

ADAPTIVE:

Adaptations to climate change amongst
natural resource-dependant societies in
the developing world: across the Southern
African climate gradient

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Section 1 – Overview of project work and outcomes

Abstract

The research project ‘Adaptations to climate change amongst natural resource-dependant societies in the developing world: across the southern African climate gradient’ examines the characteristics of people’s responses to recent historical climate variability and change in four locations in southern Africa. There has been little systematic research into adaptation in the developing world: this research both increases the data base on such adaptations and uses these data to explore key traits of coping and adaptation, in order to examine particularly the processes that contribute to the shaping and dynamics of human responses to climate change in a region where use of the natural environment is a key component of livelihoods.

Study areas were selected on the basis of exposure to drought and heavy rainfall, and then within South Africa by using the technique of Self Organising Mapping analysis to differentiate detailed trends of climate change since 1950. This allowed changes in climate to be discriminated in terms not simply of general wetting and drying trends, but of detailed changes in the timing, duration and magnitude of rainfall occurrence.

Using a range of social science data collection methods, a rich body of data on community and household-level understanding of climate trends, livelihood changes, and relationships of these changes to environmental and other processes was accrued. Importantly, the data not only explains what people know and did, but how and why decisions to respond to changes were made. It was possible therefore to establish the basis upon which changes were undertaken, and the ways in which knowledge and information was transferred or learned within communities.

A key conclusion from the research is that common attributes to the adaptation process were identified across study areas. These attributes not only related to what people actually did in terms of their changing livelihood practices, but also to how adaptation occurred and the routes and process through which successful adaptations were made. In this regard, formal and informal institutions were found to be critical for both transferring knowledge from individuals to communities, and for the development of collective practises that had community-wide benefits. In all areas, the capacity to adapt to further climate changes, if based on adaptations to changes that have already occurred, is high. However, the distribution of the benefits of adaptation within a community is not automatically equitable, since traditions and structures within communities can affect participation and uptake.

Objectives

The central aim of the ADAPTIVE project has been to inform both theoretical developments on adaptive capacity and future policy/intervention responses aiming to enhance adaptive capacity, focusing on three questions in the sphere of natural-resource dependent societies in the developing world:

- What facilitates adaptation and its social and physical dynamics?
- Does adaptation occur directly to climate change, or indirectly in response to its impacts upon components of livelihood systems, including the natural environment?
- How does adaptation contribute to evolving social differentiation and economic and well-being equity?

Work undertaken

In order to address these questions, and to enable contributions to be made to the development of theories of adaptive capacity and vulnerability, research was conducted into:

- The actual processes and patterns of adaptation amongst natural resource dependant-communities, in areas with differing climate characteristics across the southern African climate gradient.
- The current adaptive capacity in areas modelled to experience significant changes in climate, and the natural resource base, during the 21st century.

Results

Key results from this research include:

- Recognition of the high level of local knowledge of the complexity of recent-historical climate variability and change. The trends in rainfall timing and magnitude identified in the SOM analysis were widely recognised by people living in the different study areas and affected directly by these changes.
- Development of a conceptual model of the ‘response space’ in which adaptation occurs.
- Identification of distinctions between coping and adaptation practices, in terms of how livelihoods were changed, the timing of actions, their duration, and the processes through which changes were facilitated.
- Recognition of traits to responses, both in coping and adaptation, that were common across the four study areas. However, commonalities are framed in differences in political and socio-economics histories in the two countries in which the research occurred.
- Reciprocity of actions between households and individuals proved to be very important in providing the means to cope at times of stress.
- Identification of the importance of collective action as a key way to set up new, often agriculturally based, opportunities to reduce vulnerability to the risks associated with climatic uncertainty. To facilitate collective actions, both formal and informal institutions were critical. These institutions also facilitate the transfer of ideas and innovative actions from key individuals through the communities, especially access to external information and resources.
- Recognition that collective actions and community management of resources do not necessarily create circumstances for equitable adaptations amongst all households with a community.

Relevance to Tyndall Centre research strategy and overall Centre objectives

The Tyndall Centre research theme 3 assesses how people at a range of scales can adapt to unavoidable climate change. The results above contribute to key interests in *how* people adapt, the *processes* of adaptation, and whether adaptation can be *equitable and just*. The research provides one of very few detailed studies into adaptation processes in the developing world. The research findings also suggest that there may be important generic characteristics to the processes of adaptation, particularly the facilitation of successful adaptation, which contributes to developments in adaptation theory.

Communications highlights

Papers have been presented at conferences and meetings including the following:

- May 2003 Seminar and Meeting, Oxfam Southern Africa Pretoria, South Africa.
- September 2003 Third sustainability days, University of East Anglia “Equity in resource management amongst natural-resource dependant societies: implications for equity in adaptation.”
- October 2003 Adaptive Research and Governance in Climate Change Conference, Ohio State University “Equity in climate change adaptation amongst natural resource users.”
- February 2004 Tyndall Theme 3, Adaptation Meeting, London
- February 2004 Seminar and Meeting, Oxford, Oxfam
- March 2004 Policy section briefing, Oxfam UK
- March 2005 Policy section briefing, Oxfam UK
- March 2005 Tyndall Seminar Series, Tyndall UEA “Response spaces and decision filters: how does climate change contribute to livelihood adaptation in Africa?”
- April 2005 Association of American Geographers, Annual Conference, Denver.
- April 2005 Royal Society Scientific Discussion Meeting ‘Food crops in a changing climate’, Invited poster.

Written highlights:

- H. Osbahr 2003. Location reports for *Mantsie community, Lehurutshe District, NorthWest Province, Khomele community, Dzanani District, Limpopo Province, eMcitsheni community, uThukela District, KwaZulu Natal Province (South Africa) and Nwadjahane community in Manjacaze District, Gaza Province, Mozambique*, Unpublished ADAPTIVE Report, 326pp.
- H. Osbahr, D.S.G. Thomas and C. Twyman 2003. *ADAPTIVE: adapting to climate change in vulnerable environments*. Phase 1 ADAPTIVE Research Note Series 1-10, www.geog.ox.ac.uk/research/projects/adaptive. 50pp.
- H. Osbahr 2004. *ADAPTIVE Phase 2 Fieldwork Report*, Unpublished report, 300pp.
2004. Invited case study contributions to joint NGO international awareness document ‘Up in Smoke: Threats from, and responses to, the impact of global warming on human development’. New Economic Foundation, London.
- D.S.G. Thomas and C. Twyman 2005. Equity and justice in climate change adaptation amongst natural resource dependant societies. *Global Environmental Change* 15, 115-124.
- D.S.G. Thomas and C. Twyman 2006. Equity in resource management amongst natural resource dependent societies: implications for equity in adaptation to

climate change. In N.Adger et al (eds) *Equity and justice in adaptation to climate change*. MIT Press, In press.

D.S.G. Thomas, C. Twyman, H. Osbahr and B. Hewitson 2005. Adapting to climate change and variability in southern Africa: farmer responses to intra-seasonal precipitation trends. *Climatic Change*, submitted.

H. Osbahr, C. Twyman, D.S.G. Thomas and N. Adger 2005. The distinction between coping and adaptation to climate change: insights from rural livelihoods in Mozambique. *Development and Change*, submitted.

H. Osbahr, N. Adger, D.S.G. Thomas and C. Twyman 2005. Successful adaptation: social networks, institutions and climate change. *World Development*, submitted.

2005. Invited case study contributions to enlarged pre-G8 joint NGO international awareness document 'Africa -up in Smoke: the second report from the Working Group on Climate Change and Development'. New Economic Foundation, London.

TECHNICAL REPORT



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Section 2 - Technical report

What did we do and why?

Individuals, communities, and nations have to varying degrees had to cope with and adapt to climate variability and change for centuries (e.g. Tyson et al., 2002; O'Connor and Kiker 2004). For societies directly utilising natural resources within livelihoods, changes in 21st century climate may represent significant disturbances and threats, especially where changes may be significant and pervasive and incorporate elements of surprise through the occurrence of extreme events.

Developing countries are particularly vulnerable to climate change impacts, especially changes in rainfall (Vogel 2000), because of their exposure to extreme weather events and dependence on natural resources (Vogel, 2002; Ikeme, 2003). Africa has more climate sensitive economies than any other continent, with a high number of rural dwellers dependent on natural resources (Denton et al., 2000; Kikar, 2000; IGBP, 2001; IPCC, 2001). Although communities in the region may have a greater ability than is widely appreciated to adapt to long-term changes in climate, such as increased seasonal temperatures and altered patterns of precipitation, increases in the number and severity of extreme events are affecting the context in which farmers manage agricultural production (Parry, 1990; Hulme, 1996; Ribot *et al.*, 1996; Dilley, 2000). Extreme climatic events such as drought, heavy rainfall and changing seasonality are exposing rural dwellers to new and, in many cases, unfamiliar conditions. While some farmers may be in a position to take advantage of these changes, many more are vulnerable to the changes (Ikeme, 2003; Ogunseitan, 2003). Consequently, understanding how differentiated societies adapt, and how successful adaptations can be facilitated, are critical for sustainable and equitable policy, practice and livelihood security (Burton *et al.*, 2002; Adger *et al.*, 2003b).

There are various geographical scales and social agencies involved in the process of adaptation. Individuals may adapt to climate in response to the impact of extreme events. Other adaptations may be undertaken by governments on behalf of society, sometimes in anticipation of change, but again, often in response to specific events. Thus adaptations can be anticipatory and planned (disaster preparedness) or spontaneous and reactive (disaster recovery) (Smit and Pilifosova, 2001).

BOX 1. Definitions

Adaptation is seen as the adjustment of a system to moderate the impacts of climate change, to take advantage of new opportunities or to cope with the consequences. In many cases, climate does not affect people directly but indirectly, by affecting the physical and biological systems in which they live. For societies that are reliant to a significant degree on the use of natural resources, these changes take on both direct and indirect aspects, since for such groups livelihoods do not provide a buffer against climate, but are highly reliant upon it. Adaptation can be best seen as a process that involves changes in a system to increase its coping range, rather than temporary adaptation of historically familiar measures to cope with a transient threat. This is in contrast to *Coping*, which is a temporary response to either a familiar disturbance or a transient threat. *Adaptive capacity* is used to refer to the ability of countries, communities, households and individuals to adjust in order to reduce vulnerability to climate variation, moderate potential damage, cope with, and recover from the consequences, including ecosystem responses to climate forcing. *Vulnerability* can be seen as the susceptibility of people to the harmful consequences of climate variability and extremes; this is largely dependent on adaptive capacity, the level of risk, and the sensitivity of a livelihood system.

The **central aim** of the ADAPTIVE project has been to inform both theoretical developments on adaptive capacity and future policy/intervention responses aiming to enhance adaptive capacity. In particular, the research focussed on **three critical questions** in the sphere of natural-resource dependent societies in the developing world:

- What facilitates adaptation and its social and physical dynamics?
- Does adaptation occur directly to climate change, or indirectly in response to its impacts upon components of livelihood systems, including the natural environment?
- How does adaptation contribute to evolving social differentiation and economic and well-being equity?

In order to address these questions, research was conducted into:

- the actual processes and patterns of adaptation amongst natural resource dependent-communities, in areas with differing climate characteristics across the southern African climate gradient;
- the current adaptive capacity in areas modelled to experience significant changes in climate, and the natural resource base, during the 21st century;

to enable contributions to be made to the development of theories of adaptive capacity and vulnerability.

Selecting study areas: how and why

To facilitate data collection on adaptation and adaptation processes we deemed it necessary to have a robust basis for selecting study regions within southern Africa, prior to carrying out investigations at regional, community and household levels. In particular it is essential to understand which specific dimensions of climate affect behaviour, with the issue of ‘adaptation to what?’ (p882) of great importance (Smit et al., 2001). For any climate measurable it is not enough to simply consider changes in mean annual conditions. The mean is a statistical artefact of climate, not what people actually experience, and is a poor indicator of the actual conditions faced for example by farmers (Mortimore and Adams 2001). Mean conditions by definition embody acknowledgement of variability, and by not representing a steady-state, they in effect embrace the coping range that societies and communities already operate within (e.g. Fukui 1979). The period over which the mean is calculated, and over which people have direct climatic experience, also affects the manner in which climate anomalies are viewed (Quiring 2004).

The temporal and spatial dynamics of climate variables are more critical to understanding the triggers to behavioural responses (Smit et al. 2001). Other significant factors are the magnitude of variability and the frequency of occurrence of particular climatic features, and issues of climate uncertainty (Dessai and Hulme 2003). The rate of change within climate systems is also important as this too can potentially affect the ability to respond, cope and to adapt (Hulme 2003). For farmers and other land users, the dynamics of rainfall are especially important. Intra-seasonal factors (Tennant and Hewitson 2002) such as the timing of the onset of first rains, which affects crop planting regimes, the distribution and periodicity of rain events within the growing season (e.g. Mortimore and Adams 2001), and the effectiveness of

the rains in each precipitation event (e.g. Usman and Reason 2004) are real criteria that affect the effectiveness and success of farming (Levey and Jury 1996). These parameters can possess elements of uncertainty and unpredictability (or surprise), but also may experience trends in occurrence that could lead to changes in natural resource use and behaviour over and above those that might be facilitated by better drought forecasting.

To capture these vital factors in this research and in study area selection, we first needed to systematically identify from country-wide South African climate data any climatic regions experiencing particular phenomena of rainfall variability over recent decades. We also wished to explore whether the data showed trends in the occurrence of particular phenomena. To achieve these aims we used Hewitson and Crane's (2002) self-organising mapping (SOM) approach to climate data, which was first applied in southern Africa by Tennant and Hewitson (2002). This allows a 'regionalisation' of South African rainfall to be achieved, from which we then identified the rainfall characteristics of each region, and from this selected areas where investigations with natural resource users would be carried out (Thomas et al. 2005).

We utilised Tennant and Hewitson's (2002) data set of South African climate but focused only on 1950-1999, a period in which farmer's could be expected to relate to in terms of 'historical memory' of natural resource use and climate characteristics. After the initial analysis it was decided, following Tennant and Hewitson (2003), to focus on the northeastern half of South Africa, thereby excluding both the winter rainfall zone in the southwest of the country, and northwestern areas where meteorological records are sparse. The subsequent SOM analysis therefore utilised the station data for the area 24°-35°E- 20°-30°S. The regionalisation produced 12 internally homogeneous rainfall groupings. To understand the climatic underpinning of the regionalisation, eight key parameters relating to components of rainfall relevant to farming activities, were assessed from the climate data set (Box 2).

Values for each parameter were calculated using a weighted mean of all station values from the region, and time-time plots were produced allowing 50 year trends to be identified for each region (Thomas et al. 2005) Three regions, regions 1, 6 and 11 in the SOM analysis, were selected on this basis for incorporation in the study, based on their differing precipitation trend characteristics (Figure 1, Boxes 3-5). In addition to these three South African regions, termed Areas 1-3 in the project, Area 4, in Gaza

BOX 2. Rainfall parameters used to investigate region climate trends

- mean rainfall per day (mean)
- maximum rainfall event per month (xmax)
- total number of rain days per month (rda)
- rain days exceeding 2mm per month (rdb)
- rain days exceeding 20 mm per month (rdc)
- dry spell factor: the number of consecutive days without rainfall between station rain days with 2 mm or more rainfall (dfac)
- wet spell factor: the number of consecutive station rain days exceeding 2 and 20 mm (wfac)
- 80th percentile rainfall event (nth)

Province, Mozambique, was selected using in-country climate experts, because suitable data was not available for the SOM exercise. This location embraced the lower Limpopo Basin, an area susceptible to extreme cyclone impacts and flooding, in addition to longer term trends in precipitation parameters.

Data collection methods and analysis

In each study area defined on climatic grounds, local expertise was used to identify one village in which detailed investigations were conducted (Figure 1). Field research occurred in two phases. In phase 1 in 2003, detailed questionnaire analyses and in-depth interviews were conducted with households in order to investigate the risks to which livelihoods are exposed (Table 1), recognition of climate variability and change and to examine whether people acted

BOX 3
VARIABLE DRY SEASON

Area 1 (Region 6 in the SOM analysis) covers parts of **North West Province**, extending from Mafikeng in the west to the border area with Gauteng in the east. This is a dry region with mean station precipitation falling in the 500-600 mm pa range, and regular droughts in the last 50 years. In this period, early-season rain days have been increasing (September and October), but in the main wet season the principle characteristic during the past 50 years has been year-to-year variability in rainfall amounts and distributions, without any specific trends in wetting or drying being identifiable.
Study village: **Mantsie, Lehurutshe District**

BOX 4
LENGTHENING DRY SEASON

Area 2 (SOM Region 1), in northern **Limpopo Province**, north of the Soutpansberg, has a long term mean annual rainfall of 400-500mm. The climate data show evidence of a growing length to the dry season, resulting in a later start to the wet season, in late October-early November. Within the wet season there has been a trend towards fewer rain days in November and December and an increase in the overall occurrence of dry spells, in effect representing potentially damaging rainless spells within the growing season. Droughts have been frequent in the last two decades (1982-3, 1987, 1990 and 1994 in particular).
Study village: **Khomele, Dzanani District**

BOX 5
UNCERTAIN RAINFALL

Area 3 (SOM Region 11) has a recent historical mean rainfall in the 800-900 mm pa range and is in northwest **KwaZulu Natal**, extending from the border with Lesotho to the town of Dundee. There has been both increasing uncertainty within the rainfall record and a trend towards higher half of the growing season. There is also evidence for an increase in early season rain days and a decline in late season rains (February and March). This is further represented by an increase in heavier rainfall events in the early season and a predominance of low volume rain events later in the season.
Study village: **Mcitsheni, uThukela District**

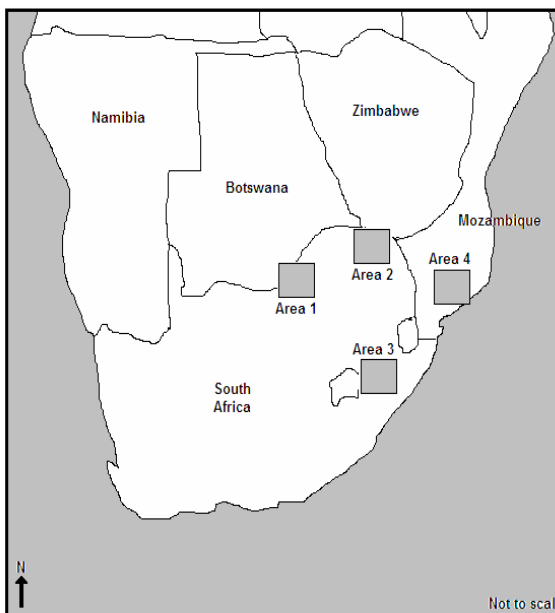


Figure 1. Location of study areas

Table 1: Multiple exposures to risks and their impacts across study locations

Livelihood risks and impacts	Study location			
	Area 1	Area 2	Area 3	Area 4
Climate	Regular drought risk, unpredictable rainy season, 550mm per year	Increasing drought risk, unpredictable and shorter rainy season, longer/intense dry season, occasional risk of intense rainfall, 525mm per year	Increasing risk of intense and variable climatic events (snow, hail, frost, drought, floods), weak wetting trend, 845mm per year	Risk of drought, unpredictable rainy season, risk of flooding, risk of tropical storms, 600mm per year
Environmental	Water shortages, damaged dams and limited groundwater, poor quality rangeland with increase in unpalatable grasses, land degradation and bush encroachment	Poor quality rangeland during droughts with limited degradation and unpalatable grasses, unproductive soils during drought (nutrients 'trapped')	Poor quality rangeland, land degradation and some soil erosion	Increasing woodland area around villages, loss of lowland during flooding, unproductive fruit and cashew trees
Socio-economic	RSA – Botswana border divided Tswana land (fragmented social networks), 1977-94 Bophuthatswana homeland (low investment and services, overgrazing) Post-1994 (government restructuring of service providers, increasing HIV/AIDS, high unemployment and poverty with a weak local infrastructure, dependency on welfare and remittances)	1960s 'new villages' (land disputes legacy), 1979-94 Venda homeland, regionally important market towns, development of strong traditional authorities, Post-1994 (government restructuring of service providers, HIV/AIDS, high unemployment, poverty and weak infrastructure, economic shocks from integrating into 'new South Africa', land reform, Zimbabwean refugees)	Importance attached to Zulu traditions in politics and culture, isolation from government services and opportunities until 1994 (legacy of townships: poverty, overgrazing, deforestation, unemployment) Post-1994 (government restructuring of service providers, economic decline for local industry, rising crime and rates of HIV/AIDS)	Legacy of Portuguese colonialism (migrant working, resettlement, land rights), Post-1975 independence (socialism and communes), civil war 1983-92 (population displacement, loss of family members and assets), Post-1994 peace agreement (economic shocks and institutional structuring, rising HIV/AIDS, poverty, poor services, low investment and weak infrastructure, high unemployment)

to enhance their resilience to climate, especially precipitation, variability and dynamics. In phase 2 in 2004, detailed analyses were carried out to research key dimensions of the processes of adaptation and agency, including the roles of external agencies, key individuals and the processes of learning and knowledge transfer.

In phase 1, quantitative and qualitative investigation of farmer understandings and responses to climate risks were undertaken. In each village, community meetings were held to give villagers the opportunity to raise questions about the research and to discuss perceptions of livelihood issues and the local environment. A series of focus group exercises, conducted with people from all sections of the communities, were held around specific topics. These concentrated on perceptions of environmental and social change with timelines, response strategies to change, sources of household income or support networks and farming practices all considered. Structured questionnaires and semi-structured interviews were conducted with thirty key informants at each village, providing detailed livelihoods information and

perceptions of risk and change, social capital, institutions and capacity. The questionnaire covered baseline information as well as specific topics relating to environmental and climate factors. These included perceptions of managing risk and adapting to environmental change, understanding of forecasts and uncertainty, information transfer, institutions and informal networks, food security and other external factors. Data analysis comprised complementary qualitative and quantitative techniques, comparing statistical patterns in the data using SPSS and minitab software with patterns in coded thematic interview narratives, interpretation of participatory and ranking exercises. By employing the same initial questionnaire survey in each village, we were able to investigate, for the three South African communities, whether the subtle differences in climate variability identified in the SOM analysis were correspondingly reflected in differing recognitions of risk in the three areas.

What have we learned about climate change adaptation processes amongst natural resource users in the developing world?

A conceptual model of adaptation

Building on findings from the first stage of research we developed a conceptual model of the ways in which adaptation and coping with major livelihood disturbances, including climate, may be constructed (Figure 2). To understand the process of adaptation, it is necessary to understand the characteristics of the risk to livelihoods in terms of disturbance or change, the sensitivity of the system to climate or environmental change and the vulnerability of the system to socio-cultural change. The responses that can occur at the household level are influenced by motivators and barriers to the decision process. This includes aspects of the household's behavioural intention and context, such as available assets (capital and resources), cohesion, values and ambition, social structures, networks and flows of information, altruism, self-efficacy, and individual experience and knowledge. These all contribute to what actually takes place in the 'response space' which is also affected by the locational context in terms of environmental resources and other opportunities, and external socio-political factors.

Identifying what occurs (and why) in the response space is important in terms not only of outcomes (whether adaptation or coping) but in terms of the potential to identify whether adaptation has generic characteristics. This would allow the processes of adaptation to be understood and their potential transferability, into the future and to new contexts, to be assessed. In this project we therefore sought to identify critical elements within the response space in terms of how people behave and have learned in respect of recent historical and current climate variability and change, in order to examine their wider relevance to the adaptation process amongst natural resource users.

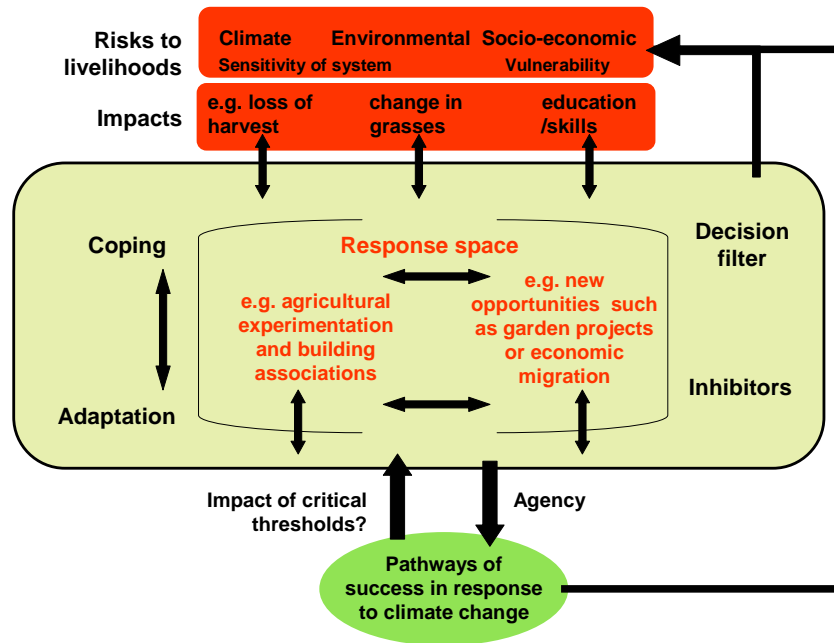


Figure 2. The conceptualised 'response space' of adapting to climate change

What do people know and recognise about climate change and variability?

Table 2 shows how issues of risk, variability and uncertainty are viewed differently in each of the three South African study areas. We specifically aimed to distinguish between *variability* as an expected climate phenomenon and *increased variability* linked with unpredictability. For example, in Khomele drought occurrence was relatively common and was thus experienced as a problem to livelihoods but not viewed as something unknown and therefore risky. Heavy rain on the other hand was seen as a 'surprise' event and in eMcitysheni the increased unpredictability of storm events posed significant risks for households. We took risk to be an understanding of *threat* (Kasperson and Kasperson 2001), that is a product of both the probability or likelihood of a particular occurrence and the related consequences perceived to affect people's livelihoods (Stirling 2003).

Drought was viewed as the prime risk in Mantsie despite occurring regularly. Inter- and intra-annual rainfall variability was viewed as increasing and changing; unpredictability was consequently seen as the most constraining climate-related issue in people's every day lives. This corresponds well with the SOM scenarios which show that this area is very dry and thus drought is common. No discernable wetting or drying trend was identified in the climate data analysis, though there is evidence for increased inter-annual variability. This latter observation is obviously posing the greatest challenge to the local population.

Table 2: Local understandings/experience of risk and uncertainty in climate

	Mantsie	Khomele	eMcitsheni
Drought experienced as problematic/negative impact on livelihoods	Yes 1957,1977,1979,1981-5, 1992-3, 2001-3	Yes 1974, 1982-4, 1990-3, 1997-98, 2001-3	Yes 1983, 1999-91, 1994, 2002-3
Heavy rain experienced as a problematic/negative impact on livelihoods	Sometimes 1994, 1999, 2000	Occasionally 1958, 1977, 2000	Yes 1996, 1998, 2001
	<i>Percentage respondents at each study location</i>		
Drought occurrence viewed as a distinctive risk	87	53	47
Heavy rain occurrence viewed as a distinctive risk	23	63	53
Increased variability and unpredictability of climate viewed as a risk to livelihoods	77	90	73

In Khomele drought and dryness are seen as normal and expected, with the main perception of changing risk being variability and uncertainty. Reports of the rains starting later and of shorter wet seasons characterised by little intense rainfall and more intense heat in the summer were expressed as the key concerns about the observed changes in, and unpredictability of, patterns of seasonality. Again, farmer interpretations of changes in precipitation correspond well with the regionalisation scenarios. Within eMcitsheni increased variability and uncertainty was again raised as a key concern amongst local populations, with 40% noting specific changes to climate patterns over a 5-10 year period. Respondents perceive climate-related risk as increasing due to growing variability and intensity of events, with more unpredictable extreme events like snow, frost, drought, and heavy rains happening more frequently.

From this analysis it is evident that natural resource users have been highly aware of changing climate conditions, with the subtleties of precipitation variability arising from the SOM analysis closing matching local understandings of change.

Is adaptation case-specific, or are there generic dimensions to community adaptation in the developing world?

Differing forms of responses to climate variability and change were identified within and beyond communities (Table 3). Responses are classified in terms of whether they are simply means of ‘getting by’ (*coping*), or whether they represent real forms of *adaptation* to the changes in precipitation parameters that have been occurring. Some of these adaptations are not responses that are unique to climate disturbances, such as diversifying livelihoods, but importantly have been clearly identified in this research as deliberate consequences of climate triggers. These adaptations occur in order to change the *nature* of the risks when living in a variable and changing climatic system, when it is not possible to reduce overall risks.

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Table 3: Impacts of, and responses to, climate parameters in the study villages

MANTSIE		
Parameters identified by focus group	Perceived impact	Range of responses – rapid (coping) and longer-term (adaptation)
Little rain Breaks in rainy season	<p><i>On welfare of household</i></p> <ul style="list-style-type: none"> • Hunger • Demands from family and friends for food • Sickness and tiredness <p><i>On NR based livelihoods</i></p> <ul style="list-style-type: none"> • Crops die • Loss of seeds less fodder for animals to eat • Debt (money owed from ploughing) • Young animals die • Less grass 	<p><i>Change a farming practice – coping</i></p> <ul style="list-style-type: none"> • Buy salt • Store fodder • Go to town to buy more seeds <p><i>Spatial/temp diversity-adapting</i></p> <ul style="list-style-type: none"> • Eat wild fruits • Look at plants and birds to decide what can be planted when and where • Buy short-maturing crop varieties • Take smallstock to river area or other villages <p><i>Commercialising –adapting</i></p> <ul style="list-style-type: none"> • Sell your animals • Try to start a business • Travel to town to find work <p><i>Networks- coping and adapting</i></p> <ul style="list-style-type: none"> • Send someone from the community to ask the government what they will do to help • Go to church • Ask family elsewhere to help • Collect your welfare payments/food • Steal
KHOMELE		
Parameter	Impact	Response
Less rain Period of no rain Unpredictable Rain out of season Late rain	<p><i>On welfare of household</i></p> <ul style="list-style-type: none"> • Tiredness and hunger <p><i>On NR based livelihoods</i></p> <ul style="list-style-type: none"> • Seeds do not germinate • Makes soil more unproductive • Affects planning – cannot tell the rainfall patterns by flowers on wild plants • Poor quality grass species • Livestock die • Dryland crops die • Pests proliferate • Leaves change colour • Less water for animals • More thorn bushes 	<p><i>Change a farming practice – coping</i></p> <ul style="list-style-type: none"> • grind maize stalks as feed • use resistant yellow maize • plant late maturing fruit trees <p><i>Spatial/temp diversity-adapting</i></p> <ul style="list-style-type: none"> • use irrigated land • eat wild fruits • work land in other places • cut fodder from ironwood trees and collect seeds from wild plants <p><i>Commercialising –adapting</i></p> <ul style="list-style-type: none"> • gardening projects to improve food security • form groups to start new business venture • Sell livestock, esp at auction • Look for piece work • Plant winter crops • Plant late maturing fruit trees • Breed indigenous species <p><i>Networks- coping and adapting</i></p> <ul style="list-style-type: none"> • Ask for money from relatives • Get help form government e.g. subsidised feed • Have village meeting • Local leasers decide what to do • Advice from church • Get medicines
EMCITSHENI		
Parameter	Impact	Response
Changing seasons Hail Drought Frost Heavy rain snow	<p><i>On NR based livelihoods</i></p> <ul style="list-style-type: none"> • No feed for animals • Makes soil more unproductive • Animals die • Can't afford to buy good seeds • Can't sell crops • Lack money (no crop/livestock sales) • No money for transport • Crops die 	<p><i>Change a farming practice – coping</i></p> <ul style="list-style-type: none"> • store fodder • build cattle shelter <p><i>Spatial/temp diversity-adapting</i></p> <ul style="list-style-type: none"> • change type of vegetable or maize type (related to spatial/temporal crop performance) <p><i>Commercialising –adapting</i></p> <ul style="list-style-type: none"> • change type of vegetable or maize type • plant vegetables • sell livestock or goods • start projects • find work <p><i>Networks- coping and adapting</i></p> <ul style="list-style-type: none"> • borrow from family • apply for government grant • have village meeting • pray at church • ask extension officer for information

Some forms of response occur in all three areas. Alongside these ‘generic’ adaptations we also found responses unique to each area. Two factors explain this: first as a response to locally-specific changes in precipitation parameters and second as a consequence of differences from place to place in socio-political structures and the availability of information. Three forms of generic activity prevailed: short-term coping; utilising landscape diversity; and commercialisation (Thomas et al. 2005).

Short-term coping. Rapid coping strategies have been widely identified (e.g. Berry 1989, Ellis 1998, Roncoli and Ingram 2001, Huq and Reid 2004). The situation in southern Africa is no different, with coping being employed across the case studies. In Mantsie and Khomele cropping ceases in the face of deficient precipitation and activities become focused in livestock management and vegetable gardening. In eMcitsheni, rapid coping strategies include the storing of fodder prior to end of the wet season, in preparation for drought events, the building of cattle shelters to protect animals from snow or cold, and in some cases, the selling of extra livestock and vegetables.

Using the spatial and temporal diversity of the landscape. Optimising livelihood outcomes by utilising spatial and temporal diversity in the environment is one way in which people can spread the risks associated with climate variability and unpredictability (Eakin 2000). In eMcitsheni and Mantsie *agricultural experimentation* and anti-erosion activities were notable actions. In eMcitsheni planting spacing of some crops were being increased in response to perceived seasonal changes in moisture availability. Short-maturing varieties of maize were being introduced in eMcitsheni and Mantsie. Contour ploughing and bunding were also being used to control soil erosion by water after droughts and as a consequence of greater rain event intensities.

In Khomele the scale of response has been somewhat different. People have gained access to land beyond the village in attempts to tackle the problems associated with the drying trend. This has either been through utilising existing friendship networks and forming small groups for projects, or through drawing on extended family in nearby areas to gain access to land. By spreading risk in this way it is possible for households to take advantage of the often patchy nature of rainfall in the region.

In Nwadjahane, Mozambique, using landscape diversity is also a very pronounced means of spreading risk. Villagers farm both the fertile lowlands through irrigation and the higher sandy dryland fields. Increasingly severe floods and droughts over the last two decades have increased demand from households for plots of land in *both* areas. While the lowland can produce good crops of rice, vegetables and potatoes, these can be destroyed during floods. Highland areas can produce good crops of maize and cassava during flood years. However, during drought years the highlands are less productive and thus the family will rely on the lowland production. Therefore in good years the family will be able to feed itself and sell surplus at a profit. Households with land in just one area have started to form informal farming associations to lobby those responsible for land allocation and have successfully managed to gain access to new areas to farm. This is especially important for very poor households as it enables them to share some of the production costs, and risks, and thus increase their overall resilience to both droughts and floods.

Collective actions & commercialising livelihoods. Collective action emerged as a key way in which people were able to set up new opportunities to reduce their vulnerability to the risks

associated with climate uncertainty. This emerged very strongly in Khomele and eMcitsheni, two communities with stronger overall profiles of community cohesion and consensus around livelihood issues. Activities included collective horticulture, poultry, and in EMcitsheni maize, production. Actions in Mantsie tended to be driven by individuals with fewer obvious opportunities and perceived incentives for people to work together.

Agricultural projects which utilised local knowledge and had a market base were the most successful. In Khomele the focus was principally on pig and cattle production to improve livelihood resilience and food security. Poultry and egg schemes were set up as general poverty alleviation projects. Deliberate attempts to improve the resilience of these farming strategies by the government extension service has also led to a return to the incorporation of indigenous livestock breeds that are more drought resistant. Small-scale horticulture projects have also emerged to supplement staple crops (sorghum and maize). Species of tomatoes were deliberately chosen for their drought resistant properties even though overall yields were lower than other varieties in good years. Many of these projects built on existing groups of people who had built up trust over time so that experimentation, innovation and information sharing were seen as risk-averse rather than risk-prone strategies.

Within Mantsie many of the activities to commercialise livelihoods to make overall livelihood portfolios more resilient revolved around individual rather than collective action. The village lacks effective leadership and has weak ties with external agencies such as government and non-governmental organisations. Exposure to successful projects is low and through sporadic family connections rather than more formalised networks as in other areas. Furthermore out migration of young men is still high and thus the stimulus for innovation here is low. Investments in livestock and poultry were seen as good ways for individuals to increase income during drought periods when crops were less reliable, thus acting as a buffer. Interestingly the closure of a nearby government-run cooperative forced small groups of friends to work together and a couple of successful vegetable projects have emerged. Though mainly for home use to improve food security, surpluses have been successfully sold to local shops.

The farming associations that have been developing in Nwadjahane, Mozambique, have become the focus of innovative and experimental farming practices. Through working in groups, villagers are able to spread the risk of new practices and technologies and learn for themselves through trial, error and experimentation. When successful, farmers have been able to take the lessons learnt back to their own individual farms. For example, 45% of those interviewed had changed to more drought resistant species of rice, maize, cassava and sweet potato at some point during the last 6 years as a direct result of the information exchange within and beyond the farming associations. The farming associations act as a buffer against initial risk with both poor and wealthy households able to experiment. The associations have also been particularly popular with groups of women, leading to a strengthening of their position within the farming community. With the support of extension officers these types of initiatives can strengthen livelihoods in the face of climate change and make livelihood activities more profitable and secure.

In the above discussion we have not included detailed findings from Mozambique. This is, because of the markedly different political history of the country, when compared to South Africa where the other three study areas lie. Our initial publication strategy has separated the presentation of first findings into those from South Africa (Thomas et al. 2005) and Mozambique (Osbahe et al. 2005). While both South African and Mozambique have undergone enormous political and social changes over the past three decades, the pathways of

change have been significantly different: in part due to the colonial legacy in Mozambique, which has distinct differences compared to the apartheid legacy of South Africa, and in part because of the role and magnitude of, several decades of frequently ruthless and bloody conflict in the country especially after Portuguese withdrawal in 1975, and during the Frelimo-Renamo civil war that ended with a signed cease-fire in 1992.

When we take the Mozambique data, we actually find that there are some notable similarities with South African findings in terms of people's responses to climate change and variability during the recent historical part. But this similarity is also framed in particular circumstances impacted on by the years of conflict which, in our study village of Nwadjahane, dramatically reduced livestock assets leading to arable production becoming dominant, and on changes in migrant labour opportunities.

Collective actions have been facilitated and through the creation of formal local associations in Nwadjahane during the last five years is a response to household labour shortages, poverty and the increasing unpredictability of the rainy season. Though these associations have been primarily driven by external NGO intervention, their success has been assisted by the strong sense of collective action and partnership that has been fostered through existing informal networks and traditional *matsoni* labour exchange practices. Some existing informal networks have been transformed into farming associations, while others have been created specifically to target households excluded from existing informal coping systems. This latter group of households have increasingly turned to more formal associations in order to gain access to the resources and capitals needed to increase their resilience to disturbances. The ideology of group associations has historical significance from the post-colonial socialist era, where in theory this form of organisation should be fair and equitable. It also reflects the community's shared experience of extreme events, which has caused natural and social disasters to become entwined in local belief systems. A shared sense of the past continues to encourage community cooperation making it socially unacceptable not to participate in meetings and activities.

Three farming associations have been formed in Nwadjahane, funded by NGOs and government institutions (Table 4). Since 1992 the more inclusive system of governance has encouraged participation and trust and improved communication links between villagers, NGOs and local government. Eighty-seven percent of households participated in a farming association and of these fifty-two percent did so to gain access to information, forty-five percent to gain access to extra labour and sixty-eight percent to gain access to more or better land.

Agricultural experimentation has also occurred in the Mozambique study village, fostered by the presence of the farming associations which have facilitated access to NGOs and extension services. It has been particularly prevalent on the lowland floodplain spoils which are less vulnerable to drought impacts. Experimentation has also included the development of citrus growing and agro-forestry, facilitated by knowledge transfer through government training courses and subsequent transfer from trained individuals, using the farming associations.

Agriculture in the Limpopo basin of Mozambique has historically used landscape diversity as a means of dealing with the seasonality of moisture and land availability in the floodplain. Access today to the dual elements of the landscape is complex for a range of reasons, some relating to impacts of the civil war on the region. The irrigated lowlands around Nwadjahane have fertile soils and villagers work these areas preferentially to grow vegetables, rice, maize and fruit. These soils are less risky during drought, despite being at risk to flooding during

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heavy rain and storms. There are differences within the village over who has access to lowland. Households with more male adults at home tended to cultivate more lowland. Similarly, those households that were closely involved in formal farming associations within the village were more likely to have access to lowland plots. Looking more closely at the profile of these households revealed that poorer households and those with fewer members tended to have access to highland areas only. Those with access solely to lowland tended to be returnees from the war; more established households with access to labour had been able to maintain the dual system. Increasingly those poorer households who were excluded from the lowland were able to negotiate access through the formal farming associations.

Within Nwadjahane, the selling of assets was also identified as a means of coping with climate stress. Of those interviewed, eighty-seven percent owned chickens and eighty-one percent owned pigs and these were reported to be the most common assets sold. Trade-offs between the benefits of livestock (e.g. milk, meat or potential income from ploughing) caused dilemmas on timing of sale in the market. However, more serious, depleting the household productive assets undermined long-term capacity to cope or escape from poverty.

Table 4: The characteristics of formal farming associations initiated in Nwadjahane

	Save the Children	INAS	ADRA
Year started	2001 (externally initiated)	2002 (initiated by village)	2002 (externally initiated)
Membership	55 members	75 members (part of larger district group)	40 in 2002 20 in 2004
Area	2ha lowland, 0.5ha dryland (traditional authorities)	2ha lowland, 2ha dryland (donated by villager)	0.5ha lowland, small plot dryland (traditional authorities)
Activities	Rebuilding irrigation system, planting vegetables, experiments: yellow sweet potato, cassava, sorghum (DDADR programme for food security and drought planning)	Planting vegetables, experiments: maize and rice, group copied cassava trials from STC	Cashew breeding, planting pineapples, groundnuts, vegetables
Organisation and external links	Bi-monthly member meetings Monthly village meetings (attended by all farming representatives) Links via traditional authorities to District Government, Extension Service and STC Accounts and records audited by STC	Informal meetings on fields Group representative attends village meetings Links via traditional authorities to INAS, extension service Financial reports audited by Extension Service	Informal meetings on fields Group representative attends village meetings Links via traditional authorities to District Government and Extension Service Finances and records groups audited by Extension Service
Rules to participation	Work groups Tuesday or Thursday, Contribute money, Vote at meetings	Work groups Monday or Wednesday, Vote at meetings	Work groups Tuesday or Thursday, 5000Mt deposit per plant
Training and equipment	Extension Service Tools, drought/disease resilient seeds/tubers from STC	Extension Service 16 head cattle donated by INAS in 2002 for ploughing and breeding	Extension Service, Plant breeding and equipment from ADRA, Training visits to successful farms in other villages

Can coping and adaptation be distinguished?

It is important to consider if it is possible to distinguish coping from adaptation, since to do so may have particular relevance in formulating policies at national and sub-national levels to deal with the impacts of climate change. While Smit and Skinner (2002) have developed a typology of coping and adaptation characteristics (Box 6), there remain significant practical issues in distinguishing them. While policy initiatives by governments may represent

adaptations for the sector as a whole, at the local or regional scale, adaptations and their likelihood of adoption will vary depending upon local circumstances. Thus, we wished to establish whether insights from empirical evidence could make an important contribution to understandings of the various dimensions of adaptation to climate change, especially within agriculture and rural livelihoods. To do this we specifically used our data from the Mozambique case study to explore: if the distinction is simply a matter of timescale; whether response to climate change is revealed as a reactive (coping) or anticipatory (adapting) action; if adaptation is triggered by events; and whether technological changes are always adaptations.

BOX 6**Coping & Adaptation characteristics**
(after Smit & Skinner 2002)

1. Intent and purposefulness differentiate between spontaneous or autonomous adaptations that are a) a regular part of on-going management from b) those consciously and specifically planned in light of climate-related risks
2. Timing and duration differentiates responses that are a) anticipatory (proactive), b) concurrent (during) or c) responsive (reactive).
3. Adaptations can be distinguished according to the scale at which they occur and the agent responsible for their development and employment.
4. Adaptation occurs via a variety of processes and can take many different forms at any given scale or with respect to any given stakeholder.

a) Coping

Most individuals and households clearly employ a combination of responses to the impacts of climate on their livelihoods. This suggests that coping occurs through incremental actions rather than in discrete stages, with types of coping actions constantly changing. It also highlights the artificiality of sequential constructions of coping and the importance of contingency in smallholder livelihoods (Watts 1983, de Waal and el Amin 1986, Corbett 1988). Faced with a combination of crises, the reality for households in Nwadjahane is that they draw upon a range of coping responses with differential effects on the household resource base (Box 7). Thus individual members of a household may simultaneously borrow, reduce food consumption, deplete household assets and engage in petty trade in other locations.

The ‘first step’ was a ‘*maintaining*’ coping response, which meant that households attempted to secure their immediate needs as far as possible without depleting liquid, capital or productive assets or diminishing the quality of their human capital. This is coping based on informal exchange, borrowing and the traditional ‘gift’ system. These activities are part of on-going daily livelihoods and cultural integrated into activities of institutions such as local churches. Despite the erosion of social networks during the civil war, these local connections and family networks are still critical for many people in times of difficulty and ninety percent had used them during the previous year. During extreme periods, households were forced to be economical with resources. These ‘*reductive*’ coping responses included reducing food consumption (by for example eating wild plants) and reducing expenditure to preserve remaining assets.

BOX 7 Coping experiences in Nwadjahane

Experience 1:

Carlos¹ family moved permanently from the village of Nhofohoco to Nwadjahane in 1983 because of the civil war raging in the remote rural areas. This was also during one of the worst droughts in the last 25 years. The family coped by buying limited food using remittances sent from Carlos' mining job in South Africa and survived by eating wild fruits and plants from the river. The family lost most of their cattle during the drought. Carlos returned to farm in Nwadjahane in 1988 on land allocated by the traditional leader. In 2000, serious regional flooding destroyed the harvest and several cattle drowned. Carlos felt cattle have become vulnerable to flooding because they are often grazing in the lowland after drought. In 2001, a storm washed away their home and animals were sold to pay for the construction. There was a bad harvest after the early season drought in 2003-4, which was compounded by damage by late heavy rains. The family sold some pigs and exchanged traditional alcohol to buy food. Goats and chickens that died from disease were replaced by gifts from relatives. They also rely on their friends to help and borrow money from family to support the large family of nine. Carlos has recently been sick and had to borrow heavily to pay for hospital treatment.

Experience 2:

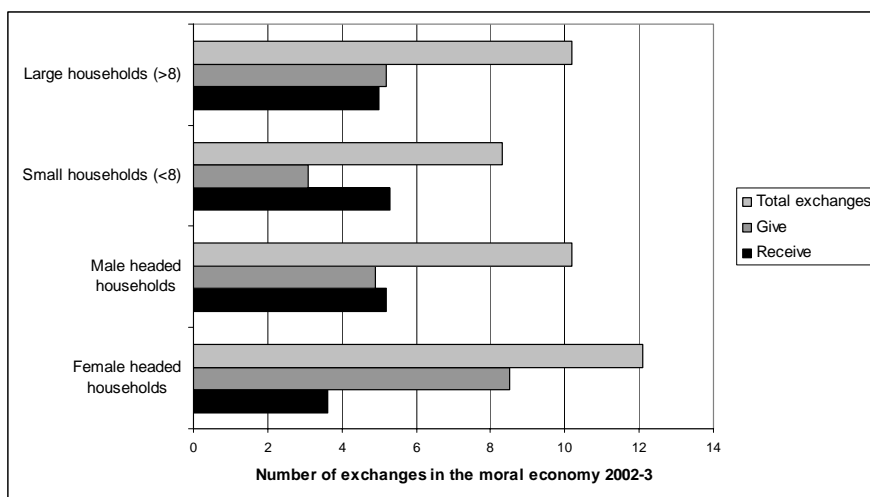
Joana returned to live in Nwadjahane with her two sons after separating from her husband. They have had to face a series of challenges and recent have coped with repeated climatic disturbances. The family lost their house in the 2000 storms and flooding and it was badly damaged again in 2004. Joana sold some pigs to pay for materials and her neighbours helped to rebuild a traditional hut. Then, in the early agricultural season of 2002 drought killed her crop seedlings. She decided to replant but the drought continued into the late summer, at the height of the rainy season. After a poor harvest, she was forced to sell some pigs and chickens to buy food and laboured on friends lowland fields in return for a portion of the vegetables. Joana decided to plant a drought resilient cassava variety at the beginning of the 2003-4 agricultural season. However, heavy rains brought flooding and destroyed the harvest. She asked her closest relatives in the nearby village of Chalala to give her food and seeds to plant on the lowland. The family borrowed cash from their neighbours because they have been able to collect firewood or labour the lowland fields in repayment. She has now temporarily sent her son, who is studying in Manjacaze, to ask family living in Maputo for money in order set up a business in clothing or cashew production which would be more resilient to climate disturbance.

The *depletion of household assets* tended to begin later than borrowing. Within Nwadjahane, the selling of assets was widely reported in times of stress, but this was a tactical reactive action and part of on-going farm management. Of those interviewed, eighty-seven percent owned chickens and eighty-one percent owned pigs and these were reported to be the most common assets sold. Trade-offs between the benefits of livestock (e.g. milk, meat or potential income from ploughing) was often reported to cause dilemmas about when to sell. This led to a lack of consistency in responses about the best time to sell, demonstrating that decisions were ultimately taken at the individual level. The coping action itself can have long-term consequences however, as depleting the household productive assets undermines long-term capacity to cope or escape from poverty.

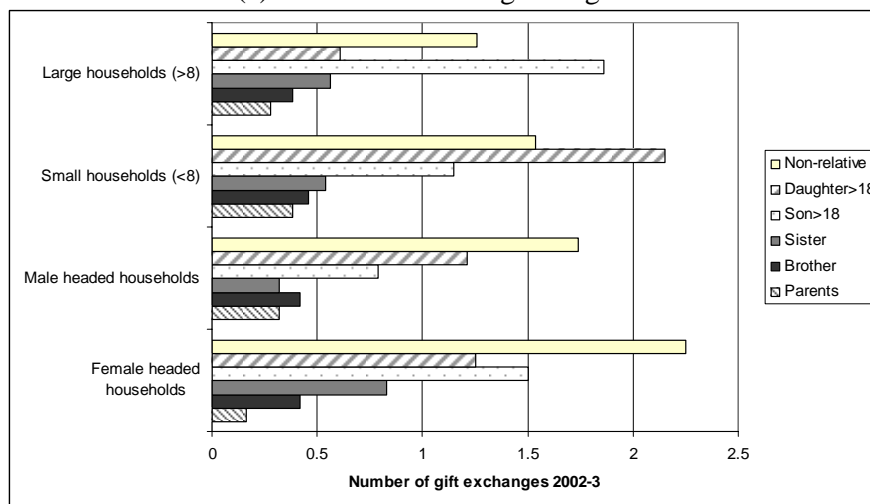
We identified two factors to be of particular importance for short-term coping: 1) having the capacity to put desired actions effectively into practice and 2) to be able to reciprocate in informal exchanges. However, ties analysis showed that once the limits of reciprocity have been reached, households can become particularly vulnerable unless alternative strategies to cope can be found. This vulnerability is highly differentiated amongst household types. Figure 3a for example shows how female-headed households are particularly dependent on these reciprocity networks, as well as having a higher dependence on support or remittances from their children. However, together with the elderly, these households often had difficulty in

¹ Names have been changed

reciprocating gifts. As a result, complex labour exchange systems are used to maintain immediate work on the land, to repay gifts with labour supply or in order to receive food for work from more wealthy households. *Kurhimela* is an informal general labour exchange used regularly by thirty-five percent, often by women and particularly by female-headed households (figure 3b). Small-scale, poor and female-headed households more frequently resorted to coping practices at the onset of stressful events though they were not necessarily successful. Larger households were most resilient in terms of being able to enact short-term coping responses and reciprocate without loss or damage to basic household assets, thus performing the ‘shock absorbing strategy’ (cf. Carpenter *et al.* 2001). *Tsima* is a form of work party arrangement where the host will provide food and alcohol to the workers: these tend to be male groups and regularly used by thirty-five percent. These mechanisms are used to rebuild houses after storm damage and help to replant fields after drought. Very poor households also send a member to food for work schemes run by NGOs called *ganho-ganho*.



(a) Household exchange categories



(b) Exchange characteristics within households

Figure 3: Understanding differentiated dependence and coping (within the moral economy active give and receive exchange include labour, food, cash, information, childcare, crafts, poultry, goats etc)

b) ‘Regenerative’ responses: moving towards adaptation

While maintaining responses are concerned with the immediate, repeated or ‘*regenerative*’ responses form the basis of dynamic attempts to address longer-term issues. They include ways in which households seek to expand the resource base and included diversification through flexible land use, petty trade, migration and the provision of services. Key regenerative responses identified in this study are discussed below.

- *Dual farming systems*

Dual farming systems are an example of regenerative coping that utilises the natural diversity of the landscape to cope with climate disturbances. In the Limpopo basin in Mozambique this involves using fertile lowlands during droughts and higher dryland fields if floodplain lowlands are flooded. However, coping decisions over land use were characterised by both spontaneity in response to immediate pressures and by changes to crops through trial and error. Two thirds of households in Nwadjahane have access to more than two hectares of lowland and half have access to more than two hectares of dryland. Maintaining the ability to diversify and be flexible enabled many households to be resilient in the face of seasonal disturbances. Of those interviewed, ninety percent had been able to maintain a dual system, though some plots were very small. The key constraint for those unable to follow this dual system was lack of access to land because land is only inherited or distributed through the chief. Thus households that could negotiate rights, and were able to foster favourable relationships with the chief, were in a better position to maintain resilient livelihood systems.

In response to an increase in frequency of drought events during the last twenty years proactive households have repeatedly exploited different features of the landscape, transforming patterns of land use. Households with more male adults at home tended to cultivate more lowland. Similarly, those households that were closely involved in formal farming associations within the village were more likely to have access to lowland plots. Looking more closely at the profile of these households revealed that poorer households and those with fewer members tended to have access to highland areas only, although these areas were more often used for insurance cropping. Statistical analyses suggested that larger households were able to better utilise these dryland plots because they had more land and family labour to work the soils using hand tools ($R^2 = 65$; at 0.0001 significance). Those with access solely to lowland tended to be returnees from the war; more established households with access to labour had been able to maintain the dual system. During the last five years, those poorer households who were excluded from the lowland have been able to negotiate access through formal farming associations. This represents a further increase in collective consistency of the practice, and an anticipatory response towards future climate events.

- *Diversification of livelihood activities*

The term *kuthekela* is used when rural people seek piece work or exchange products in urban areas. At least ten percent of respondents regularly used this coping practice. Moving the family away for longer, but temporary, periods was considered a last resort by some households during repeated or prolonged extreme situations.

Repeated and developed regenerative coping responses have transformed livelihood activities such as the intent, scale and length of migrations, forms of diversification in

production systems, and petty trade and services. These diverse activities are now consistently incorporated into rural livelihoods. Seventy-four percent of respondents had regular business activities besides subsistence farming, and an average seven livelihood activities, although the majority of these are still reliant on the natural resource base. Larger households were investing in goats because they are hardy and easier to look after than cattle. Spatial networks to other villages and towns increases access to resources unavailable locally, for example those with regular urban remittances were able to invest in cattle. The benefits of diversification remain inequitably distributed across the community, reinforcing differences in resilience.

Youths in particular invested socially in their urban contacts in Manjacaze, Xai Xai, Maputo and even in South Africa. Large households had a high dependency on remittances from sons, with seventy-one percent of households having a son away from home and nineteen percent having more than three males from the household regularly seeking work in urban areas, often in illegal temporary work. This form of adaptation has become a part of local identity, with time to seek wage labour seen as a ‘right of passage’ for young men. This is also partly a legacy of social adaptation to the shocks of forced labour, civil disturbance and the rapid transitions of liberalisation. However, the youth were experiencing push factors from the village as they claimed it was difficult to gain access to land and they felt alienated from the local decision-making structures. Those interviewed resented their family’s expectance of them to do well and send home remittances, but did not see subsistence farming as a way of life of which they could be proud. They wanted to generate ‘skills’ through education or exposure to skills training during migrant work. While these are recognised by NGOs working in the area, it raises the issue of how to address youth identity when assessing longer-term adaptations in rural livelihoods.

- *Reorganising social networks to formalise reciprocity*

The move towards an inclusive system of governance in Mozambique, with formal structures and clear responsibilities, has increased communication channels between the village, local authorities and the extension services. This had served to reinforce locally initiated coping responses and encourage the activities of ‘para-extensionists’ that facilitate the transfer of ideas about innovative new technologies. Critically, the ability to creatively reorganise social support networks, especially labour arrangements, and formalise the process of reciprocity in the moral economy, has helped sustain these practices.

This is largely a reflection the serious economic decline during the 1980s and 1990s and the lack of migrant work available that had previously provided the necessary cash inputs into the farming system. Heavy losses of cattle due to war and drought in the 1980s also destroyed assets that were once readily available to liquidate. Even twenty years on, many households have been unable to compensate for this loss. The traditional practice of *kuvekala* when those caring for others’ cattle and livestock get to keep the first born is more popular now than before 1992 according over seventy percent of respondents. Such practices protect social norms, including aspirations of livestock ownership, and strengthen solidarity and trust within the ‘community’ through the promotion of equity, at least in terms of access to productive assets. The formalisation of these networks has improved livestock health and increased communication between the Ministry of Agriculture’s veterinary staff and rural households.

Likewise, the labour exchange mechanisms of *matsoni* and *tsima* are more popular now than twenty years ago. Repeated exploitation of the non-cash exchange system by larger households created a buffer against the impacts of disturbance, and helped to explain longer-term patterns of inequalities in adaptive capacity across the community. However, villagers claimed that these formally recognised activities had helped maintain solidarity between neighbours, facilitating families a share in limited food during times of difficulty. This adaptation had potentially strengthened the village's capacity to cope with future shocks and can be likened to Carpenter *et al.*'s (2001) second key component of resilience, the ability to self-organise. That self-organisation has strengthened in response to climate drivers suggests that at the community-level resilience is strong, and that the 'culture' of cooperative action and solidarity was important. This is seen most clearly in the formation of farming associations.

The ideology of group associations has historical significance from the socialist era, where in theory this form of organisation should be fair and equitable. To date, the farming associations have begun to secure the natural resource base for the poor, who previously had little access to the lowland or even limited access to dryland plots. It also reflects the community's shared experience of extreme events, which has caused natural and social disasters to become entwined in local belief systems. Such cultural norms, where it is difficult to promote the 'individual' or talk about the success of individual fulfilment, makes the establishment of collective projects relatively easy because principles associated with new associations have deliberately aimed to reinforce these cultural norms and values. This has also made it easier for local leaders to initiate rule for membership.

- *Technological change and innovative farming responses*

Individuals have always responded to seasonal climate variability, but only in the last five years have farmers collectively been developing repeated and specific regenerative farming responses which plan for drought, heavy rains and increased variability. Government rural development strategy has specifically encouraged experimentation with improved varieties through its support of farming association programmes (Gomes and Carr, 2003) and this has had a direct impact upon Nwadjahane. Eighty-seven percent participated in a farming association. Over half the respondents claimed to be actively experimenting with new technologies (including both wealthy and poorer households) and had changed to a more drought resistant or a shorter maturing crop variety, such as rice, maize, cassava and sweet potato, as a direct result of extension advice disseminated through farming associations. Using new technologies in response to recent extreme climate change can be attributed as strategic adaptations because the changes included structural management and livelihood activities. Farming associations have also provided a formal buffer to the risks of individual farming with knowledge transfer back to the individual farm plot to address problems such as crop pests, effective use of fertilisers and the application of newly learned skills. Representatives from each farming association group are trained as 'para-extensionists' and become responsible for sharing new information amongst the association, and information exchange goes well beyond the boundaries of the farming associations and the slow process of copying uptake.

Active development of agro-forestry has been another recent innovation in local farming practice to drought. The Ministry of Agriculture and Rural Development have tried to revive the cashew industry, in collaboration with local NGOs such as the ADRA farming association through the provision of specific training on planting, breeding and nurturing trees which are a valuable source of food and income. The association has facilitated

investments in citrus plantations suited to dry conditions and provided further opportunities to exploit urban markets. Through their own social networks, influential individuals established links to government-run training centres for dryland agro-forestry in a nearby village, but information that is received gets shared at group meetings. Young people in Nwadjahane felt that the planting of individual trees had increased their access to land and cashew and fruit harvests had provided valuable cash crops. Associations have facilitated institutions that support the independent work of innovative individuals as well as the collective actions of the group. The impact of the government programmes could be distinguished from trial and error practices by individuals because of the intent and purposefulness of the action, its strategic impact on management structures and the uniformity of uptake by groups.

c) Key points on the differences between coping and adaptation

- We identified a difference in the **timescale** over which coping and adaptation operate, with ‘coping’ a response to short-term immediate situations. However, the case study illustrates that a distinction is more complicated when regenerative coping responses are repeatedly used to develop adaptations to longer-term or more persistent change. For example, responses to regular drought and risk of flooding have established a dual land use system, where consistency has developed; tactical ‘trial and error’ farming practice by individual farmers has become a more strategic ‘proactive’ practice by village groups.
- Certain actions can be both coping and at the same time form part of the process of adaptation. This is because people have **dynamic livelihood responses** and are reacting and anticipating to events. For example, the enhancement of social networks for economic migration was used to access coping support and longer-term business development. While adaptation was often triggered by events (e.g. climate change, economic shocks and war), such as land use change or creation of informal support groups, not all the observed adaptations within the case study had been triggered by specific events; some were the result of strategic interventions by government programmes, evolving social dynamics or the actions of innovative and well-connected individuals.
- **Technological changes** (such as observed crop innovations) are not always adaptations undertaken outside times of crisis. New ways of doing things were distinctive during reactive coping too, and successes of changes brought about during coping, for example experimenting with new groundnut varieties during drought, sometimes became part of subsequent ongoing technological strategies.
- Generally we found adaptations to operate at larger **scales** than coping. This resulted in differentiated success across the study households, because not all households were able to uptake new adaptations, due to lack of access to or exclusion from information, institutions or crucial resources such as skills and cash. Particularly vulnerable households, often headed by females, pursued the exhaustion of reciprocal exchanges. While the study found significant differentiation in human capacity within the village, individuals still turned to collective support networks and the traditional authorities in times of stress. The role of the traditional authorities therefore remained central to facilitation of initiatives at the local level.

The research highlights how **resilience operates at different scales through the form and timing** of adaptation. For example, while remittances obtained using social networks are important to local investment (improved housing, cattle restocking, education, and

farm supplies) in general, a complex and dynamic set of push and pull factors operate at the individual-level creating increased inequalities within the community. Likewise, the activities of farming associations as institutions may have increased community resilience to drought, but the labour intensive technologies they promote have yet to create the wage economy that will stimulate development.

- Adaptations were generally distinguished by their ‘**appropriateness of action**’, and by livelihood progression beyond reactive responses to climate change. This was reflected in structural management changes, such as in land use, livelihood activities or crop type.

What is the scope for equity, and social justice, to take place at the community level during adaptation?

Adaptation to climate change presents formidable dilemmas of equity and justice, many of which are most acute in natural resource-dependent communities in the developing world (Adger et al. 2003b, Paavola and Adger 2002). Equity and justice, or ‘fairness’ (Beg et al.(2002), in climate change can be considered in terms of *processes*, which largely relate to emissions issues, and *outcomes*, that relate to impacts, vulnerability and adaptation (Rayner and Malone, 2000). Justice can also be considered to have *distributive* (cf. Miller 1992) and *procedural* (cf. Anand 2001) forms, where the former relates to the distribution of benefits and adverse affects of climate change across society, and the latter, in this theoretical framing, to how and by whom decisions on adaptive responses are made.

The predominant focus of the UN Framework Convention on Climate Change (UNFCCC) on issues at national and larger scales potentially leaves a vacuum at sub-national levels with regard to the equitable nature of the impacts of adaptive strategies to climatic change. Indeed, issues of equity and justice in the context of climate change are probably far more readily argued and embraced at this country-to country level than at smaller scales, where, to date, they have received scant attention. This is significant, since climate change is likely to impact and disrupt the development process, with adaptation processes potentially exacerbating inequalities in well-being by creating winners and losers (Kates 2000). As part of ADAPTIVE, we explored the issues of equity and justice in adaptation at the community level, especially in the context of community management of resources, which has often been seen as the panacea for many development problems in for example Africa. To do this we utilised data and experiences from as series of previous research projects in southern Africa, using adaptations and responses to non-climatic livelihood disturbances as analogies for adaptation to the stresses brought about by climate changes (cf. Meyer et al. 1998; Thomas and Twyman 2004). There are strong explicit and implicit linkages within current development agendas between *empowerment* and equity and justice (Brown, 2002; DFID, 2002; Logan and Moseley, 2002). These linkages have implications for adaptation because of links to procedural and distributive elements of the development process. These were explored in case studies drawn from southern Africa research conducted through the PANRUSA and the CINDE projects² (Thomas et al., 2002).

Decentralisation of the control and management of rural water supplies in Namibia was used to explore the notion of equity and *procedural justice*. Procedural justice is closely linked with notions of legitimacy (Adger et al., 2003a). In particular it is concerned with the absence of effects on others, or with obtaining their consent when impacts occur (Paavola and Adger, 2002). However, when policies affect the social institutions that govern key natural resources,

² See www.shef.ac.uk/panrusa and www.shef.ac.uk/cinde for further information.

especially at the local level, some fundamental questions relating to equity and justice are raised. In Namibia, following legislative changes, the Directorate of Rural Water Supply (DRWS) in Namibia aims to have all rural water points in communal areas under community-based management by the year 2007, utilising the principle of cost recovery with local water point committees handling water management at the village level. The DRWS is aware that the cost recovery approach could cause marginalisation of the poorest but admit that this will be difficult to identify. To address this, DRWS maintains a degree of formal procedural justice at the core of their approach. For example, extra extension officers are being recruited to introduce this system to communities. For those communities that can be identified as 'very poor', water points will continue to be subsidised by the government. However the overall aim is that the 'very poor' households in differentiated communities will be subsidised by the 'rich'. How this is to be achieved in practice is unclear and the potential for exploitation remains. Although this policy sees decentralisation of resource management as the key to empowering local communities, the complex relationship between empowerment and equity has not been thought through (Thomas and Twyman 2005).

Equity and *distributive justice* were investigated through analysis of the implementation of financial assistance programmes aimed at benefiting dryland farmers in Botswana. In southern Africa, households and communities are recognising new natural resource use and livelihood opportunities in response to a range of different drivers (Thomas et al., 2002), of which climate change is one. Adaptations occur through both formal and informal opportunities, and, regardless of whether there are government interventions, rural people have demonstrated their resourcefulness. Some interventions, and some situations where interventions are not currently occurring, may be contributing to a growing polarization of well-being and an uneven distribution of intervention impacts. In Botswana, the Finance Assistance Programme (FAP) was established by the national government in 1982 as a means of encouraging small entrepreneurs, including farmers, to set up businesses or diversity activities, particularly in rural areas, through 90% loans. The implementation of FAP has not, however, been even. FAP funded initiatives have included livestock purchases, for example poultry and smallstock, agricultural development such as market gardens, and small enterprises including brick making and bakeries. There have been notable discrepancies within the manner of FAP implementation between districts in Botswana. In southeast Botswana close to the market town of Lobatse, a range of individuals received FAP funding for a diversity of projects. However in remote and arid southwest Botswana, where small stock farming dominates, many potential FAP benefits were not realised for two main reasons: very few non-smallstock related schemes were supported, and the absence of a regional financial infrastructure restricted the ability of individuals to make applications (Thomas and Twyman 2005). This example illustrates that intervention-generated opportunities are not being taken up, or even applied, evenly in Botswana. Formal attempts at distributive justice can be well placed but may not always have intended outcomes. Some interventions are actually even increasing, rather than reducing, vulnerability, particularly amongst poorer groups. Though the focus on smallstock support in southwest Botswana was environmentally appropriate, this had the potential to increase vulnerability by restricting people's attempts at diversification. Furthermore, well-being differentials (i.e. inequality) in the region were increasing as poorer farmers were excluded from the means of access to the intervention, because of the difficulties of traveling to a distant bank to make an application. Situations such as this can therefore contribute to widening gaps in well-being and to unsustainable natural resource use, as well as inhibiting local creativity and innovation in adaptation.

There are a number of important implications of the findings above for equity in climate change adaptation. From the perspective of community level equity and justice in resource use and management, the case studies above show clearly that community management is not as utopian as is widely suggested in the literature. Wider evidence to support this can be drawn from research in the Machakos District of Kenya, where the reinstatement of traditional land use practices can be equated with self empowerment, and aggregate assessments of the outcomes in terms of productivity and wealth generation showed significant livelihood improvement (Tiffen et al., 1994). Murton (1999) however identified losers as well as winners, with the marginalization of some households, leading to polarisation of well-being. Twyman et al. (2001) also found community self-empowerment to have marked implications for equity considerations and for those involved in the formalization of development outcomes. Therefore, only with such multi-scale analysis can the full nature of equity and empowerment issues be exposed, allowing particular attention to be paid to supporting strategies that will enhance secure livelihoods and aid poverty reduction, in addition to enhancing our understanding of fairness.

Procedural justice that empowers local actions needs to create ‘head room’ (Tompkins and Adger 2004:3) within which local actions can develop. Furthermore, even when this occurs, devolved decision making (an element of procedural justice) does not necessarily lead to distributive justice and equity in terms of resource access and actual local level decision making. As a result winners and losers are produced at a range of scales, and equity may well be sidelined as an unobtainable ideal. So, if climate change in low latitude developing countries impacts on the natural resource base, by for example affecting species distributions, crop growing seasons, and water availability, the ‘head room’ for equity is likely to be reduced through the diminishment of resource base availability. While resource shortages do not necessarily create conflict, they may well create different spaces in which it is more likely for winners and losers to polarise. Furthermore, given the variability of institutions potentially adapting to climate change at a range of different scales, the explicit role of equity in outcome (whether intended, unintended, expected or unexpected, as in the case of the FAP in southwest Botswana) needs to be a central concern.

How can successful adaptation be engendered, and by whom? (The role of agency and social capital)

Within the conceptual model (Figure 2), individuals and communities have some autonomy to choose adaptation pathways and locate themselves within the adaptation space. The degree to which they are autonomous is, of course, constrained both by the wider economic and political environment but also by antecedent decisions that partly lock them into particular pathways. A key issue then is to identify whether any location or pathway is in any sense superior to any other. This is a normative issue: the success of adaptation clearly involves judgement regarding values and priorities and depends on who is making decisions within the adaptation process. Nevertheless, there are widely accepted notions that successful adaptations should reduce the risks associated with present day and future climate for all involved, and should not reduce the options for future actions. While the assessment of adaptation is inevitably normative in nature, identifying successful and potentially unsustainable adaptations is important both for policy purposes as well as to highlight how the issue of adaptation can become a crucible for amplifying, or potentially resolving, existing conflicts over development, progress and the allocation of resources.

Issues about the success of adaptation parallel debates seek to define the sustainability or resilience of resource use or policy intervention. Recent insights into the resilience of social and ecological systems are particularly relevant here (Carpenter et al. 2001; Folke et al., 2002; Berkes et al., 2003; Adger, 2000; Gunderson, 2003). Since resilience is a technical term related to the properties of a system, it can be assessed through indicators that measure, in the context of specific configurations and disturbances, the ability of a system to:

- absorb shocks and retain its basic function;
- self-organise, for example through social institutions and networks; and
- innovate and learn in the face of disturbances.

We take on board elements of resilience theory and define successful adaptation as *adaptation that increases resilience*. The benefits of this approach are that it recognises that there is no single pathway within the adaptation space in our conceptual model, and allows for considerations across scales and contexts. Additionally, it allows the role of governance to be integrated, since a resilient adaptation is likely to require legitimate and inclusive institutions if collective and self-organised (and hence autonomous) actions are to be facilitated in a sustainable manner (Agrawal, 2002).

Livelihood stability – the coping dimension

In this research we found that institutions provided both stability and a framework for taking action to respond to climatic disturbances and change. These institutions were essentially informal networks that developed to facilitate coping actions or daily livelihood activities, including those associated with generating economic income or support. Through these institutions, individuals and households received and gave activities, products or money that formed the elements of the coping system. We term these links ‘ties’. The institutions that provided frameworks for these relationships occurred not only within a village, but also networks that extended to other locations. Both institutional forms were found to play vital roles within coping strategies.

The role of informal village institutions

We found these informal institutions to be **exclusive types of networks**, defined by kinship, neighbourhood or friendship, and are loose and changeable rather than being reliant on leaders or external instigation. For example, the closure of a local farming cooperative in the town of Lehurutshe, North West Province, had forced friends in Mantsie to work together occasionally for the economic reason of supplying produce, but groups did not endure. However, informal institutions remain especially important where there were weak formal institutions, such as southern Gaza Province in Mozambique. However, such snap-shots disguise the stark differences between the two locations in long-term coping resilience. Despite the high number of active exchanges in Lehurutshe, villagers felt there was weak solidarity, ineffectual leadership and high levels of crime. They felt that only the local church system had encouraged a sense of local reciprocal support. Women in particular have maintained strong friendship networks through the church, reinforcing historical networks developed when men are more regularly working away from the village. The church has increased in popularity in the last five years, which local people attributed to the increase in households seeking support with AIDS/HIV in the family, and as a result, attitudes about everyday actions, destiny and environmental management have adopted an ideology of fatalism, which contrasts with the elders’ beliefs of ancestral protection and knowledge to use nature. Meanwhile, the networks of exchange in Mozambique had developed a more inclusive of exchange.

Exclusive groups were reinforcing patterns of inequalities, inflaming feelings of jealousy and disillusionment, and making daily response a competitive process. At the household level, inequalities were skewed even further. At all locations, larger households were better able to initiate and maintain informal social networks based on reciprocity without damaging local labour demand for subsistence activities. In Limpopo, large households had more receive ties and were able to secure stability in their livelihoods even during times of difficulty, whereas small households were forced to resort frequently to reactive temporary migrant work or the giving of labour for food. In both Limpopo and KwaZulu Natal, large households had been more able to establish a geographically wide network of ties, offering options for migrant work, and reinforcing patterns of vulnerability.

The role of informal networks outside the village

People have also evolved a dependency on complex informal institutions to provide them with the essential networks external to the villages. These **'bridged' networks** have historically provided temporary coping responses, such as migrant work, opportunities to develop more diverse livelihoods and access to technology or access to land in other locations.

Maintaining external relationships brought more coping options during times of difficulty. For example, people from Lehurutshe who invested in bridged networks had received statistically more gifts during drought and had better access to tractor hire for ploughing, allowing them to counteract the lack of labour and cattle.

The migrant wage remains an important part of male identity and a regular part of coping. This is despite recent political and economic changes forcing many who used to have jobs in industry or on commercial farms to return home and farm. In Limpopo and KwaZulu Natal, these returnees were particularly enthusiastic about the 'modern' farming they had encountered elsewhere and were more likely to favour new practice and seek and disseminate new ideas. Migrant work is the main source of cash for all the rural villages, where there is a lack of microcredit. Even the traditional chief in the village in Limpopo was not immune to the necessity of the migrant wage. However, it was most significant in the village in North West Province where entrepreneurial examples were only the result of migrant activities. Here most households were dependent on networks extending outside the village, suggesting a lack of internal village stability. In particular, they relied on matrilineal networks to other villages, and these had been used to initiate work opportunities, provide exposure to new projects that are not dependent on the rains, such as poultry or crafts, or access to other water sources essential to a dry area regular water supply or the transfer of water from the region's Sehegeyare Dam. Likewise, the village in Kwa-Zulu Natal experienced more reciprocity in external networks (again, for access to temporary job opportunities and tractors) than between villagers; the lowest ratio of give to receive ties suggested that the community preferred to use social institutions that facilitate links outside the village.

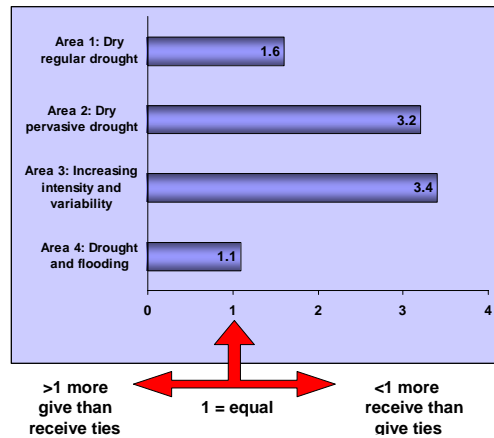


Figure 4: Direction of household within- village reciprocity by study area.

These external networks are not secure and must be reinforced constantly by the exchange of gifts or domestic work, especially by women, if they are to provide essential access to resources during drought. This was particularly difficult in KwaZulu Natal where most institutions were non-inclusive and the powers of traditional leaders had been eroded, with a male-dominated world of local politics determining local economic support and shaping future activities. The village was especially dependent on the charisma of their local councillors to interact with formal institutions outside the village. Most villagers claimed it was difficult to find out about the opportunities these institutions presented, with young men feeling notably alienated. Perhaps because of this lack of access to institutions and to the new ideas they may bring, young men were the group least interested in developing farming opportunities. Instead they used their informal external contacts to find temporary work away from the village, and in so doing the individuals concerned were lost from the household farm labour pool. Not all households who lost family labour in these way received remittances from the absent members and, for an area where no labour exchange system exists, this made the KwaZulu Natal case study particularly vulnerable during times of difficulty.

Within a household, several actions were sometimes found to be occurring simultaneously, each involving a different household member. Within this dynamic ‘response space’ there are feedbacks not only between risk, impact and action but also between the different actions. However, the research found that not all coping responses had a positive impact on livelihood resilience to climate change, nor did they always have the potential to evolve into ‘regenerative’ adaptations. For example, although there were double the number of average receive ties for households in the Limpopo case study, this did not necessarily mean households were successful. While eighty-seven percent of households had members away in urban areas, few were sending remittances and the money that was sent was generally used on foodstuffs. Furthermore, in all the locations, the youth claimed exclusion from institutions that facilitate coping responses and instead sought their own networks. This was most evident in KwaZulu Natal in South Africa and Gaza in Mozambique.

The ability to self-organise (autonomous action)

Individual action and the drivers of agency in adaptation

Successful individual actions were undertaken by those who had a history of external networks or regular migrant work, which gave exposure to new ideas and practices. The ability to develop a spatial network was essential to innovation, and these individuals only pursued cooperation when it increased status or provided access to resources. Successful individuals were characterised by their entrepreneurial attitude, were often young and were risk takers. In Mantsie, individuals had been frustrated by a lack of interaction between ‘new leaders’ in the municipality and the traditional authorities, as well as by the inability of the local chief to encourage solidarity and self-organisation. In Khomele, successful individuals were charismatic people, who had exposure to education, agricultural training or professional employment. In eMcitsheni, households with men recently returned from working on commercial farms had the greatest entrepreneurial spirit, and these households were prepared to take risks with farming practice. In Nwadjahane, larger households, especially those with extended family and more adult men, had developed the most urban ties, and were often able to secure a migrant wage.

At all the locations, risk takers with surplus cash income conducted autonomous agricultural experimentation. For example, in North West Province they had responded to increasing uncertainty in the rainy season and to regular drought by planting short-maturing crop varieties and occasionally winter maize. Once introduced, new ideas were only slowly adopted by other community members because information transfer is reliant on exclusive networks and because of the exclusivity of the behaviour of these individuals. The critical point from this example is that communities had not been able to use their informal or formal institutions to promote collective action based on these individual actions. Only in locations where formal associations had developed structures for sharing new ideas were transfers more inclusive. Indeed, in Limpopo Province, where traditional values were strong, the key individuals who acted as agents of new ideas were often regarded as outspoken modernizers and sometimes as troublemakers by conservative members of the community. This was partly because they challenged traditional hierarchies and authority and because their activities increased inequalities across the community. For example, extra capital from migrant work was used to buy farm labour or participate in reciprocal exchange, which increases the amount and diversity of food and cash crops. Most significantly, in all locations these individuals were able to invest in cattle breeding, increasing their status in the village and providing a buffer to drought with assets that are easy to liquidate and provide better returns to investment than rainfed cropping.

The importance of collective action

Institutions define the rules and patterns of behaviour that shape social interaction. Institutions can relate and even lead to, organisations that are groups of individuals bound by a common goal. In their positive sense, both institutions and organisations can facilitate collective action and enable individuals to transcend the limitations of acting in isolation. Without institutions, individuals would not have access to the key sources of knowledge and innovation that lead to adaptation.

Table 5 shows the four important forms of adaptation that we identified within this study: agricultural changes, social capital changes, commercialisation, and off farm activities. Only off-farm activities were reliant on individual actions. In almost all other cases, collective

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actions facilitated changes in farming, including moves towards commercialisation, and in social capital. Even in Limpopo Province, where traditional leaders and conservative individuals regarded individuals with new ideas with suspicion, these ideas were spread through the community because of the importance of institutions and organisations. In this study as a whole, the success and development of adaptations was widely found to be dependent on establishing formal farming associations, developing clear membership structures and responsibilities, the involvement of strong traditional authorities, entrepreneurs from the village and the establishment of channels for regular communication (especially bridged networks for accessing information and resources from the government and NGOs via the extension service). Furthermore, there were subtle differences in the way in which these responses had been used because of the climatic context of each study area.

Table 5: Adaptation characteristics across the study areas

Livelihood adaptations	Area			
	1	2	3	4
Agricultural changes and skills	Individual agricultural experimentation, Storage of fodder, traditional knowledge, using natural landscape	Structured agricultural experimentation	Structured agricultural experimentation, conserving resources, regulating and branding livestock	Individual agricultural experimentation, planting trees, using the natural landscape diversity
Social capital changes	Investment in support networks, Building of exclusive networks by neighbourhood, Exploiting matrilineal ties	Investment in support networks, Increasing participation in exclusive networks by type, Publicly promoting social cohesion	Building of male maize cooperative, investing in women's groups, investing in political networks, Investment in support networks	Building of agricultural cooperatives, evolved traditional non-cash exchange mechanisms, interactions between traditional leaders and local administration
Commercialising	Investment in poultry and livestock	Investment in poultry and livestock, Collective attempt to buy game farm	Women's horticultural collectives, Limited investment in livestock	Limited investment in vegetables, cashew and livestock
Off-farm roles	Regular migrant work for cash to mines in nearby Zeerust, Mafiking or Gaborone, Gauteng, Johannesburg or Rustenburg	Regular circular migrant work and long-term migrant jobs to nearby Dzanani, Thohanyandou, Makahado, Musina or Gauteng region	Regular migrant work in nearby Ladysmith or Durban, Johannesburg	Regular migrant work and long-term migrant jobs to nearby Manjacaze, Xai-Xai or Maputo and South Africa

Overall it was found that sustained collective actions in the study villages had five significant impacts on the ability to adapt to climate change. These were:

- establishing institutions that increased equity at village level;
- permitting structures to evolve that increased communications at the village level, with strong interaction between different formal and informal institutions and between households and individuals (allowing information sharing between entrepreneurs and the village);
- evolving structures that facilitated further self-organisation, rather than relying on external facilitation, and the opportunity to create ownership of the process of learning;

- permitting the regular use of these structures and networks to plan for the future, especially trials with new technologies (resilient crop varieties, increased crop base diversity, new methods of mulching and ploughing, indigenous livestock breeding, investment in irrigation pumps and mechanisation) to be more resilient to future drought and seasonal variability;
- facilitating livelihood specialisation and agricultural commercialisation, with investment in resilient cash crops and in livestock ranching, labour and land in other surrounding areas (to spread risk).

These impacts are illustrated in the following examples.

- 1) Men in KwaZulu Natal, who in the last three years returned from labouring on commercial farms, established a maize cooperative. The group has trialled short-growing resilient varieties and changed planting densities to minimise crop risk to increasingly variable weather. They have also benefited from shared resources and mechanisation. In the last two years, they organised the collective sale of surplus crop in order to compete in the rapidly changing local market. Establishing a spatial network of ties is therefore critical to innovation and collective action where no formal mechanisms exist. The highly variable and intense weather events in the area have also promoted the cooperative to introduce of conservation practices (e.g. extensive contour stone bunding) for the first time by over a third of those interviewed in order to reduce soil erosion on the maize fields. The fields are especially vulnerable to sheet wash during heavy rainfall before planting or after harvest.
- 2) Women in KwaZulu Natal formed horticultural projects, which are based on exclusive friendship networks. These have formal committee structures and responsibilities and penalties for non-participation. However, this has been partly a response to increased vulnerability because of changing regional economics since 1994 and partly increasingly unreliable intra-annual rainfall. Agricultural Extension Officers initiated projects with microcredit since 1994, but women in the village have actively chosen to participate because the collective irrigated gardens allow individual households to diversify their crop base (e.g. potatoes can compensate for damaged rainfed maize harvests) and they have successfully begun to enter the commercial market in nearby towns by selling surplus vegetables. Collective responsibility for transport and sale, with profits reinvested in fertilisers and seeds, has encouraged them to compete with established commercial outlets. Encouraged by success, individual profits and remittances are invested in extra labour and irrigating pumps for improved maize production. Larger households and those with regular remittances have been able to benefit most by being able to devote most project time because they can pay local women to take over their domestic duties. In 2004, some projects have begun to seek business training from extension officers, which has been used to initiate other activities and improved marketing.
- 3) In Mozambique, Extension Officers and individuals with external contacts initiated formal farming associations and developed a system of co-management that promoted collective social resilience to climate disturbance and change. Large groups had been able to deliver genuine opportunities for vulnerable individuals to participate and the benefits were less exclusive. Their clear structures (membership, work rules, strong leadership, and regular meetings to share information) did not conflict with local cultural norms, which allowed the community to continue to self-organise. A history of limited external development intervention means that networks, based on family and friendship ties, have generated complex traditional exchange systems, which is more pronounced than the

South African locations. Strong traditional leadership had been able to take advantage of recent changes in regional governance and increase interaction with ‘new leaders’, while trained ‘para-extensionists’ within the village have been used to transfer information from the Extension Service to the village. Entrepreneurs who innovate individually and have large spatial networks (including to urban areas and other countries) use the newly formed structures to share ideas and contacts with the community.

- 4) In Limpopo, many formal institutions established by the Agricultural Extension Service during the last seven years have endured and increased their interactions. A system of participatory service delivery was introduced in 2004, when extension officers began to be trained at the same time as village representatives or ‘para-extensionists’. Group visits to successful projects in other areas proved critical in establishing village commitment to projects such as an irrigation cooperative in an increasingly dry and drought-prone area. The projects have a clear structure and charismatic leadership, with rules and regular meetings. The projects have allowed entrepreneurs to flourish as well as allowed the poor to benefit on a smaller scale. Participation provides access to forecasts, crop advice and subsidised training. The villagers are using indigenous varieties of livestock, particularly goats, which are hardy to dry climes and lack of fodder, and initiating structured crop experiments. For example, they found open-pollinating yellow maize to be most resilient to drought, while they tested tomatoes to find varieties that could stand increased heat. Winter maize planting captures late season rains and an improved irrigated system has provided a reliable vegetable crop throughout the year. Animal-traction techniques have been improved and mulch made from goat manure and ironwood leaves is used instead of cattle manure and expensive fertilisers. Once formed, associations have found collective strength through the organisation of livestock auctions to compete with commercial farmers, the maintenance of a community tractor and irrigation system and the negotiation of contracts with local factories for their produce. Technical training has ensured that the agricultural groups have been able to initiate further self-organisation and respond rapidly to the changing local market, including to access of credit for farm improvement and spin-off businesses in poultry and pigs to improve food security. Those who are part of a farming association have been able to substitute dependence on the informal moral economy, which used to act as a safety net during drought, for the security of the association and increased commercial production. The agricultural groups have also negotiated access to land elsewhere, allowing farmers to make use of natural diversity in the landscape, where there is high spatial variability in rainfall. This includes exploiting opportunities in the South African land reform system to rent commercial farms, besides grazing livestock in communal areas that belong to other villages.
- 5) Unlike in the North West Province case study, other institutions in the Limpopo village have encouraged community cooperation. The church remains important and the cooperation between ministers presents a message of harmony and encouragement for collective activities. Ministers have initiated and supported youth and women’s groups that enhance a sense of shared identity and friendship, while church garden projects have provided food and agricultural experience for the poor. Tribal authorities continue to command respect locally, and while their power may have been eroded with democratic change, increased collaboration with ‘new leaders’ from the civic organisation and political parties allows their opinions to remain locally relevant. The community have been effective because they have collectively focused on one problem at a time, seeking political support and communicating with external networks, which has increased the confidence of local villagers, especially that of women’s groups.

Are adaptation processes competitive across scales?

Multiple pathways within the ‘response space’ raise questions about the competitive nature of the adaptation process, and whether adaptations at the household scale impede adaptations at the village scale. Parallel levels of success manifest themselves at different scales. This has implications for rural development, agricultural extension service delivery and longer-term resilience to climate change variability.

While informal institutions are dynamic, we have seen how they are often exclusive and require regular investment by households to maintain strong social support networks. This especially applies where there are weak formal institutions, for example in the case study villages in North West Province, South Africa, and Gaza Province, Mozambique. Moreover, different individual household members use different coping options simultaneously. A spatially diverse network provided more options; stability relied on a combination of access to local resources and opportunities outside the village for migrant work, microfinance or information. The case studies suggest that where there has not been investment in developing within-village networks, dependency on networks extending outside a village can lead to vulnerability in the longer-term. External networks require constant reinforcement, otherwise a lack of continuity can result in reduced stability, and therefore lesser resilience.

There is strong evidence that adaptation at the individual and household-level is a competitive process, subtly differentiated by context, household adaptive capacity and perception of risk. As local reciprocity is difficult for the most vulnerable; coping is an unequal process at the household level. Furthermore, while small households practiced risk-adverse strategies, larger cash-rich households were able to develop a more ‘focused’ or specialised livelihood strategy.

Equitable adaptations at the village level were determined by the development of formal organisations. Collective farming associations only endured where the benefits contributed by individuals could be captured with clear enforced structures and communication forums. These benefits included networks to outside sources of information, markets or resources, which we found to be essential elements of collective action that planned for the future, using new technologies or seeking microfinance.

Vulnerability to the impacts of climate change may be buffered by building a wide network of ties in the geographic sense, especially where this process was formalised. While these different pathways must be represented within any conceptual model, collective associations that link informal and formal institutions had the most significance in establishing equitable benefits across sections of the village. The ability of households to use social networks and institutions (the connectedness, especially across difference scales) is important in mediating the adaptation space. Individual success can enhance vulnerability differentials between households, but when individual success is channelled into institutions that lead to collective actions, this success is captured and then shared amongst those who participate in a network or institution. Where group membership is exclusive, for example by requiring a financial contribution to become a member, benefits may not transfer community-wide. Again, scale contrasts in the ability to adapt successfully may ensue. Exclusive groups, for example where members have to contribute financially, are only equitable if information and benefits are transferred outside the group to the community, as was the case in Mozambique. Otherwise, an adaptation outcome that leads to resilience at the village-level will not mean resilience for all at the household-level.

In every study area, there were examples of individuals who captured the process of adaptation and examples of collective action reinforcing pre-existing social hierarchies, power relationships and entitlement inequalities. The critical factor drawn from the research for community-scale adaptation was the importance attached to the ability to collectively self-organise and innovate in order to respond to and plan for change. This suggests that although adaptation can occur as a result of regenerative reactive coping responses (as detailed earlier), successful adaptation is a learned process and most easily facilitated where there are formal communication channels and responsibilities.

Some recommendations

Facilitating adaptation

Our research suggests that there are distinctions between coping and adaptation, and in the mechanisms and processes by which communities and the households within them learn to cope and adapt. The need for adaptation to occur amongst natural-resource dependant communities in Africa is self-evident given that climate change is a reality. This research has identified important elements of the process of adaptation, and the means by which adaptation is facilitated. In particular, the roles of formal and informal institutions, and the transfer of knowledge not simply between individuals but from key individuals to communities, are vital if successful adaptation is to take place into the future.

- The establishment of formal farming associations, with clear membership structures and responsibilities and democratic leadership is potentially a very effective way for expertise and knowledge about successful practices to be transferred from key individuals to communities. Key individuals are not just extension officers, but may be people from within the community who have experimented or brought in knowledge gained in other places. These associations are most effective and endure where there are high levels of solidarity.
- It is important to develop structures that increase communication at the village level, with strong interactions between different formal and informal institutions and between households and individuals (allowing information sharing between entrepreneurs and the village). These structures can in turn increase access to external organisations for information and resources. This may encourage self-organisation, social learning and prioritisation (as well as an opportunity to create ownership), rather than developing a reliance solely on external facilitation. It works to enhance adaptive capacity that is the broader ability of a system to cope with climate related risks and opportunities. Not only does understanding success in this process allow for local and individual assessment of options, and the incorporation of adaptation into existing risk management processes (rather than separate new ones), but it also recognises the distinct roles of the public and private sectors.
- Structured experimentation, skills training and access to new technologies offers social learning for proactive innovation and resilience to future drought and seasonal variability. This process is most effective where inclusive systems of communication exist. Unlike technology-driven efforts (used more widely in the commercial sector), investment values should encourage learning in order that smallholders can deal with a broad set of actors and opportunities in the modern market. Although with differentiated success at the research case studies, schemes have enabled farmers to realise their own capacity to make

decisions as they try to move from semi-subsistence livelihoods to those incorporating commercial agriculture opportunities.

- The development of specific adaptation product choices or policy prescriptions (i.e. direct adaptation measures) may not be the most useful means of promoting adaptation in agriculture to climate change or in any sector. As instruments for development, our findings suggest that adaptation policy needs to be particularly sensitive to this. Stakeholders have to be involved in the adaptation option and how an adaptation relates to broader decision-making processes. Opportunities for micro-finance and business training, together with infrastructural support, will facilitate livelihood specialisation and agricultural commercialisation, but can also finance risk-spreading options that include diversification and access land in a range of ecosystem and catchment contexts. It will also ensure that opportunities remain equitable, especially to young people. Building human capacity at the local-level requires a long-term and focused commitment to develop skills.

Equity issues

- Our findings suggest that at the national and international levels, policy responses to climate change should be oriented towards creating or facilitating the emergence of ‘head room’ thus enabling, rather than inhibiting, local and regional level adaptation options. Clearly, international responses to climate change, including the mitigation of grievances, must not compromise the development process if international justice is to attain fair outcomes (cf. Kates 2000). Advocating the creation of head room is not to suggest a lighter touch to climate change adaptation policy, nor vagueness, nor inaction. Rather it calls for recognition of the need to *create* space, and the right kind of space, and to *facilitate* appropriate, innovative and creative adaptation, that retains principles of equity and social justice at its core.
- Empowerment is regarded as a key element of creating equity in decision making (World Bank, 2000b), and as central to reducing vulnerability (Skoufias, 2003; Tompkins and Adger, 2004). However it needs to be coupled with notions of procedural and distributive justice within all levels of decision making (Thomas and Twyman 2005). Collective self-organisation is important in this respect, but it is not sufficient to regard the creation of space for empowerment as a successful and just achievement in dealing with climate change impacts, since local empowerment is not a simple recipe for the generation of just and equitable outcomes at community and household levels. The issues of scale raised by adaptation to climate change themselves generate a range of complexities for the processes necessary to engender equity and justice. These include the relationships between global processes (including emissions effects, international conventions, etc), national responses and local outcomes, the effects of national decisions and policies on local opportunities and abilities to adapt, and the means by which local opportunities and knowledges of adaptation transfer between households and within communities.

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