as being less likely than the non-climate related events on the questionnaire, and while the climate-related events have become more frequent in recent years, they do not expect them to be more frequent in the future. Policy makers, by contrast, view the climate-related events as more likely, with that likelihood increasing in the present and continuing into the future. The survey results suggest that simply providing them information about climate change and climate risks will not easily change these farmers' perceptions. Rather, the perceptions grow out of lifetimes of experience.

These results lend additional empirical support to the proposition that Model B in Figure 1 is in fact the more accurate representation of the adaptation and coping process. They also suggest that real problems in implementation can arise when adequate communication is absent at the risk analysis and policy design stages, because of the potential for major differences in perception of risk. We have identified a number of behavioral reasons why such differences in perception may exist.

Unfortunately, the communication that is necessary to avoid the types of problems that occurred in Mozambique is not easy. The resettlement program in the wake of the 2000 flooding was designed quickly, by government ministries, in response to a pressing need. By contrast, involving citizens in the analysis and planning process can take significantly longer, at significantly higher cost. Since the failure if the resettlement program, the Government of Mozambique requested assistance to start over, doing a better job, and the result was the development of a collaborative project with the governments of Zimbabwe, South Africa, and Botswana, funded by the Global Environmental Facility and the United Nations Environment Programme. They launched this project, "Sustainable Land Use Planning for Integrated Land and Water Management for Disaster Preparedness and Vulnerability Reduction in the Lower Limpopo Basin," in late 2004 with a total budget of $2.8 million. The project incorporates participation of the affected farmers in the process of assessing the risks to people in floodplains, and developing land use plans to minimize those risks in several targeted communities. While it is too early to assess the effectiveness of that project, early reports are that it is succeeding at stimulating a dialogue between farmers and national level planners on the issue of flooding and land-use planning (GEF, 2007). Spending nearly $3 million on a pilot project to engage in land use planning may seem like a lot of money, but it is significantly less than the $13 million that was spent, largely ineffectively, on the quickly-designed resettlement program.

National governments, non-governmental organizations, and donors need to devote the resources to engage the local population before they engage in costly adaptation programs. It may seem like money spent talking, which could better be spent on concrete action. But without that talking, there is a significant risk that the concrete will be poured in the wrong place, and go to waste. Among certain communities this is accepted wisdom, and yet there are still those who believe otherwise. If it is expected that citizens will participate in the process of implementing adaptation policies, then it is vital to involve them in the process of designing the policies from the very beginning.

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