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Adaptations to climate change, drought and desertification: local insights to enhance policy in southern Africa

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ABSTRACT

The impacts of climate change, drought and desertification are closely interlinked, and most acutely experienced by populations whose livelihoods depend principally on natural resources. Given the increases in extreme weather events projected to affect the Southern Africa region, it is essential to assess how household and community-level adaptations have been helped or hindered by institutional structures and national policy instruments. In particular, there is a need to reflect on efforts related to the United Nations' environmental conventions to ensure that policies support the maintenance of local adaptations and help retain the resilience of socio-economic and environmental systems. This paper examines three interlinked drivers of adaptation: climate change, desertification and drought, assessing the extent to which international and national policy supports local adaptive strategies in three countries in southern Africa. We show that while common ground exists between desertification and climate change adaptations at the policy level, they are insufficiently mainstreamed within broader development approaches. Similarly, there are some overlaps between policy-driven and autonomous local adaptations, but the mutually supportive links between them are poorly developed. Further efforts to integrate local adaptation strategies within policy could increase local resilience to environmental change, while also contributing to wider development goals.

1. Introduction

Rainfall variability and uncertainty surrounding its annual reliability have prompted dryland communities to adapt to dynamic climatic, environmental and weather conditions throughout history. However, the speed of current climate change is feared to exceed the limits of adaptation in many parts of the world (Adger and Vincent, 2005; IPCC, 2007b). The African continent has been highlighted as particularly vulnerable in the future, primarily due to its low adaptive capacity and its sensitivity to many of the projected changes (IPCC, 2007b; Callaway, 2004). Additionally, climatic changes are taking place in the context of other developmental stresses, notably poverty, fluctuating oil prices, and food insecurity (FAO, 2006), as well as in combination with environmental change, drought and land degradation (Tho-

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mas et al., 2008). It is thus essential to develop and implement effective adaptation measures so that climate-related risks and opportunities might support development objectives within local and policy decision-making processes (Adger et al., 2006; IPCC, 2007b).

Adaptation is a process of deliberate change, often in response to multiple pressures and changes that affect people's lives. Identifying the precise drivers of these changes, whether environmentally, climatically, or economically driven, is extremely difficult (Adger et al., 2005). Successful adaptations may be viewed as those actions that decrease vulnerability and increase resilience overall, in response to a range of immediate needs, risks and aspirations (van Aalst et al., 2008). Indeed, vulnerability depends on: (i) the degree to which a system is exposed to a perturbation; (ii) its sensitivity to that perturbation (i.e. the degree of system change associated with a given degree of perturbation); (iii) its adaptive capacity (the ability – often measured in the time it takes – for a system to change its structure to support basic system functions in response to perturbation); and (iv) its resilience (the rate at which a system regains structure and function following a perturbation) (Holling, 1986; Kasperson et al., 1995). For dryland populations, whose livelihoods are often tied to subsistence agriculture and the natural resource base, successful adaptations build resilience and decrease vulnerability to multiple threats.

This paper examines adaptations to three closely linked processes: climate change, desertification and drought.[1] These are considered in three case study countries (Swaziland, Botswana and Malawi) in which we compare national policy strategies to local level adaptations identified through research reported in the literature. Our analysis provides an important first-step in assessing adaptation across space and institutional levels. It is envisaged that this paper may help inform more appropriate adaptation over the long term by identifying where more detailed research is needed and by suggesting how the links between policy and practice can be strengthened. To achieve this, the concept of adaptation is first unpacked through a detailed exploration of what it can mean and consideration of the role it plays in international approaches and instruments for managing global environmental change. The projected climate change and desertification impacts for southern Africa are then examined, and our three case studies are presented. Finally, the extent to which local and policy adaptive strategies are working together is analysed alongside the challenges and research gaps that need to be overcome for successful adaptations to continue into the future.

2. Unpacking adaptation

2.1. *Adaptation in the context of climate change and desertification*

To unpack our understandings of adaptation specifically in relation to environmental and climatic change, we first look at definitions and typologies, both of which abound in the literature. Burton et al. (2002) consider adaptation to be the ability of social and environmental systems to adjust to change in order to cope with the consequences of change. Similarly, Smit et al. (2000) suggest adaptation to be the adjustments made in ecological–social–economic systems in response to actual or expected climate stimuli, their effects or impacts. Adaptation is therefore a process of deliberate change in anticipation of or in reaction to external stimuli and stresses (Nelson et al., 2007). Approaches to adaptation tend to be either actor-oriented, focusing on the agency of social actors or institutions to respond to specific environmental stimuli, or resilience-based, focusing on systems approaches that see adaptive capacity as a core feature of socio-ecological systems (Nelson et al., 2007). While the understanding of adaptation as a process of deliberate change is now widespread in climate change circles, the notion of adaptive capacity built on understandings about resilience has a broader application, encompassing deliberate changes in response to or anticipation of environmental changes including drought and desertification.

Of central interest to our analysis is the relationship between managed, policy-driven adaptation and autonomous, locally driven adaptation, and the ways in which these play out in the context of environmental changes more broadly. Conventionally, local level adaptations are thought of as reactive, while policy-driven adaptations tend to be planned (Smit et al., 1996; Burton et al., 2003). However, this is not always the case and as we argue in this paper, the complexity of adaptation across levels and scales is vital to understand if appropriate adaptation is to be supported over the long term. Adaptation may reduce risk at one (short) time scale yet cause an increase in exposure to risk in the long term (Adger et al., 2005). Furthermore, what may be effective adaptation for one community may undermine the ability of others to adapt through spatial spill-over and negative externalities (Osbahr et al., in review). For example, land use shifts towards the cultivation of new species in one area may alter the dominant biodiversity, undermining the provision of ecosystem services such as pollination in other areas (e.g. Olschewski et al., 2006). In turn, this may affect the abundance of wild plants that rely on mobile ecosystem services for their reproduction, and reduce the potential for adaptations incorporating the use of those plants.

Long-term climate disturbances may produce changes in behaviour that are more lasting, and Smit and Skinner (2002) provide a useful typology for analysis around the criteria of: intent and purposefulness, time and duration, scale and responsibility, and form. Responses undertaken sponta-

[1] In some cases, drought and desertification can be separated from global climate change processes. Similarly, desertification does not always result from drought but can be the product of contingent factors (intended and unintended; human induced and climatic). Therefore, neither climate change nor drought is necessarily synonymous with desertification (see e.g. Fairhead and Leach, 1996), but drought may be linked to both phenomena (see Thomas, 1993; Dougill et al., 1999; Thomas et al., 2008). In our case studies, drought and climate variability are considered inherent characteristics of the dryland environment, and are not just a result of the climate change taking place at the moment. As such, we treat climate change, drought and desertification as separate but interlinked phenomena throughout the paper. This reflects the approach taken in the international policy arena too.

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neously and/or autonomously as a regular part of on-going management are differentiated from those consciously planned in the light of climate change. Agricultural adjustments such as selling off livestock are therefore tactical, while structural changes in management such as land use, livelihood activities or crop type are strategic. Despite such typologies, distinctions between anticipatory, concurrent and reactive action are much less definitive in practice. They nevertheless form a useful basis for analysis, and help draw out the distinctiveness between managed policy-driven adaptations (for example, through drought early warning systems) and autonomous locally driven adaptations (such as a change to the dominant livelihood activity).

Osbahr et al. (in review) further suggest the need to think about an adaptation 'space' that allows a range of drivers to be concurrently recognised as important in shaping adaptation activities (climatic, environmental, political, etc.). This provides a useful framework for linking broader adaptations with processes of climate change, desertification and drought. It allows linkages to be made across scales (cf. Cash et al., 2006), connecting everyday adaptation practices on the ground concurrently with international policy and practice. Such concepts focusing across institutional levels and scales underpin the analysis of the three case studies in this paper.

2.2. *Adaptation in the context of international policy*

Further analytical distinctions can be made in terms of adaptation policy, where differences between adaptation and mitigation strategies are apparent, and where a variety of policy tools operating concurrently at a number of scales are used to facilitate and support planned adaptation. These are considered in the following sections.

2.2.1. *Climate change and development links*

Adaptation is critical in dealing with the unavoidable impacts of climate change (Stern, 2006; UNFCCC, 2007), yet the enactment of strategies to aid adaptation at the international level has been slow. International policy (through the UNFCCC and its Kyoto Protocol) has historically focused on the development of climate change mitigation measures. This was justified by the need to reduce the risk of dangerous climatic outcomes by lowering greenhouse gas emissions at source or absorbing them through management of carbon sinks (Barker, 2003), thus reducing the magnitude and rate of change (IPCC, 2007a). At the same time, proponents of adaptation were viewed as rather defeatist and were thought to demonstrate a lack of faith in countries' abilities to limit emissions. The reluctance to focus on adaptation was also linked to discussions on liability, compensation, equity and fairness (Paavola et al., 2006), which developed countries were keen to avoid. As such, a historical distinction between mitigation and adaptation evolved.

With the agreement on the 2001 Marrakesh Accords to the Bonn Agreements under the United Nations Framework Convention on Climate Change (UNFCCC), international policy acknowledged that mitigation and adaptation can be synergetic and that they both have an important role to play in managing future climate change (UNFCCC, 2007). Indeed, adaptation is paramount for the world's poorest countries, which contribute least in terms of greenhouse gas emissions but are the most vulnerable to the effects of climate change (Huq et al., 2003; Lobell et al., 2008). Adaptation is also likely to play a key role in meeting the Millennium Development Goals (UNFCCC, 2007), as reflected in the growing emphasis placed upon it within Overseas Development Assistance debates (e.g. DFID, 2005). Similarly, while adaptation to climate and other environmental changes may be taking place in parallel to development frameworks that inform responses to risk (Thomalla et al., 2006), scholars are now questioning whether processes of adaptation may actually be considered the same as the processes of development (Schipper, 2007). Certainly, at the policy level the linkages between development and climate change responses have been noted, with adaptation being considered an integral component of overall poverty reduction efforts (e.g. Yohe et al., 2007; Giannini et al., 2008; Twomlow et al., 2008; African Development Bank et al., 2003).

2.2.2. *International policy tools for adaptation*

Since 2001, at the international policy level, the UNFCCC's NAPAs (National Adaptation Programmes of Action) have become an increasingly important tool for the world's Least Developed Countries (LDCs). While many countries may have developed NAPAs primarily due to their international commitments rather than due to buy-in at the national strategic level, they nevertheless are attracting the support of a greater range of actors, particularly in identifying priority activities in adapting to climate change. NAPAs are required to engage local stakeholders in the NAPA process, and take into account existing coping strategies at the local level, building upon them to identify priority activities for which further delay could increase vulnerability or lead to higher adaptation costs at later stages. Similarly, parties to the United Nations Convention to Combat Desertification (UNCCD) that declare themselves affected by desertification are required to develop NAPs (National Action Programmes). The need for NAPs is embodied in the UNCCD (1994) text, which states that affected parties should highlight the key challenges they face in relation to desertification and drought, and present a strategy through which these challenges will be addressed. Once again, community participation in the development and implementation of NAPs is considered vital.

Of the 49 LDCs (30 of which are located in Africa) 36 (or 73%) have produced NAPAs; 26 (or 53%) have produced NAPs, with 21 (or 43%) producing both a NAPA and NAP (data as of November 2008). This demonstrates that despite the priority now afforded to adaptation strategies in the international political arena, several vulnerable countries are yet to formally define their adaptation priorities within national policy. This does not mean that adaptation is not taking place, rather that actions to manage the impacts of climate change and desertification have not yet been absorbed at a strategic level (cf. Huq et al., 2003; Klein et al., 2007). Indeed, further mainstreaming of both desertification and climate change issues are essential if synergy in addressing these challenges is to be more effectively fostered.

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2.3. *Adaptation in the context of academic research and project planning*

The participatory ethos that is increasingly visible in adaptation instruments and policy communications emanating from the international level have also become more apparent in the context of academic research and project planning for adaptation. For example, early scientific approaches to understanding the impacts of climate change and desertification used comparatively top-down methods, often involving the global mapping of desertification extent (e.g. UNEP, 1997) or climate change impacts (IPCC, 2007a,b) leading to the development of mapped outputs for specific focal areas such as crop production (van Aalst et al., 2008). Such top-down approaches do not take into account how people adapt on the ground, as scientific research is outside the realities of everyday life in affected areas. For policies to build on the strengths of local practices and to address issues relating to poor (or short-term) decision-making, it is imperative to understand how specific factors influence local practices. This requires holistic frameworks to be developed and applied, which look across time and spatial scales and consider the environmental, social and economic elements of people's lives. In turn, it requires the interdisciplinary and participatory multi-stakeholder approaches discussed at the international policy level, to be implemented on the ground. The UNDP (2005) has taken important steps towards promoting such a holistic attitude, outlining an Adaptation Policy Framework Process (APF) which aims to ''guide studies, projects, planning and policy exercises towards the identification of appropriate adaptation strategies, policies and measures'' (UNDP, 2005). However, few academic studies have attempted to directly link policy discourse with local practice such as we aim to provide in this paper.

From a methodological standpoint, tools such as community-based vulnerability and capacity assessments (e.g. Adger et al., 2003) and Participatory Rural Appraisal (PRA) techniques (e.g. Chambers, 1994) play a key role in informing more holistic approaches. These situate people's livelihoods at the centre of analyses, with frameworks such as the Sustainable Livelihoods Approach (Scoones, 1998) acting as a basis from which to consider people's assets and resources (usually conceptualised as five types of capitals). As Eakin and Bojorquez-Tapia (2008) suggest, this allows the elucidation of general lessons regarding the implications of various shocks and stresses for households engaging in particular strategies and adaptations, as well as helping to understand the advantages and disadvantages of pursuing specific strategies in the context of particular asset combinations when managing risk. The SLA also considers the institutional context and broader changes that influence the types of adaptation that can take place (e.g. demographic and large-scale socio-economic processes) (Scoones, 1998). As stated by Smit and Pilifosova (2001:882) ''the determinants of adaptive capacity [i.e. people's ability to adapt] relate to the economic, social, institutional, and technological conditions that facilitate or constrain the development and deployment of adaptive measures'', so it is important to look across different sectors and examine the interaction of local, national and international drivers and outcomes of adaptation (Eakin, 2005). Similarly, while traditional practices and structures can help local adaptive capacities to develop, they may also prevent people from making longer term or more permanent adjustments as a result of the lock-ins they can cause (Patt and Gwata, 2002). By building a more complete picture of the situation, it may be easier to evaluate the appropriateness, acceptability and cost-effectiveness of different adaptation options, as well as expose any local capacity gaps that might be present and any conflicts with policy statements at a national level.

3. Climate change, drought and desertification in southern Africa

The relationships between climate change, drought and desertification have begun to be unpacked through the analysis of a number of climate-related and biological feedback loops (e.g. see Sivakumar and Ndiang'ui, 2007; Sitch et al., 2007; Cox et al., 2000), while the nature of the linkages have led the IPCC (2007a) to predict that the extent of arid and semi-arid areas will expand between 5 and 8% under a range of future climatic scenarios. At this point, it is imperative to draw the distinction between (i) long-term regional climate change predictions provided by downscaled GCM outputs, which typically show a warming and drying of southern Africa (Christensen et al., 2007), and (ii) the occurrences of drought events, defined as multi-year events with rainfall significantly below a mean level (Warren and Khogali, 1992). Drought events can be a consequence of climate change and a driver/cause of desertification, but they are a distinctly different short-term meteorological phenomenon that is too often confused with climate change and desertification in the academic literature, popular press and policy debates (e.g. Thomas, 1993). Before analysing specific issues and policies in the case study countries, we outline the current climatic conditions, recent trends and the projected changes associated with future climate change, desertification and drought on a regional level across southern Africa, as best as current socio-economic scenarios and scientific model projections allow.

The climate of southern Africa is controlled to a large extent by global patterns of atmospheric circulation, in particular the movement of the inter-tropical convergence zone that determines the annual seasonality of rainfall across tropical Africa (McGregor and Nieuwolt, 1998). A range of agro-ecological zones is found, extending from winter-rainfall Mediterranean climate around Cape Town, to summer rainfall regions, including areas such as Swaziland where local orography of mountains significantly increases rainfall, compared to the semi-arid summer rainfall savanna regions of the Kalahari (on which our Botswana case study focuses). Moving north, the climate moves towards dry sub-humid and then sub-humid rainfall regimes that typify the Malawian case study region. Across the whole of southern Africa, natural intra- and inter-annual variability of rainfall is high linked to shifts in the tropical temperate trough over the region (Usman and Reason, 2004) and also regional sea surface temperature effects linked to ENSO events (Todd and Washington, 1998). Consequently, droughts and changes in the timing of rainfall are typical characteristics of the regional climate, but also

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features that appear to be increasing in their variability and intensity over the last 50 or so years (e.g. Tennant and Hewitson, 2002; Thomas et al., 2007). This has been marked in terms of intense drought events, such as those linked to famine episodes witnessed in Malawi in 2002, and also flooding, as seen across the region in 2000.

The inter-annual variability and significant differences between GCM projections from alternative models (see Hewitson and Crane, 2006) mean that as yet, regional downscaling for southern Africa cannot provide confidence on whether drought events will become more or less frequent under future climate change scenarios (Christensen et al., 2007). Despite this, much literature cites that droughts can be expected to become more frequent across southern Africa (e.g. Awosika et al., 1998; Reed et al., 2007). To this end, it is pertinent to note that the IPCC's regional climate projections highlight a significant drying for southern Africa in the dry season months (JJA and SON annual quarters), but that no significant differences are projected in rainfall for the wet season months (DJF and MAM annual quarters) and no increased risk of drought events is reported (Christensen et al., 2007). Empirical downscaling with a view to producing such regional climate predictions (e.g. Hewitson and Crane, 2006; Tadross et al., 2006) remains constrained by the same uncertainties as the GCMs that guide them, but the downscaled information provides improved spatial and temporal variance at the local scale.

Despite the remaining uncertainty, the combined evidence of current trends (of increased rainfall variability and intensity of extreme events including droughts) together with global climate model predictions of warming and drying across the region, add significantly to concerns that climate change will exacerbate land degradation and desertification problems (Meadows and Hoffman, 2003) and add to the difficulties faced by farming communities in adapting to climate variability (Washington et al., 2005; Thomas et al., 2008). Given these pressures it is essential that policy instruments aimed at addressing climate change adaptation measures, capacity and support (i.e. NAPAs) and those instruments and policies to combat the causes and impacts of desertification and drought (UNCCD NAPs) are analysed to identify their mutual support. This is paramount and an important research gap given the need to consider climate change, desertification and drought as interlinked problems of increasing severity into the future.

4. National case study analyses from across Southern Africa

In light of the environmental changes and model projections described above, we now move our focus to the autonomous (local) and managed (policy) adaptations of three countries in southern Africa: Swaziland, Botswana and Malawi. Each of these countries includes significant areas of arid, semi-arid or dry sub-humid land, where droughts are both common and unpredictable; has policies that address adaptation to extreme droughts; and is reporting significant problems of land degradation (or desertification) with action programmes formulated under the framework of the UNCCD. Each of these nations is a member of the Southern African Development Community (SADC), is party to both the UNFCCC and the UNCCD, and is a non-Annex I party to the Kyoto Protocol. As such, all three countries have produced UNCCD NAPs and Malawi, as one of the world's LDCs, has developed a UNFCCC NAPA. This supports our policy focus on the Initial/First National Communications to the UNFCCC for both Swaziland and Botswana; Malawi's Initial Communication to the UNFCCC, as well as its UNFCCC NAPA; and finally, the UNCCD NAPs for all three countries.[2]

The methodology followed for each country is based on a common meta-analytical framework involving first, a literature analysis of the adaptation challenges facing rural agricultural communities (drawing on the authors' published research and the broader literature). As such, an inductive research approach was taken, as the key drivers of and responses to local adaptations to climate change, desertification and drought in our study countries were identified from the literature. Second, a discourse analysis of each study country's policy communications to the UNFCCC and UNCCD was undertaken. This involved identifying the patterns of dominant narratives present within each document (Gard, 2005), along with those powerful adaptation strategies afforded most prominence. In doing this, we also attempted to understand the process through which each narrative entered the policy (i.e. whether wholly top-down processes were used in policy development), and assessed what this could mean in relation to the more participatory approaches espoused at the international level. Next we used an approach broadly based on grounded theory (Strauss and Corbin, 1990) to draw up key categories in which to place the policy adaptations. These categories emerged from the analysis, and at times shared similarities with the distinctions in typologies such as that developed by Smit and Skinner (2002). Next, we examined the overlaps and differences in the adaptive strategies detailed in policy communications to the UNCCD and the UNFCCC, as well as the similarities and differences between local and policy adaptations. A matrix was then developed to assess these results. In evaluating our methodology, we appreciate that there may be other adaptations taking place beyond those documented in the literature we uncovered and that our findings are not exhaustive. Our approach nevertheless permitted the relationship between local and policy adaptations to be explored in a novel and appropriate way to provide new information required to inform both academic research and policy debates. Finally, we also acknowledge that we do not focus on all crops when considering agricultural adaptations in both the policy and local adaptation literature. Instead, we consider only those crops and practices most central to subsistence production. This is because the impacts of climate change, drought and desertification on these crops are likely to have the most profound effect on household wellbeing.

[2] Despite the limitations in comparing these policy documents (particularly due to the lack of national and international expertise on adaptation when many of these documents were created), these provide the most reliable and accessible secondary data sources at present.

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4.1. *Swaziland*

Swaziland is considered vulnerable to the interlinked effects of climate change, desertification and drought, primarily due to its heavy dependence on food imports, weak private sector, landlocked geography and limited land area (UNCCD Secretariat, 2006). The country's skewed wealth distribution further influences the adaptation capacities of the poor, making the success of policy adaptations and their links to broader development approaches even more crucial to building resilience.

In most of the central 'middleveld' part of the country, agricultural production is a key component of local livelihoods, with maize cultivation being the most important land use. Our literature review of Swaziland's farming systems indicated nine key interlinked challenges for agricultural (particularly maize) production: (1) drought, (2) lack of water for irrigation, (3) weed infestations, (4) gullies, (5) soil infertility, (6) high input prices (fertilisers, seeds, tractor hire, etc.), (7) a lack of alternative employment opportunities, (8) land shortages, and (9) conflict over chiefdom boundaries (see e.g. Stringer et al., 2007a). Of the problems identified above, adaptations relating to each of climate change, drought and desertification reported in the literature tended to target four of these challenges: (1) drought, (2) weed infestations, (3) soil erosion and gullying, and (4) declining soil fertility levels (Table 1).

The most critical rains for crop production are those from December to February, as this is the growing season of the maize crop. Despite lacking the facilities to measure rainfall, the literature suggests that land users often recognise and remember the nature of rainfall inputs from previous years, mentally modelling patterns and relating them to the yields produced (Stringer et al., 2007a,b). In response to local understandings that the rainy season is starting later in the year (which indeed, is supported by meteorological data from the Swaziland Meteorological Office, spanning the period 1985–2002), farmers have adapted the timing of ploughing and planting accordingly to minimise the threat to their livelihoods (see Table 1). Many of the local adaptations undertaken are not only to climate change but relate to a broader consideration of climate, drought and desertification issues, manifest through low agricultural productivity. This suggests that farmers evaluate climate change and desertification within the overall remit of factors affecting *production* and that they look beyond the biophysical to include socio-economic dynamics within their decision-making processes (cf. De Haan and Zoomers, 2005). This supports the view that for appropriate support to be provided at a policy level, adaptation needs to be mainstreamed across sectors (cf. Huq et al., 2003), as local communities do not disaggregate their adaptive strategies (nor diversify their livelihoods) in order to address single issues.

In comparison to the local adaptations in Table 1, Swaziland's National Action Programme (NAP) prepared under its commitments to the UNCCD cites the use of unsuitable cultivation practices at the local level as one of the key causes of land degradation and low agricultural productivity, and

Table 1 – Local adaptations to climate change, drought and desertification in Swaziland (synthesised from Stringer et al., 2007a,b,c,d; Osunade, 1992, 1994).

Driver of adaptation	Adaptive strategy
Drought and climate change can cause poor yields; reduced amounts of organic matter returned to the soil as plant remains do not rot; gullying when the rains arrive.	Different fields planted at different times to minimise risk to the whole crop; alternative food sources sought in the case of crop failure (e.g. maize from government/aid agency sources); employment sought elsewhere (sometimes abroad in South Africa); people pray to God for rain.
Land degradation manifest as weed infestation (especially *Striga asiatica* which grows well in poor dryland soils with low nitrogen). Weeds decrease yields as they prevent maize crops from growing properly.	Thorough, regular weeding in January and February; early planting so weeds flower after the maize cobs have grown; annual crop rotations to increase soil fertility and decrease weeds; intercropping of maize and cowpeas to increase soil nitrogen levels.
Land degradation manifest as soil erosion and gullying. This decreases field sizes making ploughing difficult and washes away soil and fertilisers.	Furrows dug to divert water; aloes and grasses planted to bind soil together; ploughing across – not down– slope; gullies filled with stones; 'traditional' grass strips maintained.
Land degradation manifest as declining soil fertility levels (often due to reduced cattle numbers or a combination of drought and a lack of money for fertiliser). This can cause crops to grow shorter and lower yields to be obtained; weeds such as *S. asiatica* to flourish; and maize cobs to be poor quality.	Cows borrowed from friends or neighbours to gain manure in exchange for labour needed to look after them; manure is purchased; advice sought from agricultural extension officers; fertilisers applied; different seed varieties used that are adapted to poorer soil conditions; crop rotation practiced; intercropping practiced; fields left fallow to naturally regenerate; crop remains left in the soil after harvest; associations and cooperative membership is sought for discounted access to fertilisers; fields planted at different times according to financial ability and fertiliser availability; livelihoods are diversified (e.g. making and selling clothes, moving to towns and returning remittances, selling products from communal land, setting up irrigated vegetable gardens and selling any excess, developing informal village trading networks) with income being used to buy fertilisers.

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Table 2 – Planned adaptations in Swaziland's agricultural sector (based on the analysis of documents GOS (2000, 2002) as submitted under obligations to the UNFCCC).

Proposed adaptations relevant to the agricultural sector	Level (and stakeholder involvement where appropriate)	Focus of adaptation
Introduction of high yielding, drought- and disease-tolerant seed varieties for maize.	Multi-level (local and national); stakeholder involvement unclear.	Adaptation of crop varieties.
Training of farmers and extension personnel to help meet the goal of maize self-sufficiency.	Multi-level; implies involvement of extension workers and farmers.	Education.
Legume improvement and production campaign. The legumes are being promoted to enhance food nutrition and to widen the base for income generation for small-scale rural farmers.	Multi-level; involves Ministry of Agriculture and Cooperatives research division and extension services with small-scale subsistence farmers.	Adaptation of crop varieties and species.
Programme to promote sorghum production in drier areas of the country.	Multi-level; stakeholder involvement unclear.	Adaptation of crop species.
Introduction, evaluation and crossing of cotton varieties in order to identify those that are pest- and disease-tolerant, and superior in yield and quality.	National level; implies involvement of MOAC research division.	Adaptation of crop varieties.
Encouragement of domestic production of high quality maize and bean seeds.	Multi-level; stakeholder involvement unclear.	Adaptation of crop varieties.
Strengthening of linkages between stakeholders.	Multi-level; involves researchers, extension workers, NGOs and parastatals.	Institutional development.
Identification and development of cost-effective production technologies.	National level; implies involvement of MOAC research division.	Technological development.
Recognition that more tractors need to be made available to meet changing demands prior to early planting.	National level; implies involvement of farmers through reference to "demand".	Technological availability and institutional development.
Increased finance for fertilisers and hybrid seeds.	National level.	Institutional development and development of financial mechanisms.
Encourage farmers to increase agricultural productivity by hectare.	Multi-level; implies involvement of extension workers and farmers.	Technological/input-based development.

recognises the problems associated with low technological and capital inputs in the small-scale farming sector (GOS, 2000). Other drivers of land degradation identified within the NAP include drought, overgrazing, indiscriminate use of fire, deforestation, poverty, inappropriate afforestation (with non-native species such as *Eucalyptus*), improper location of roads (leading to drainage and erosion issues), and an absence of controls over livestock numbers and population growth.[3] The NAP priorities are placed under 14 different headings. However, a review of the NAP undertaken in 2003 proposed the rationalisation of these into more coherent (manageable) groupings, along the lines of: institutional arrangements; general support, in particular to communities and local leadership; direct support in land management and rehabilitation; research and technology development; policy support programmes and strategies; and risk-related support programmes. Within these priorities, in the most recent Swaziland Government report on the status of NAP implementation (GOS, 2004), focus appears to have been mainly on projects to address food security (e.g. awareness raising activities to promote conservation agriculture); water supply and management (e.g. smallholder irrigation schemes), poverty alleviation (e.g. through rehabilitation and creation of earth dams) and more cross-cutting concerns such as the development of a rural resettlement policy (GOS, 2004). Despite evidence from the NAP analysis that environmental change issues are starting to be addressed at the national policy level, discourse analyses of Swaziland's First Communication to the UNFCCC (GOS, 2002) shows that mainstreaming is not yet recognised within all sectors. The key areas in which managed (policy) climate change adaptation strategies are considered necessary are presented in relation to four key (separate) economic areas: forestry, agriculture, water and energy. We focus here on adaptations directly relating to agriculture (Table 2).

While the planned adaptations address each of the five capitals considered in the sustainable livelihoods approach, emphasis is mostly on the adaptation of crop varieties and species (Table 2) aided by advances in biotechnology and improved national market systems. In particular, planned adaptations encourage a shift towards varieties of maize that are tolerant to high temperature and a move from maize to cassava in the most drought prone parts of the country (GOS, 2002). Institutional and technological developments are also recognised as important alongside education and financial mechanisms. However, these are given a subsidiary role compared with the adaptation of crop species and varieties.

[3] Population growth may be more appropriately conceptualised as population and demographic change. This is due to Swaziland's high HIV/AIDS infection rates (estimates suggest 35–40% of the working aged population is infected with the virus (Mushala, 2003), while population estimates for 2006 suggested an overall population decline, with growth rates at −0.23% (http://www.indexmundi.com/swaziland/, June 2006)).

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Table 3 – Local adaptations to climate change, drought and desertification in Botswana (synthesised from Behnke et al., 1993; Tainton, 1999; Smit et al., 1999; Twyman et al., 2001; Hitchcock, 2002; Reed et al., 2007, 2008).

Driver of adaptation	Adaptive strategy
Land degradation (especially around boreholes).	Borehole rotation and shifting grazing through the creation of farmer syndicates; manure distribution from kraals around boreholes; cattle posts in healthy rangeland with water transported to area in dry season; herd separation to avoid over-grazing on less healthy rangeland; avoiding felling trees in borehole area; pollarding to maintain tree cover; regular movement between kraals.
Bush encroachment (especially *Acacia mellifera*).	Use of herbicides; combining stem cutting with intense small-stock browsing; below-ground stem cutting; stem cutting and painting paraffin on stumps; uprooting; stem burning of individual bushes. For rangeland rehabilitation after bush clearance: leaving wind-breaks against the prevailing wind to reduce wind erosion after clearance; resting cleared land using whole uprooted bushes as fencing or laying broken up bushes on the ground to protect recovering grass from grazing, recycle nutrients and reduce wind erosion.
Drought and climate change.	*Mafisa* livestock movement system (movement or selling of livestock at onset of drought, facilitated by social networks); changing to more drought-resistant livestock breeds, e.g. karakul sheep; livelihood diversification–switching from livestock to game farming supplemented by photographic tourism and sale of hunting licenses.

In assessing the suitability of the planned national adaptations in terms of their links to autonomous (local) adaptations and attitudes, as well as their connections to NAP priorities, several challenges arise. First, an emphasis on changing the crop varieties and species grown may not be accepted by farmers. Some land users have already opted to plant more drought-resilient maize varieties while concerns exist over the low nutritional value and health implications of increasing shifts to cassava cultivation. Additionally, low market values for some varieties together with the need to buy new seeds each year for hybrid strains prevent these from being more widely adopted. Shifts towards cassava may be even more difficult to promote, despite the labour savings to be made compared with maize cultivation. This is because maize plays an important role in Swazi culture, having been grown consistently since it was introduced in the early 16th century, such that today Swaziland consumes over 100 kg year^{-1} per capita (De Vries and Toenniessen, 2001). Any promotion of crops other than maize will have profound cultural implications and will be largely dependent on farmers' individual willingness to use their land for crops that are traditionally of minor importance (cf. Abunyewa and Padi, 2003). The other culturally related omission from Swaziland's current adaptation policies relates to the role of non-agricultural livelihoods in providing finance for investment in agriculture. Most households' livelihood portfolios are diverse, spreading risks beyond agriculture and allowing the profits from some activities to be invested in others. For example, many households use indigenous plants to make and sell medicines, grass mats, wood poles, etc. (Osunade, 1994). The wider role of the natural resource base beyond agricultural production therefore needs to be acknowledged within managed adaptations, within the broader remit of the country's development. Similarly, support for rural employment and industry is not mentioned in the country's National Communication to the UNFCCC, yet this could play a key role in providing additional adaptation options within a broader development framework.

Overall, Swaziland faces a challenging future. Problems of drought, desertification and climate change are closely interlinked but efforts to promote adaptation are often found to be in competition with other national priority issues such as poverty alleviation and managing HIV/AIDS (Mushala, 2003). In this regard, the above analysis of policy, communications and local adaptive strategies demonstrates that while efforts to address climate change, desertification and drought are becoming more integrated at the international policy level, much still remains to be done in terms of mainstreaming and promoting synergy at national level. Furthermore, while participatory approaches are being enacted to develop and implement policies, there remains a gap between the policy proposals and the local acceptability of some of the planned adaptations.

4.2. *Botswana*

Botswana is a country of inequality: 47% of people live below the national poverty line[4] and 20% of the population own 60% of the wealth (Adams et al., 2002; CIA, 2004). Livestock farming provides the main source of income for approximately 40% of the population, including many of the poorest communities (Cullis and Watson, 2004). However, a number of field-based research studies have questioned the long-term sustainability of such farming practices due to the evidence of increasing land degradation and desertification, in particular, ecological changes towards greater bush dominance on semi-arid rangelands (see Dougill et al., 1999; Dougill, 2002). These areas are further threatened by ongoing privatisation and the likelihood of increased droughts under a future warmer and drier climate.

Participatory research with pastoral communities in three different regions of Botswana (Reed et al., 2007) has identified strategies to both reduce sensitivity and increase resilience to climate change and drought through land degradation

[4] Botswana Institute for Development Policy Analysis (1996 in CIA, 2004), considered income and capability measures of poverty in Botswana through a comparative analysis of the Household Income and Expenditure Surveys conducted in 1984/1985 and 1993/1994 by the Ministry of Finance and Development Planning.

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prevention or remediation (Table 3). The majority of strategies were only used at the local level, and many of these ideas were being applied autonomously at this scale. However, many of adaptation strategies that were identified require greater government involvement and support at both local and national levels to be most effective. For example, market-based mass destocking would require co-operation and organisation on a scale not currently seen in Botswana (Dougill, 2002). The Botswana Meat Commission would have to play a significantly larger role in supporting reactive destocking programmes. Morton and Barton (2002) propose that a combination of partial destocking and livestock movement may be appropriate, reserving sale of animals for more extreme, geographically widespread droughts such as those of the late 1980s.

Most of the local level strategies address the likely increased frequency and severity of drought under future climate change in the context of ongoing land degradation. This echoes findings from Swaziland in which land managers were found to address simultaneously the interlinked challenges to agricultural production. In contrast to the local level, Botswana's NAP identified a number of priority areas for preventing and remediating land degradation (GOB, 2006: 4). These focus on: (i) poverty alleviation and community empowerment (e.g. through promotion of sustainable alternative livelihood projects); (ii) partnership and capacity building amongst stakeholders and researchers (e.g. through education and technology transfer); (iii) sustainable natural resource management (e.g. by strengthening drought early warning systems, rehabilitating degraded land and lobbying the Government to develop legislation preventing the use of dual grazing rights by private owners who use communal land and retain ranches as drought grazing reserves) and (iv) developing mechanisms to fund and resource these activities.

For example, Botswana's Drought Early Warning system was launched in 1984, relying on rainfall and agro-meteorological input indicators, and outcome indicators based on human nutrition and agricultural production data (Morgan, 1985). The system is limited by the availability and quality of data (e.g. widely spaced meteorological stations and subjectivity of some agricultural data such as estimates by extension staff of livestock condition or area ploughed) and could be improved through greater use of regional long-range forecasts, incorporating information from ENSO bulletins, using remotely sensed data (e.g. to monitor arable cultivation) (Rook, 1997). It is notable that most years are being classed as drought years using this system and this is leading many communities to become increasingly dependent on government drought relief handouts (Sallu et al., 2008). Nevertheless, the approach is supported by the regional political body (SADC) through the Southern African Regional Climate Outlook Forum (SARCOF), which aims to improve the identification, assessment and management of drought risk. However, as yet, these national and regional policy efforts do not support the local level adaptive strategies that build on traditional systems such as *kgotla* village meetings and the *mafisa* system of cattle movement in times of drought (Reed et al., 2007).

Thus far, planned adaptations under Botswana's Initial National Communication to the UNFCCC include: inter-basin water transfers; improved used water recycling; water conservation measures; purchasing water from neighbouring countries; control of deforestation; tree planting around homesteads; improved rangeland management; a national drought early warning system; changing crop varieties; expansion of protected areas and expansion of Community Based Resource Management (Table 4, GOB, 2001). These take greater account of the role of water and trees in facilitating adaptation than the strategies mentioned in Botswana's NAP. In contrast, the NAP tends to focus more on broader development mechanisms rather than specific adaptations. In common with suggestions from pastoralists in research by Reed et al. (2007), the Government of Botswana in their Initial Communication to the UNFCCC (GOB, 2001) propose "marketing and slaughter support for strategic destocking ...diversification of the breeds and species used, including greater use of managed wildlife", although no operational details are suggested (p. 65). In contrast to the views of pastoralists reported in Reed et al. (2007), the communication suggests regulatory control of animal numbers and grazing reserves as suitable routes for future policy priorities and mechanisms. So, while there are areas of common ground between local and policy adaptations, there are also clear differences of emphasis.

In contrast to the emphasis of Botswana's NAP and Initial Communication to the UNFCCC on technological adaptation at national scales, the proposals emerging from participatory research, suggest that there may be a greater role for multi-level adaptation approaches that incorporate local innovation, and that this can be applied at both local and national scales with adequate support from extension services (e.g. Dougill et al., 2002; Reed et al., 2007). Such strategies have a greater capacity to be adopted by a wide range of land managers, without the need for specialist training, equipment or financial capital, and hence to enhance the future sustainability of land management and the livelihoods of those who depend upon the land. Such approaches also emphasise the need to go beyond climate adaptation and consider approaches that can reduce vulnerability and increase resilience of agro-ecosystems to the combined challenges of climate change, drought and desertification. Nevertheless, policy statements remain top-down in their approach to technological adaptation and do not adequately account for local innovation. Integrating pastoralists' knowledge to incorporate local innovation would help responses to be rolled-out and applied at both local and national scales by those managing the land. This could yield multiple benefits, assisting pastoralists to simultaneously address land degradation, drought and climate change challenges, but poses a series of significant research and political challenges to be addressed nationally in the years ahead.

4.3. *Malawi*

Malawi is one of the poorest countries in sub-Saharan Africa with a per capita GNI in 2000 of US$ 170 (GOM, 2006). Approximately 90% of the country's population inhabits rural areas and relies on rain-fed, subsistence agriculture, typically cultivating small-scale holdings of 0.2–3 ha (Ellis et al., 2003), with maize constituting the staple crop. Rapid population

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Table 4 – Planned adaptations in Botswana's agricultural sector (based on the analysis of Botswana's Initial National Communication to the UNFCCC (GOB, 2001)).

Proposed adaptations relevant to the agricultural sector	Level (and stakeholder involvement where appropriate)	Focus of adaptation
Inter-basin water transfers.	National.	Technological development and institutional development.
Improved used water recycling.	Multi-level: may involve researchers, extension workers, NGOs and other stakeholders.	Technological development and institutional development.
Water conservation.	Multi-level: may involve researchers, extension workers, NGOs and other stakeholders.	Technological development and institutional development.
Purchase of water from other countries.	National and international.	Institutional development.
Control of deforestation.	Multi-level: may involve researchers, extension workers, NGOs and other stakeholders.	Education and institutional development.
Encouraging tree planting around homesteads.	Multi-level: may involve researchers, extension workers, NGOs and other stakeholders.	Education and institutional development.
Improved rangeland management.	Multi-level: may involve researchers, extension workers, NGOs and other stakeholders.	Education and institutional development.
National drought early warning system.	National.	Technological development.
Changing crop varieties, e.g. plant sorghum instead of maize.	Multi-level: may involve researchers, extension workers, NGOs and other stakeholders.	Adaptation of crop varieties.
Expansion of protected areas.	National.	Institutional development.
Expansion of Community Based Resource Management.	Multi-level: may involve researchers, extension workers, NGOs and other stakeholders.	Education.
Strategic destocking.	Multi-level: implies use of extension workers.	Institutional development.
Diversification of breeds and species used, including greater use of managed wildlife.	Multi-level: may involve researchers, extension workers, NGOs and other stakeholders.	Adaptation of livestock and crop varieties.
Control of animal numbers and grazing reserves.	National.	Institutional development.

growth and a heavy dependency on natural resources within agriculturally based components of rural livelihood strategies have led to increased pressure on land and vulnerability to the increasingly frequent climatic hazards of droughts and flooding (Ellis et al., 2003).

The research reviewed from within Malawi covers the four major agro-ecological zones: Ngabu in the Lower Shire, Bvumbwe in the Blantyre Shire Highlands, Chitedze in the Lilongwe Kasungu Plain and Lunyangwa in the Nyika area. The recent elements of the field research (see Mkwambisi, 2008, 2009) demonstrate that key issues affecting rural livelihoods and people's ability to adapt to drought, desertification pressures and climate change include poor soils, poor infrastructure for the delivery of inputs, lack of education resulting in barriers to technology transfer, and HIV/AIDS impacts on the labour force. More widely, there is evidence within academic and non-governmental organisation (NGO) literature of many adaptations already being enacted at a local level to mitigate the effects of these problems on agricultural production in Malawi (Table 5).

The Malawi UNCCD NAP (GOM, 2001) cites extreme poverty, a heavy reliance on natural resources, low land availability and rapid population increases as the main drivers of land degradation and low agricultural productivity. Prolonged periods of drought have further exacerbated the situation, notably in the devastating drought of 2001/2002 when maize yields fell to 1.4 million tonnes, significantly below the estimated need of 2 million tonnes per annum (Potts, 2006). Since Malawi is one of the world's LDCs, a NAPA (GOM, 2006), as well as a NAP (GOM, 2001) and the Initial National Communication (INC) to the UNFCCC (GOM, 2002), has been produced. The Malawi NAP addresses agricultural adaptation within the context of desertification and drought primarily through a focus on issues of food security and environmental management rather than explicitly focussing on agricultural adaptations. The INC and NAPA, however, clearly identify agriculture as a sector its own right, in which it is imperative to evaluate the impacts of climatic variations (Table 6).

When comparing the local adaptations and those proposed in the policy documents, common ground is clearly apparent. The emphasis on both subsistence and cash crop diversification (see Table 6) appears to be a strategy already being undertaken autonomously and therefore may prove to be effective and acceptable to local populations. However, Ellis et al. (2003) note that the cultivation of crops such as groundnuts and sweet potatoes (encouraged by both the NAP and NAPA) is rare, covering only 10% of the country's cultivated area. Similar to Swaziland, there remains a heavy reliance on maize within smallholder agriculture. The growth of burley tobacco as a cash crop has only recently (since 1990) been authorized for smallholders and was intended to increase agricultural outputs. Nevertheless, this has not been the case due to fluctuations in market prices and quality issues (Ellis et al., 2003) supporting the NAP's encouragement of a decreased reliance on both maize as a subsistence crop and tobacco as a cash crop. Recent studies (Mkwambisi, 2008) have also indicated that a lack of government commitment to reduce rural poverty has resulted in people (including children) being trafficked for forced labour in tobacco estates as a survival mechanism. This is most prominent in Thyolo and Mulanje districts where the population density is very high. Droughts have also resulted in problems accessing water for domestic use in the main agricultural districts of Kasungu and Mchinji (Mkwambisi, 2008). This has forced young girls to be engaged in domestic work as a means to contribute to household incomes. This suggests that as survival strategies change and people adapt over the longer

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Table 5 – Local adaptations to climate change, drought and desertification in Malawi (synthesised from Mkwambisi, 2009; ActionAid, 2006; Orr and Mwale, 2001; GOM, 2001; Vermuelen et al., 2008; Potts, 2006; Bryceson and Fonseca, 2006; Ellis et al., 2003).

Driver of adaptation	Adaptive strategy
Climate: changing rainfall and temperature patterns.	Shortening and modifying of growing season, e.g. maize has been planted in November in the past but is now planted in December; changes in crops cultivated, e.g. hybrid maize; cultivation of burley tobacco as a cash crop; intercropping field pea and pigeon pea to replace beans which cannot tolerate low rainfall.
Land degradation and soil infertility.	Cultivation of field pea and pigeon pea crops as relay and cash crops, also fix nitrogen so aid in soil fertility; intra-rural migration from southern Malawi further north as a result of population pressures on land availability and poverty.
Drought.	Unpredictability of rainfall has seen shifts away from reliance on agriculture as a key income source towards development of microenterprise, e.g. handicrafts in tourist areas; income transfers; remittances; migration; inter-household labour exchanges (ganyu).

term, it will not only lead to a change in agricultural strategies, but also runs the risk of increasing child labour and other exploitative practices. Adaptation therefore could have far-reaching social impacts which need to be acknowledged.

Potts (2006) believes the importance of intra-rural migration is underestimated as an adaptation strategy in Malawi. To prevent those areas currently experiencing lower levels of population pressure and land degradation becoming uncultivatable under future conditions of climate change and drought, a need for anticipatory adaptation is apparent as this is currently unacknowledged in policy. Similarly, none of the policy documents recognise the significance of *ganyu* (casual rural labour exchange) and the social impacts of adaptations involving this strategy. Bryceson (2006) describes how *ganyu* may be deepening impoverishment by widening the gap between those who can afford *ganyu* labour and those who rely on it. This has led, in many cases, to exploitative contractual terms, reduction in time to tend agricultural assets and has also been linked to the spread of HIV/AIDS with the incorporation of 'transactional sex' into *ganyu* contracts. If this were formally addressed at the policy level, it may be possible to reduce these negative effects and harness benefits simultaneously, e.g. targeting education programmes at community *ganyu* networks to concurrently enhance adaptation capacities, reduce poverty and help reduce the spread of HIV/AIDS.

Snapp and Slim (2002) identify the need for cultivars that require low levels of manual labour, something increasingly critical due to declining rural labour availability as an effect of the HIV/AIDS pandemic (Bryceson and Fonseca, 2006). Micro-enterprise also seems to be a potential area for policy adaptation support and is already in evidence. For example, handicrafts have been marketed to tourists in Mangochi, Salima and Nkhata Bay districts (GOM, 2001) along with locally produced gin in the Blantyre Shire Highlands (Orr and Mwale, 2001). This has been facilitated by market liberalisation in the early 1990s however it is unlikely that in areas of extreme poverty smallholder farmers will have access to the funds and assets needed to exploit these opportunities as a larger scale adaptation to climate change, drought and desertification (GOM, 2001). Poverty may therefore hinder the possibilities for adaptation.

Education in the form of awareness raising about potential options features strongly in both the NAP and NAPA, particularly in terms of increasing the effectiveness of new crops and techniques in enhancing adaptation capacity. Similarly, both documents place an emphasis on the diversification of current livelihood options, either through cultivation of different and more suitable crops, or by engaging in other employment opportunities. An important difference nevertheless lies in the policies' different approaches to promoting diversification: the NAP proposes to attract greater private sector investment, while the NAPA tends to focus on improving market access links (Table 6).

While some common goals are identified within the policy documents, these fail to adequately harness and support current local practices. Malawi urgently needs effective adaptation strategies that are both complementary across scales (local–national) as well as synergetic across policy sectors (including across climate change, desertification and drought issues). The predominance of HIV/AIDS and projections of a changing climate increases the risk of exacerbating food insecurity into the foreseeable future. Malawi's landlocked location within southern Africa limits the options for food transfer, further increasing vulnerability in the context of drought, floods and worsening land degradation. Policy adaptation strategies therefore need to take greater account of the limited access smallholder farmers have to resources and technologies, as well as a limited capacity for risk-taking.

5. Discussion

This section discusses the implications of the contradiction and synergy that has been revealed in our analysis, between climate change and desertification policies, and between the challenges this presents for policy and practice. It considers how policy adaptations may become more mutually supportive if they are embedded within a broader development framework, and argues that adaptation needs to take place synonymously with sustainable development to help reduce vulnerability, in order for it to be successful (as per Schipper, 2007).

Our case studies have shown that a combination of reactive and anticipatory adaptation is taking place in southern Africa, both within policy and on-the-ground practice. While there is

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Table 6 – Planned adaptations relevant to Malawi's agricultural sector within the INC, NAP and NAPA (based on information in GOM, 2001, 2002, 2006).

Proposed adaptation relevant to the agricultural sector	Level (and stakeholder involvement where appropriate)	Focus of adaptation
Increase production of food and cash crops and livestock products through promotion of crop diversity according to ecological suitability (INC, NAP).	Multi-level: stakeholder involvement unclear.	Adaptation of crop and livestock varieties.
Promotion of livestock production (NAP).	Multi-level: stakeholder involvement unclear.	Livelihood diversification.
Education of farmers to improve land husbandry techniques (INC, NAP).	Multi-level: implies involvement of extension workers and farmers.	Education.
Provision of irrigation services and resources (NAP).	National level.	Technological availability and institutional development.
Promotion of food processing and marketing by farmers (NAP).	Multi-level: implies involvement of GOM as well as farmers and extension workers.	Livelihood diversification and technological availability.
To reduce dependence on agriculture as income base by encouraging private sector investment, especially in dryland areas; training communities in vocational skills (NAP).	Multi-level: implies involvement of GOM, private sector and extension workers.	Livelihood diversification and financial mechanisms.
To encourage community participation and education into natural resource management through training (NAP).	Multi-level: may involve GOM, NGOs, extension workers, farmers.	Education.
Mapping out of vulnerable areas and identification of drought-tolerant crops (NAPA).	National: implies agricultural research.	Adaptation of crop and livestock varieties.
Promotion of livestock production and identification of drought-tolerant livestock (NAPA).	Multi-level: implies research and involvement of farmers.	Livelihood diversification.
Multiplying and distributing appropriate crops and animals; dissemination of relevant information for successful cultivation (INC, NAPA).	Multi-level: implies research and involvement of farmers.	Technological availability and institutional development.
Controlling rainwater, floods and residual soil moisture (NAPA).	Multi-level: implies technology provision and extension workers at community level.	Technological availability and institutional development.
Training farmers and extension workers in agricultural husbandry techniques; storage; utilisation and value-adding to crops and animal products (NAPA).	Multi-level: implies research and extension workers at community level.	Education.
Encouraging agro-processing and developing market access links (NAPA).	Multi-level: implies involvement of industry, institutions and farmers.	Livelihood diversification and institutional development.

some degree of overlap between documented adaptations to desertification and drought and those targeting adaptation to climate change (see Table 7), few steps have currently been taken to mainstream adaptation across policy sectors, nor to absorb local level strategies. There are important instrumental reasons why such mainstreaming is necessary at the policy level—not least because there appears to be a real risk that NAPs and NAPAs are in danger of being duplicative at times rather than complementary, particularly with regard to their efforts in the agricultural domain (Table 7). This problem is likely to extend outside our case study countries to other LDCs in southern Africa and beyond, where resources for such policy development are already limited (Sporton and Stringer, 2007). A lack of integration also increases the risk of negative externalities over both time and space (Osbahr et al., in review; Adger et al., 2005) and further analytical research is needed to unravel the complexity of adaptation interactions to support successful strategies over the longer term.

There is also a danger of lock-ins in both policy and practice, as existing strategies are reinforced over time and resistance to change develops. This is apparent at the local level in our case studies. Despite, for example, the proposal within Swaziland's communication to the UNFCCC to increase availability of micro-credit, rural people are not necessarily keen to engage in finance schemes, often due to cultural and traditional reasons. Many of the poorest members of society do not have a bank account and even the wealthier families would likely need to use cattle as collateral in place of other assets (cf. Ferguson, 1994). In much of southern Africa there is a reluctance to use livestock in this way due to the social status that cattle ownership bestows. As such, households may become locked in a downward spiral of declining yields, that they are unable to break free from, because they do not have the finances or other capitals to draw upon to afford the fertiliser inputs or livestock feed needed to increase production.

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Table 7 – Synthesis matrix showing overlaps and differences between local and national policy adaptations.

Focus of adaptation	Examples of adaptive strategy	Malawi			Swaziland			Botswana		
		Local	NAP	NAPA	Local	NAP	UNFCCC FNC	Local	NAP	UNFCCC INC
Land use	Promotion of crop diversity and livestock production		X	X						X
	Promotion of sorghum production in drier areas						X			X
	Encouragement of domestic production of high quality maize and bean seeds						X			
	Growth of cash crops	X	X		X					
	Encouraging tree planting around homesteads									X
Land management practices	Strategic destocking									X
	Use of legumes to increase soil N	X			X		X			
	Modification of planting times according to climate and rainfall	X			X					
	Appropriate land husbandry techniques, e.g. wind breaks to reduce wind erosion	X	X	X	X	X		X		X
	Controlling and managing rainwater, floods and residual soil moisture			X	X			X		X
	Encourage farmers to increase agricultural productivity per hectare						X			
Education	Education					X			X	
	Training of farmers and extension personnel for maize self-sufficiency						X			
	Strengthening of stakeholder linkages					X	X			
	Awareness raising to promote conservation agriculture					X				
	Community training in natural resource management		X						X	X
Cultural	Migration	X			X					
	Praying for rain				X					
	Community networks, e.g. mafisa and ganyu	X			X			X		
Economic	Remittances	X								
	Value adding to primary products			X						
	Livelihood diversification	X	X		X				X	
	Promotion of food processing and marketing		X	X						
	Distributing crops, livestock and relevant information			X						
	Encourage agro-processing and develop market access links			X						
	Microenterprise	X			X			X		
	Increased finance for fertilisers and hybrid seeds						X			
	Purchase of water from other countries					X				X
	Attracting private sector investment		X							

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Table 7 (*Continued*)

Focus of adaptation	Examples of adaptive strategy	Malawi			Swaziland			Botswana		
		Local	NAP	NAPA	Local	NAP	UNFCCC FNC	Local	NAP	UNFCCC INC
Legislation	Control of deforestation							X		X
	Expansion of protected areas									X
	Legislation to prevent use of dual grazing rights								X	
	Rural resettlement policies					X				
Legislation/ technological	Early warning system for drought					X			X	X
Technological	Technological improvements					X			X	
	Provision of more tractors						X			
	Identification and development of cost-effective production technologies						X			
	Provision of irrigation services and resources			X		X				
	Introduction of high yielding, drought- and disease-tolerant seed varieties of crops	X		X	X		X	X		X

The most grounded policy strategies emerging in our analyses can be viewed as those that help people to enact the adaptive strategies they are currently using or would like to employ should the necessary support be present and accessible. For example, 'adaptation of crop varieties' is mentioned in national level UNFCCC- and UNCCD-related policies and documents, as well as being identified within local adaptive practice. Indeed, local adaptations show similarities in this regard across our case study countries (see Table 7). Despite this seemingly successful tessellation of adaptation strategies at different levels, the cultural context of such changes is not recognised within policy (Table 7), even though participatory approaches are becoming more widely used. Land users are consequently shifting towards the use of higher yielding, drought- and disease-tolerant varieties far more readily than they are adopting different crop species (e.g. sorghum and cassava rather than maize, as encouraged by policy in Swaziland and Botswana). As such, policy development needs to acknowledge cultural- and context-specific practices more prominently and recognise that adaptations are a response to multiple changes and stressors that are dynamic over time and affect different groups of society in different ways. Indeed, livelihood responses to climate change and land degradation are evaluated within a broader framework of immediate risks and needs, while access to livelihood assets is mediated by factors such as land tenure, social norms and formal or informal institutional arrangements.

Innovative and complementary bundles of adaptation strategies to deal with current and future drivers of change need to be developed and facilitated by an integrated policy approach. Innovative adaptation options may include new ways of using and/or combining existing capital assets. For example current adaptations in Botswana include transporting livestock and water to ungrazed pasture on a daily basis during drought events modifying the traditional *mafisa* systems of movement (Reed et al., 2007). Alternatively, innovation may focus on the realisation of untapped capital assets, including the tapping of new ecosystem services. In this context, carbon storage is a currently an untapped ecosystem service that could potentially finance some ecological restoration through access to carbon markets via Clean Development Mechanism opportunities. However, the science of carbon fluxes from Kalahari soils (see Thomas et al., 2008) would need significant development before a direct link between land management practices and carbon storage could be proven to the extent that would be required to justify flows of funding to regions changing their land management practices. Given these remaining uncertainties, policies may be better able to support adaptation options that are tailored to the realities of the current varied and dynamic livelihood contexts seen across the region (Reed et al., 2007), including the fact that livestock grazing of rangeland resources is no longer the main livelihood resource for many rural communities in the Kalahari (Chanda et al., 2003; Sallu et al., 2008). Once again, this underscores the importance of mainstreaming across policy sectors, in order for broader considerations and their potential (cumulative) impacts on practice to be taken into account.

A key argument emerging from this analysis is that the linkages between adaptation and development should be made more explicit. Adaptations like livelihood diversification to reduce vulnerability have long been taking place at local and policy levels in each of our case study countries (Table 7), despite variation in the specifics of novel livelihood components across time and space and attribution of the diversification to a number of different drivers. This observation demonstrates how successful sustainable development that helps reduce vulnerability needs to take place concurrently with adaptation for it to be successful (Schipper, 2007; Small, 2007). Although the rhetoric of these developmental approaches is present within international political debates on adaptation, the reality of applying for example, participatory approaches, can often flounder in practice (Stringer et al., 2007b). Often this is because the politicised nature of policy

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adaptations is ignored but also because the perception of risk plays an important role in influencing both policy and practice (Patt and Schroeter, 2008). This, in turn, is highly contingent on the social, cultural and economic remit within which people situate their needs and aspirations and which, inevitably is not free from conflicts and trade-offs over both time and space.

Despite these complexities, there may be lessons for policymakers to learn from the local level and the more integrated approach to adaptation that typically plays out on the ground. Our case studies are grounded in literature analyses and show that people often combine different adaptations to climate change in an attempt to address the multiple effects on socio-ecological systems. In addition, people do not adapt only to climate change. Their strategies represent the aggregate result of multiple drivers, needs and aspirations operating over myriad time and spatial scales. However, not all adaptation options are necessarily compatible with one another, and further research is needed to investigate (in advance) the likely aggregate effects of combining anticipatory adaptations to reduce trade-offs and promote win-win situations. There remains an urgent need to further examine top-down policy strategies and make use of the holistic approaches that play out at local level when developing adaptation policy. Our analysis suggests that participatory approaches can assist with this, in particular, by improving the accessibility of local adaptive strategies to those operating in the policy realm. However, the enthusiasm for broader participation in the rhetoric of international politics does not yet match the realities of its enactment on the ground. Furthermore, for the adaptations themselves to be successful, resilient and more widely adopted, it is important they are applied beyond the level of the household and community. Legitimate and inclusive institutions can play a key role in achieving this (Osbahr et al., submitted), as could informal institutions and social networks/practices (e.g. *ganyu* in Malawi and *mafisa* in Botswana).

6. Conclusion

This paper has focused on the integrated challenges of climate change, desertification and drought. It has drawn on adaptive evidence from three case study countries in southern Africa to explore the similarities and differences between autonomous (bottom-up) and managed (top-down) adaptations as well as the synergy in policy strategies to address desertification and drought, and climate change. Our findings indicated considerable common ground; both between local adaptations in the three countries, and between UNFCCC and UNCCD national policy documents within each country. However, the mutual reinforcement of policy and local adaptations is not always well developed. Policy appears to inadequately support adaptations that rely on social networks and neglects to capitalise on other more traditional practices identified in the literature, despite taking more participatory approaches towards policy formulation. While the complementarities between efforts to adapt to climate change, desertification and drought are clear at the policy level, we conclude that these need to be situated within a more joined-up development context that cross-cuts policy sectors in order to reduce vulnerability and increase resilience. Without further integration, the likelihood of possible contradictions and duplications that waste already limited resources may increase. In this regard Osbahr et al.'s (in review) calls for an adaptation space could act as a useful way of conceptualising such integration, offering the opportunity to harness benefits in addressing other key issues too (e.g. HIV/AIDS). Nonetheless, this will not necessarily be straightforward, as policy processes across national and regional levels are dependent on the political structures and governance regimes of those in power (see Stringer et al., 2007c for consideration of this in Swaziland). Despite the challenges, in light of the predicted climatic and environmental changes that southern Africa faces, the need for mutually supportive policy and local adaptations becomes increasingly urgent.

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