Perceptions of climate risk in Mozambique: Implications for the success of adaptation strategies

Article *in* Global Environmental Change · August 2008

DOI: 10.1016/j.gloenvcha.2008.04.002

2 authors:

Anthony G. Patt
International Institute for Applied Systems A…
9 PUBLICATIONS **653** CITATIONS
SEE PROFILE

Dagmar Schröter
ETH Zurich
62 PUBLICATIONS **2,876** CITATIONS
SEE PROFILE

Global Environmental Change 18 (2008) 458–467

Contents lists available at ScienceDirect

Global Environmental Change

journal homepage: www.elsevier.com/locate/gloenvcha

Perceptions of climate risk in Mozambique: Implications for the success of adaptation strategies

Anthony G. Patt [a,*], Dagmar Schröter [b]

[a] International Institute for Applied Systems Analysis, Schloßplatz 1, 2361 Laxenburg, Austria
[b] Austrian Environmental Agency, Spittelauer Lände 5, 1090 Vienna, Austria

ARTICLE INFO

Article history:
Received 1 October 2007
Received in revised form
15 April 2008
Accepted 20 April 2008

Keywords:
Climate
Risk perception
Adaptation
Mozambique

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 program 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 resettlement program in Mozambique shows this to be the case. Farmers and policy makers disagreed about the seriousness 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 implemented.

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. That water followed its way down the Limpopo River valley, and several days later 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 4–8 m 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 7000 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. Losses were borne unequally, with gender, knowledge, and social capital all playing a role in defining who suffered and who recovered most easily (Brouwer and Nhassengo, 2006). 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 had been 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

* Corresponding author. Tel.: +43 2236 807 306; fax: +43 2236 807 466.
E-mail addresses: patt@iiasa.ac.at (A.G. Patt), dagmar.schroeter@gmail.com (D. Schröter).

0959-3780/$ - see front matter © 2008 Elsevier Ltd. All rights reserved.
doi:10.1016/j.gloenvcha.2008.04.002

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.[1] 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, p. 100). It was also not the first time that rural people in Mozambique were pulled along as unwilling participants in important government decisions. Bowen (2000) analyzed the transition from Portuguese colonial government to the post-colonial period, using a case study in the Maputo Province, to find that the rural peasantry remained as powerless over their own collective destiny after the transition as before. Galli (2003) told a similar story, with a more specific focus on land planning and settlement decisions, showing a pattern of decision-making that paid little attention to the desires of farmers. Viewed in this light, the reluctance of the Limpopo floodplain residents to move makes complete sense.

Viewed in another light, however, it may seem foolish. Climate change is predicted to increase the risk of extremely intense rainfall over southern Mozambique and the headwaters of the rivers that drain there (Solomon et al., 2007). There are good reasons to believe that the risk of dangerous flooding is increasing, and that at some point many people will decide that the risk is one not worth taking. Indeed, this appears to have been one of the motivations for designing this particular resettlement program. Given climate change, it may be important for future resettlement schemes, and other adaptations, to succeed in the future, and hence to understand why the particular scheme in Mozambique failed. In this paper, we examine one potential explanation among many: could it be that the residents of the Limpopo floodplain viewed the risks of leaving as greater than the risks of staying? If so, then it would suggest that greater attention to the risk perceptions of residents in places affected by climate change is important, at the time that policies are being designed.

The remainder of the paper proceeds in three sections. In Section 2, we review the literature on climate adaptation, to suggest that the problem encountered in Mozambique is one that will increasingly become serious, in need of a solution. We also suggest reasons why we would expect a difference in risk perception, between policy makers and farmers, to exist. In Section 3, we report on a series of empirical studies designed to explore whether a difference in perceptions existed. In Section 4, we discuss our findings, and offer policy recommendations.

2. Background

2.1. Adaptation and risk management

In the last decade it has become increasingly apparent that climate change is already happening, and will continue to happen, bringing with it local impacts on people's livelihoods (Parry et al., 2007). People will need to change their lifestyles—adapt—either because the local impacts of climate change leave them no alternative, or because specific adaptation will reduce the losses associated with those impacts substantially. In many places, climate change will not manifest itself merely as a gradual change in average conditions, but rather a change in the frequency and intensity of extreme events, such as heavy rainfall or drought, or periods of extreme heat or cold (Solomon et al., 2007). These event place communities at risk, and climate change adaptation, then, is increasingly viewed as an issue of risk management (Hellmuth et al., 2007). Risk is the product of the magnitude and likelihood of harm, and risk management is the process of taking actions to improve expected welfare by reducing the likelihood or severity of future risks. Some types of risk management efforts involve state action, and require little involvement from citizens. For example, if a coastal or estuarine region faces the risk of flooding due to more intense storm surges, then the government may respond by building physical flood control measures. Other risk management measures, however, require the active participation of the people.

Like other programs to help people cope with climate variability, the resettlement scheme in Mozambique can be viewed as a climate adaptation requiring the willing participation of the people it was designed to protect. Another example is the application of weather, climate, and hydrological forecasts. Indeed, such forecasts were being used in Mozambique in 2000, with mized success. Lucio et al. (2007) reported that a long-range forecast of an especially wet rainy season did lead to increased planning efforts, but that it was often hard to convince people to take them completely seriously. Similarly, as Christie and Hanlon (2001) reported, many of the warnings—from months to hours before the flood hit—went unheeded. 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). Research has shown that in these cases, efforts are much more successful when they incorporate participatory communication practices. Patt et al. (2005) and Diarra and Kangah (2007) both give quantitative evidence of the benefits that seasonal forecast application can make when agricultural extension officers work with farmers to interpret the forecasts and incorporate them into locally-specific management practices. Many other studies have shown forecasts to be poorly or inappropriately used when such interaction was absent (Patt et al., 2007; Tarhule and Lamb, 2003).

The finding that participatory decision-making is necessary to support effective climate risk management echoes over three

[1] Based on evidence from the Zambezi River valley, however, there is some 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 (FEWS-NET, 2007).

decades of experience from efforts to manage technological risks, where the same conclusions have been reached (Fischhoff, 1995). In the field of risk communication, which studied and responded to the conflicts between risk experts, policy makers, and the public over issues of technological risk, the need for partnership between analysts and decision-makers emerged over the course of time. One of the other set of findings that emerged was that many people, experts included, often have a difficult time estimating and responding to risks in ways that actually minimize the likelihood of harm occurring. To explore whether particular patterns exist that risk communication practices could address, they turned to the results of experiments run by cognitive psychologists and behavioral economists on risk perception and risk minimizing behavior. In the next section we turn to those findings that seem most relevant for understanding how people perceive risks, and hence potential disagreements about risk in Mozambique.

2.2. Behavioral factors influencing risk perception

Experimental evidence has led to theory on how contextual factors influence how people perceive both the seriousness and the likelihood of outcomes. One factor that appears to play a large role in judging the seriousness of outcomes 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. A 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 personal responsibility for the losses (Baron and Ritov, 1994, 2004; Ritov and Baron, 1990, 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 result 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 exhibiting action bias, people want to take an action that will lead to a demonstrably good outcome, even when doing so will prevent another equally good outcome from occurring, or will indirectly allow another equally bad negative outcome to occur.

When it comes to estimating the likelihood of outcomes, people do not use mathematical formulae such as Bayes' Rule to estimate probabilities, but rather use a variety of mental shortcuts, known as heuristics (Tversky and Kahneman, 1974). Several of these are particularly important for suggesting how disagreements about relative likelihoods can arise. The *availability* heuristic describes a search pattern people use: people search their memories for instances of a particular kind of event occurring, and to the extent vivid memories are readily available, they will estimate the probability of that particular kind of event to be high (Tversky and Kahneman, 1973). Memories are vivid when they are recent (which would correlate with higher frequency), but also when they created a strong emotional impact (which would not necessarily correlate with higher frequency). Particular emotional responses, such as dread or disgust, can lead to very high estimates of likelihood for similar events occurring in the future (Covello, 1990). Another heuristic is *representativeness*: people evaluate the likelihood of an event affecting a particular person or group based on how representative the person or group is of ones that are affected by this particular risk (Tversky and Kahneman, 1974). Hence, one might judge it more likely that a homeowner in California will suffer a loss due to an earthquake than a landslide, because California is very representative of the kind of place that suffers earthquakes, and less so of the kind of place that suffers landslides, while ignoring evidence that landslides occur more frequently than earthquakes. 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). Indeed, most people's estimates of likelihoods for events that are not certain tend to be biased towards 50%: either an event will happen or not, and people tend not to rank one as much more likely than the other (Bruine de Bruin et al., 2000).

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 over-estimate climate-related risks.

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

We tested the 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. We describe the methodology and results from each empirical component in turn.

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. We organized the workshop in coordination with the local office of the Mozambique Red Cross, a representative of which invited a group of farmers with whom she was familiar to attend. 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 2 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 did not 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 did not 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 cannot 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. We organized this workshop in collaboration with the Mozambique Red Cross, and with them invited a diverse group 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 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

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

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 are consistent with 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. 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 10 different events occurring within their lifetimes. Some of these events were climate related, such as flooding, drought, and malaria, while 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 5 years, and over a 5-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, by comparing the two sets of answers, whether participants expected particular risks to grow worse in the future than they are today. The third set of questions focused on the climate-related events, and asked farmers to indicate whether these events are, in the present, becoming more or less likely. The purpose was slightly different than for the second set, namely to see if participants were already becoming more worried about particular risks. 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).

To select participants, the local office of the Mozambique Red Cross sent out a general invitation to farmers in the community to attend a meeting to discuss disaster management issues. After this meeting, we invited all farmers present to fill out our questionnaire. Seventy-five farmers from the village of Chiguidela completed the questionnaire, which took approximately 3 h, with the farmers dividing into groups of six to eight people, each being led by a facilitator from the Red Cross 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 the Mozambique Red Cross, completing the same paper survey as the farmers. The remainder responded to an email invitation that we sent out to a long list of key governmental and non-governmental policy makers in Mozambique, acquired as part of a separate World Bank study on climate adaptation institutions. These people 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 Fig. 1, 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

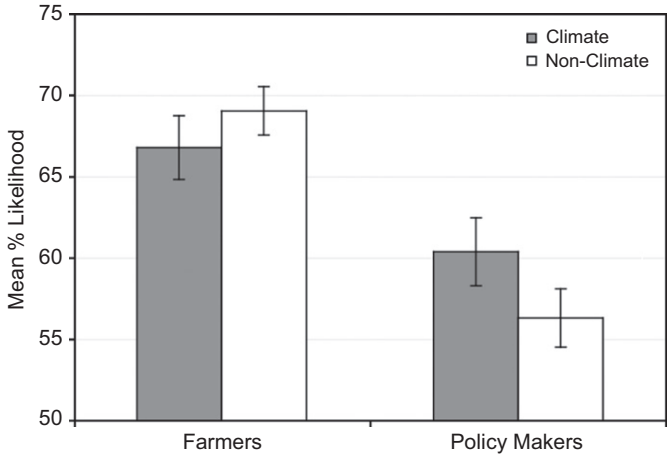

Fig. 1. Average assessed likelihoods of climate and non-climate events, among farmers and policy makers. Error bars represent one standard error. Farmers on average thought that the non-climate events were more likely, while policy makers thought that climate events were more likely, and the difference between the two groups is significant. The question to which people responded was: "Please indicate the likelihoods of the following 10 events that may occur within your lifetimes." The climate-related events were: the Limpopo River valley experiences floods more severe than those in 2000; two major cyclones hit the coast of Mozambique near Beira in a single year; a series of droughts in the Gaza province causes the majority of farmers to cease growing maize. The non-climate-related events were: an African country wins the football World Cup; a woman becomes the President of Mozambique; a major earthquake hits southern Mozambique; a large new civil war begins in one of Mozambique's neighboring countries; passports become unnecessary to travel between Mozambique and South Africa the mining industry in South Africa collapses; crime levels fall in Maputo, causing security guards to become unemployed.

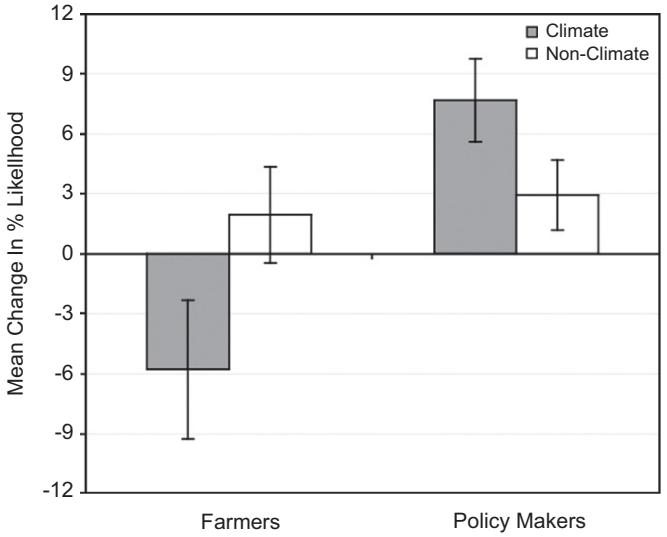

Fig. 2. Average assessed change in likelihood of climate and non-climate events, among farmers and policy makers. Error bars represent one standard error. Farmers anticipate that climate events will be less likely 20 years in the future than they are today, while policy makers believe that they will be more likely. The question to which people responded was: "Please indicate the likelihood of the following events for the typical farmer in the Limpopo River floodplain in the Gaza Province. If you are farmer there, please indicate how likely each event is for you." The participants then had two places to mark, one for "within the next 5 years," and the other "between 15–20 years from now." The climate-related events were: losing the entire maize harvest due to drought in 2 successive years; having to evacuate because of a tropical cyclone making landfall in the region; having to evacuate because of river floods, from heavy rainfall upstream; losing a close family member to a tropical disease, such as malaria. The non-climate-related events were: losing a close family member to HIV/AIDS; not being able to afford basic commodities because of high inflation; losing important items in the home to crime.

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* $t = 1.96$, $p = 0.054$). What is important is that the effect of climate-relatedness was negative in one group, and positive in the other. Because of this change in sign, the difference-in-differences was significant (*Student's* $t = 2.51$, $p = 0.01$; *Mann–Whitney* $z = 2.62$, $p = 0.009$). Relative to the other group, farmers saw non-climate-related events as the more serious, and policy makers saw the climate-related events as more serious.

On the second set of questions, farmers thought that the climate-related risks would be less likely in the future than they are now, (with marginal significance: *Student's* $t = 1.66$, $p = 0.10$), as Fig. 2 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. 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 (with marginal significance: *Student's* $t = 1.68$, $p = 0.099$). Again the difference-in-difference we were interested in was significant (*Student's* $t = 3.29$, $p = 0.0014$), as relative to the other group, farmers thought climate-related events would become less likely in the future, and policy makers thought they would become more likely. There was no such significant difference-in-difference for non-climate-related events.

We show results from the third set of questions, all of which concerned climate-related events, in Fig. 3. 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* $t = 2.54$, $p = 0.012$). Policy makers thought that the risk of river

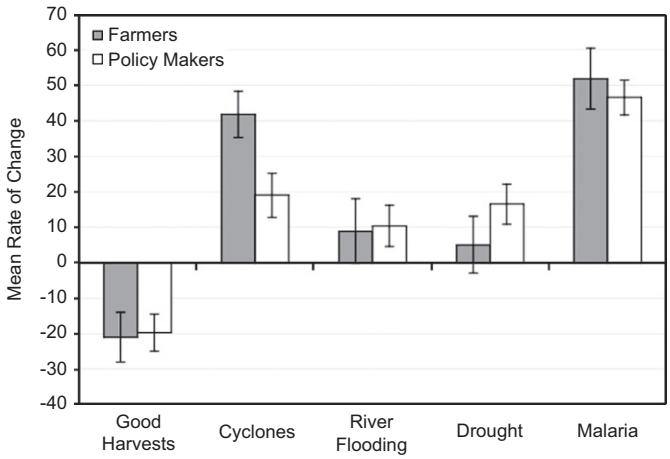

Fig. 3. Average assessed rates of change in likelihood of climate and non-climate events, among farmers and policy makers. Error bars represent one standard error. Both farmers and policy makers believe that the risk of cyclones and malaria is increasing, while good harvests are becoming less frequent. The question to which participants responded was: "Some events are become more frequent over time, while other events are becoming less frequent, and still others do not seem to be changing in frequency. We are interested in whether you believe that some events in Mozambique are becoming more or less frequent. Please draw an arrow to a point on the scale, to indicate whether the event is increasing or decreasing in frequency, and by how much."

flooding was increasing (marginally significant: *Student's* $t = 1.80$, $p = 0.077$), whereas farmers did not see any significant change. The same story existed for drought: farmers' saw no significant change, whereas policy makers' thought the risk of drought was

increasing (*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). Fig. 3 shows consistency across the two groups of participants: cyclones and malaria were the two risks that both farmers and policy makers saw as becoming more worrisome. But the difference between the results in Fig. 3, and those seen in Fig. 2, is revealing. Policy makers saw climate-related events changing in the present (Fig. 3), and expected those changes to continue into the future (Fig. 2). Farmers, by contrast did not extrapolate the current trends into the future: climate-related events are becoming more worrisome in the present (Fig. 3), but will be less of a worry in the future (Fig. 2).

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 an earlier set of Red Cross workshops that had been designed to promote climate change adaptation. The workshops, which had taken place in the communities of Chiguidela and nearby Malhazene in late 2005 and early 2006, 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. 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. The workshops, which lasted for an afternoon, asked farmers to contribute their own perceptions and beliefs about climate change, presented the scientific consensus that the main driver of climate change was carbon dioxide emissions, mainly from more developed countries, and then presented some simple scenarios about what this could mean for the future. The survey was administered in the two communities in December 2006, with randomly selected participants who included both workshop attendees and those who had not attended the workshops. The study area appears in Fig. 4.

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 Fig. 5, 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 Fig. 5, 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, 19 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

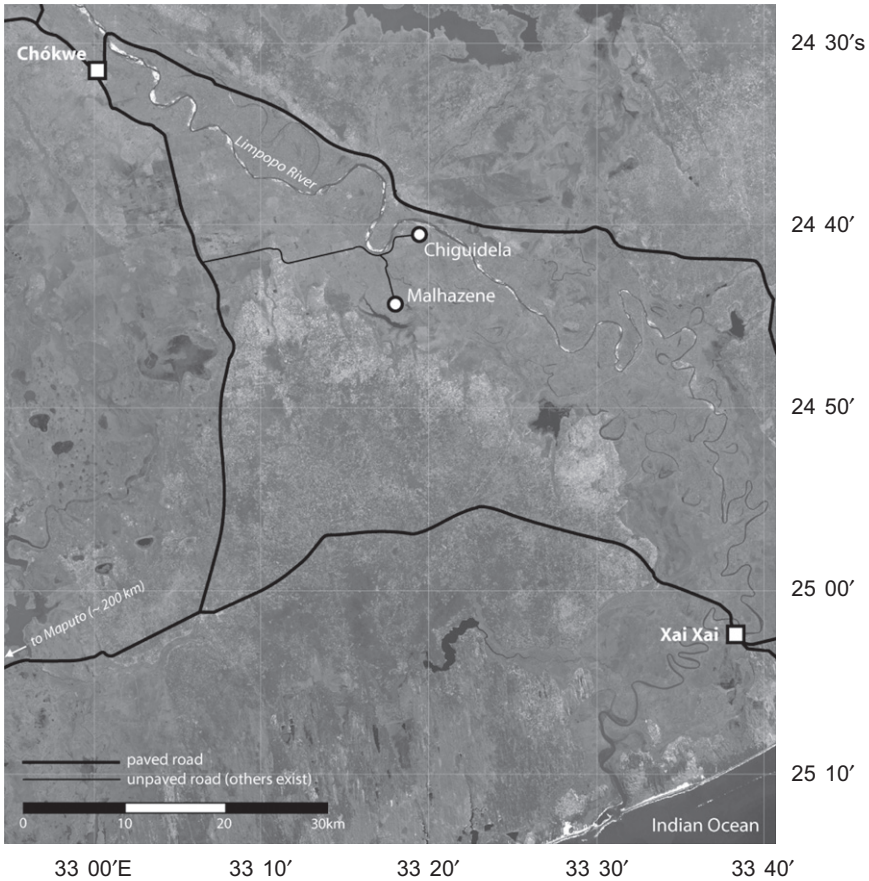

Fig. 4. Map showing the study area, including two survey villages Chiguidela and Malhazene, the district seat Chókwe, the provincial capital Xai Xai, roadways, and the Limpopo River. Data source: Global Land Cover Facility (http://glcf.umiacs.umd.edu).

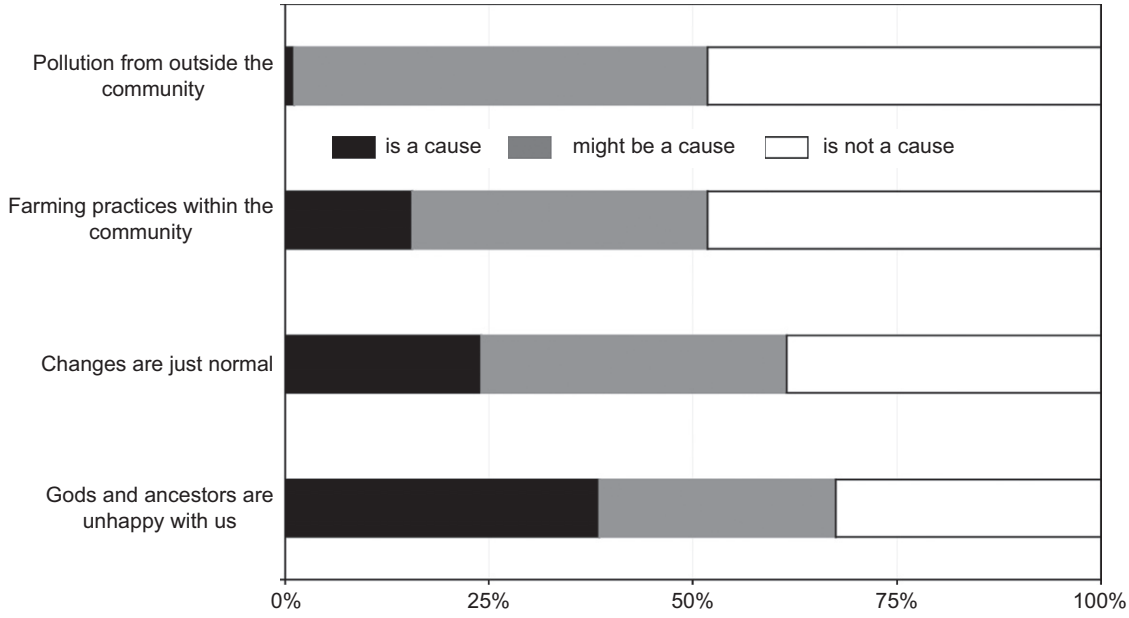

Fig. 5. Beliefs about causes of climate change. While about half of survey respondents thought that pollution from outside the community might be a cause of climate change, only 1 of the 83 respondents was confident in this. Many more identified their own behavior, the normality of change, and supernatural factors as being causes of climate change. The question which participants answered was: "Please indicate whether you believe each of the following is a cause, might be a cause, or is not a cause of any climate changes you have noticed."

of workshop attendees than non-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; what is noteworthy is how small and insignificant ($\chi^2[2] = 0.49$, $p = 0.782$) this difference is.

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, they suggest 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 are not the first results of studies of adaptation behavior, and indeed attitudes towards climate change, that reveal "behavioral" factors at work. The perception of climate risk is highly contingent on the social, cultural, and economic conditions within which people experience the risk, and perception influences behavior. Weber (1997), for example, 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 farmer 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. Grothmann and Patt (2005), as another example, examined 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. Using regression analysis, they found that psychological variables—factors such as feelings of control, optimism, and fatalism—were able to predict self-protective behavior with significantly greater accuracy than were the

socio-economic variables. Nicholls (1999) 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. 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). 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. Lemos et al. (2000), working in northeast Brazil, showed how behavioral biases can play a role in interpreting and applying information about climate variability. Hansen et al. (2004) showed how many farmers simply have a "finite pool of worry," and simply do not have the time to concern themselves with minor changes in climate risks. Marx et al. (2007) provide a useful review of this literature.

All of this work, ours included, supports the idea that climate risk management policies need to incorporate a great deal of participatory risk appraisal and response. Telling people that risks are increasing, and that they need to respond in particular ways, simply does not work. Rather, people need to be included in understanding how climate change may place them at greater risk, and play a large role in helping to design the strategies to respond.

Unfortunately, this level of communication and participation 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 of 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.

Acknowledgments

Funding for this research has been provided by the World Bank Development Economics Research Group project on Institutions for Climate Change Adaptation. We would like to acknowledge the assistance of Alexander Lotsch, Pablo Suarez, Moises Benesene, Rebecca Chalufo, Jorge Uamusse, Pedro Mondlane, Pedro Wate, other staff members of the Mozambique Red Cross, and two anonymous reviewers. All remaining errors are those of the authors.

References

ADPC, 2005. Integrated Flood Risk Management in Asia. Asian Disaster Preparedness Center, Bangkok.

Arndt, C., Bacou, M., Cruz, A., 2003. Climate forecasts in Mozambique: an economic perspective. In: O'Brien, K., Vogel, C. (Eds.), Coping with Climate Variability: The Use of Seasonal Climate Forecasts in Southern Africa. Ashgate Publishing Ltd., Aldershot, UK.

Baron, J., Ritov, I., 1994. Reference points and omission bias. Organizational Behavior and Human Decision Processes 59, 475–498.

Baron, J., Ritov, I., 2004. Omission bias, individual differences, and normality. Organizational Behavior and Human Decision Processes 94, 74–85.

Bowen, M.L., 2000. The State Against the Peasantry: Rural Struggles in Colonial and Postcolonial Mozambique. University of Virginia Press, Charlottsville, 320pp.

Brouwer, R., Nhassengo, J., 2006. About bridges and bonds: community responses to the 2000 floods in Mabalane, Mozambique. Disasters 30 (2), 234–255.

Bruine de Bruin, W., Fischhoff, B., Millstein, S., Halpbern-Felscher, B., 2000. Verbal and numerical expressions of probability: "It's a Fifty–Fifty Chance". Organizational Behavior and Human Decision Processes 81 (1), 115–131.

Christie, F., Hanlon, J., 2001. Mozambique and the Great Flood of 2000. African Issues. Indiana University Press, Bloomington, IN, 176pp.

Covello, V., 1990. Risk comparisons in risk communication: issues and problems in comparing health and environmental risks. In: Kasperson, R., Stallen, D. (Eds.), Communicating Risks to the Public: International Perspectives. Kluwer Academic Publishers, Dordrecht, pp. 79–124.

Diarra, D., Kangah, P.D., 2007. Agriculture in Mali. In: Hellmuth, M., Moorhead, A., Thomson, M.C., Williams, J. (Eds.), Climate Risk Management in Africa: Learning from Practice. International Research Institute for Climate and Society (IRI), Columbia University, New York, pp. 59–74.

FEWS-NET, 2007. Mozambique Food Security Outlook: March to July 2007. FEWS NET Mozambique, Maputo.

Fischhoff, B., 1995. Risk communication and perception unplugged: twenty years of process. Risk Analysis 15, 137–145.

Galli, R.E., 2003. Peoples' Spaces and State Spaces: Land and Governance in Mozambique. Lexington Books, Lanham, MD, 313pp.

GEF, 2007. Preventing Casualties and Livelihood Loss in Flood Prone Areas in Southern Africa. Global Environmental Facility, New York.

Government of Mozambique, 2000. In: N.I.f.D. Management (Ed.), Mozambique: INGC Situation Report, 24 May 2000.

Grothmann, T., Patt, A., 2005. Adaptive capacity and human cognition: the process of individual adaptation to climate change. Global Environmental Change 15, 199–213.

Hansen, J.W., Marx, S., Weber, E., 2004. The Role of Climate Perceptions, Expectations, and Forecasts in Farmer Decision-Making: The Argentine Pampas and South Florida. International Research Institute for Climate Prediction, New York.

Hellmuth, M., Moorhead, A., Thomson, M.C., Williams, J. (Eds.), 2007. Climate Risk Management in Africa: Learning from Practice. Climate and Society Publication Series. International Research Institute for Climate and Society (IRI), Columbia University, New York.

International Research Institute for Climate Prediction, 2000. Coping with the climate: a way forward. In: Basher, R., Clark, C., Dilley, M., Harrison, M. (Eds.), A Multi-Stakeholder Review of Regional Climate Outlook Forums, Pretoria, South Africa.

Johnson, E.J., Hershey, J., Meszaros, J., Kunreuther, H., 1993. Framing, probability distortions, and insurance decisions. Journal of Risk and Uncertainty 7 (1), 35–51.

Kahneman, D., Tversky, A., 1979. Prospect theory: an analysis of decision under risk. Econometrica 47, 263–291.

Kahneman, D., Knetch, J., Tversky, A., 1990. Experimental tests of the endowment effect and the Coase theorem. Journal of Political Economy 98, 1325–1348.

Klopper, E., Vogel, C., Landman, W., 2006. Seasonal climate forecasts—potential agricultural-risk-management tools? Climatic Change 76, 73–90.

Lemos, M.C., Finan, T., Fox, R., Nelson, D., Tucker, J., 2000. The Use of Seasonal Climate Forecasting in Policy-Making: Lessons from Northeast Brazil. University of Arizona, Tuscon.

Lord, C.G., Ross, L., Lepper, M.R., 1979. Biased assimilation and attitude polarization: the effects of prior theories on subsequently considered evidence. Journal of Personality and Social Psychology 37, 2098–2109.

Lucio, F., Muianga, A., Muller, M., 2007. Flood management in Mozambique. In: Hellmuth, M., Moorhead, A., Thomson, M.C., Williams, J. (Eds.), Climate Risk

Management in Africa: Learning from Practice. International Research Institute for Climate and Society (IRI), Columbia University, New York.
Marx, S.M., et al., 2007. Communication and mental processes: experiential and analytic processing of uncertain climate information. Global Environmental Change 17 (1), 47.
Mozambique News Agency, 2001. AIM Report No. 2006, 3 May 2001. Mozambique News Agency, Maputo.
Nicholls, N., 1999. Cognitive illusions, heuristics, and climate prediction. Bulletin of the American Meteorological Society 80, 1385–1397.
NOAA, 1999. An experiment in the application of climate forecasts: NOAA-OGP activities related to the 1997–98 El Niño event. NOAA Office of Global Programs, US Department of Commerce, Washington, DC.
O'Brien, K., Vogel, C. (Eds.), 2003. Coping with Climate Variability: The Use of Seasonal Climate Forecasts in Southern Africa. Ashgate Publishing Ltd., Aldershot, UK.
Parry, M.L., Canziani, O.F., Palutikof, J., van der Linden, P., Hanson, C. (Eds.), 2007. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, 976pp.
Patt, A.G., Zeckhauser, R., 2000. Action bias and environmental decisions. Journal of Risk and Uncertainty 21 (1), 45–72.
Patt, A.G., Suarez, P., Gwata, C., 2005. Effects of seasonal climate forecasts and participatory workshops among subsistence farmers in Zimbabwe. Proceedings of the National Academy of Sciences of the United States of America 102, 12623–12628.
Patt, A.G., Ogallo, L., Hellmuth, M., 2007. Learning from 10 years of Climate Outlook Forums in Africa. Science 318, 49–50.
Podestá, G., et al., 2002. Use of ENSO-related climate forecast information in agricultural decision-making in Argentina: a pilot experience. Agricultural Systems 74, 371–392.
Ritov, I., Baron, J., 1990. Reluctance to vaccinate: omission bias and ambiguity. Journal of Behavioral Decision Making 3, 263–277.
Ritov, I., Baron, J., 1992. Status quo and omission biases. Journal of Risk and Uncertainty 5, 49–61.
Samuelson, W., Zeckhauser, R., 1988. Status quo bias in decision making. Journal of Risk and Uncertainty 1, 7–59.
Solomon, S., et al. (Eds.), 2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK and New York, USA, 996pp.
Tarhule, A., Lamb, P., 2003. Climate research and seasonal forecasting for West Africans. Bulletin of the American Meteorological Society 84 (12), 1741–1759.
Thaler, R. (Ed.), 1991. Quasi-rational Economics. Russel Sage Foundation, New York.
Tversky, A., Kahneman, D., 1973. Availability: a heuristic for judging frequency and probability. Cognitive Psychology 5, 207–232.
Tversky, A., Kahneman, D., 1974. Judgment under uncertainty: heuristics and biases. Science 211, 1124–1131.
Unganai, L., 1998. Seasonal Forecasts for Farm Management in Zimbabwe. Department of Meteorological Services, Harare.
USAID, 2002. Impact Evaluation: Resettlement Grant Activity. US Agency for International Development, Washington, DC.
Weber, E., 1997. Perception and expectation of climate change: precondition for economic and technological adaptation. In: Bazerman, M., Messick, D., Tenbrunsel, A., Wade-Benzoni, K. (Eds.), Environment, Ethics, and Behavior: The Psychology of Environmental Valuation and Degradation. New Lexington Press, San Francisco, CA, pp. 314–341.
World Bank, 2000. A Preliminary Assessment of Damage from the Flood and Cyclone Emergency of February–March 2000. The World Bank, Washington, DC.