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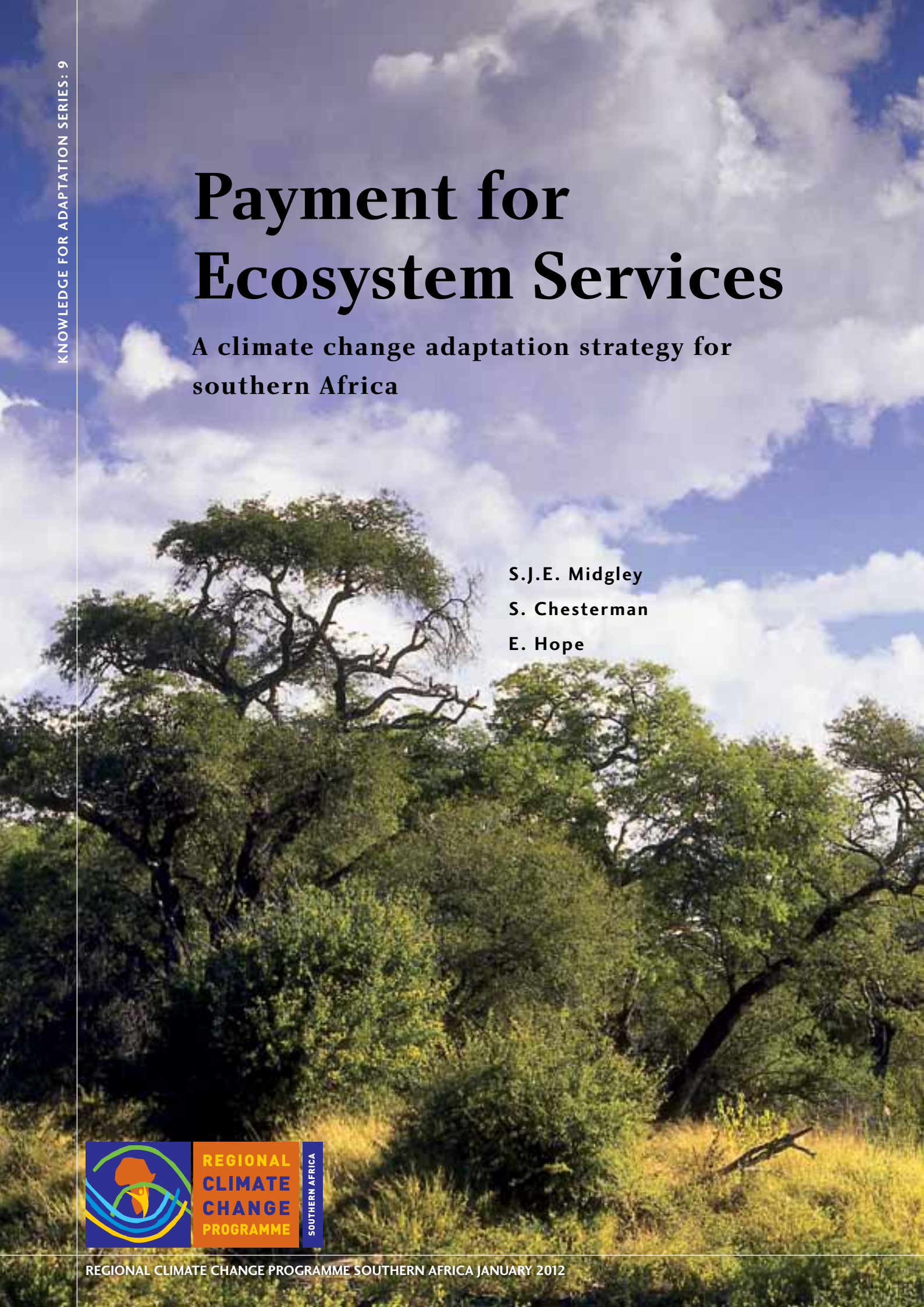

REGIONAL CLIMATE CHANGE PROGRAMME SOUTHERN AFRICA

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REGIONAL CLIMATE CHANGE PROGRAMME

The Regional Climate Change Programme Southern Africa (RCCP)

The RCCP aims to contribute to the achievement of southern Africa's climate change adaptation needs, socioeconomic development and poverty alleviation objectives, including the Millennium Development Goals.

By synthesising the relevant climate change science, developing strategic research and strengthening science-policy-governance-finance dialogue, the RCCP will build an evidence base for appropriate transboundary responses, strengthen the region's voice on international platforms and negotiations, and enhance its ability to equitably access the necessary finance for effective climate change adaptation.

The five-year Regional Climate Change Programme of work (2009–2014) with Southern African Development Community (SADC) partners on the impact of climate change, aims to increase regional participation in globally funded adaptation projects and improving resilience. The RCCP has four outputs, the first of which focuses on the scientific basis for understanding climate change impacts in southern Africa.

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Key messages

Millions of people across the SADC region depend directly and indirectly on ecosystem services for their food, water and energy security, as well as their health and livelihoods.

Ecosystem services (ES) are the benefits people obtain from ecosystems, and include a range of goods and services which satisfy human needs directly or indirectly. These services include provisioning (provision of water, food, medicine, grazing, building materials, genetic resources and energy), regulating (regulation of climate, water, sediment, waste, pests and diseases), supporting (nutrient cycling and seed dispersal), and cultural (spiritual and recreational benefits) services. Lessons from community-based management of forest, rangelands, wildlife, wetlands and their associated biodiversity indicate ecosystems can potentially contribute to reducing vulnerability and increasing resilience to improve the well-being of local communities dependent on natural resources.

African rural populations rely mostly on rainfed farming with significant linkages to ecosystem services and they are often *highly* vulnerable to climate variability and climate-related disasters, with severe capacity constraints to deal with the impacts.

Climate change, increasing climate variability and climate shocks will directly impact the flow of ecosystem goods and services, notably those relating to water, food and energy security. The human response to the impacts of climate and other stresses on livelihoods, which in southern Africa frequently involves a switch from farming to the use of natural resources as a livelihoods safety net, could place further strain on ecosystems. This will require a strong focus on the capacity for sustainable natural resource management, not simply in a protection or conservation frame but in line with socioeconomic and development imperatives for the region and in close cooperation with communities.

The role and value of ecosystem services in the climate change arena has traditionally been considered in terms of mitigation – there is a need to approach this also from a climate change adaptation perspective.

Globally and in southern Africa there exists a strong push for afforestation programmes and other forms of carbon sequestration. However, adaptation and strengthening of resilience for local communities and the ecosystems they depend on should receive equal attention, within an overall adaptation strategy and policy framework. Ecosystem-based adaptation (EbA) refers to the sustainable management, conservation, and restoration of ecosystems and their biodiversity to provide services that support adaptation, build resilience, and in so doing can generate significant socio-ecological, socioeconomic and cultural co-benefits.

The multiple benefits of Ecosystem-based Adaptation have clear linkages to development priorities and the ambition to reduce poverty and food insecurity over the short and long term, whilst simultaneously dealing with the impacts of climate change.

Enhancing ecosystem resilience restores natural protection against extreme climatic events, thus limiting losses and damages. Economic gains from ecosystem or land use conversion may be outweighed by the potential benefits of conservation and/or restoration, especially as multiple ecosystem services are considered in the assessment. The multiple benefits of EbA offer the opportunity to integrate adaptation priorities with development processes. The Millennium Development Goals make these linkages (MDG1 and MDG7 in particular) but MDG7 (ensure environmental sustainability) is not on track for achievement over much of the region. This will require increased political will and investment, and a robust regulatory framework.

A set of market-based approaches broadly known as payment for ecosystem services (PES) has *significant* potential as part of an overall climate change adaptation strategy within the development context.

The PES mechanism includes financial payment, compensation or exchange systems for the conservation or restoration of vital ecosystem goods and services, or compensation where these are being degraded. PES agreements could provide an income buffer and a source of income diversification, and thus aid communities in increasing their resilience to climatic shocks. Valuation frameworks and methodologies do, however, require further development and agreement, especially where multiple ecosystem services are at play.

Both EbA and PES must be rooted in the local context, with local communities taking ownership of the process.

As part of the social process a measure of learning on the part of the beneficiaries is necessary, with a strong basis in existing indigenous and local knowledge, enhanced with knowledge building around socio-ecological processes and feedbacks, financial mechanisms, and appropriate institutional and governance strengthening at local level. At the same time, good scientific baselines around ecosystem services are required prior to implementation, with continued monitoring thereafter. Data and research capacity and funding are currently rarely available and should be strongly supported with investment.

A comprehensive status quo study and inventory of PES projects shows a lack of capacity around EbA and PES in many responsible institutions in the region and insufficient understanding and awareness on the part of policy and decision makers.

Thus it may be inappropriate to implement highly complex and financially rigorous PES systems in southern Africa. Instead, a pragmatic approach to adaptation requires an assessment of the existing institutional baseline from which options for climate change adaptation and the integration of ecosystem services can be evaluated. Small scale projects based on simple exchanges around key services need to be actively encouraged in the region. These can be locally based and administered within a community, and payments for different ecosystem services do not necessarily have to involve monetary exchange. A transition to ecosystem-aligned and holistic land use planning and management is required. In southern Africa, land cover change is one of the most important drivers of change to ecosystems and their services. Institutional capacity building, supported by appropriate national policy and regulatory frameworks and close attention to strengthening governance in this arena, are required.

Millions of livelihoods across the region depend on the natural resource base for provisioning, regulating and cultural purposes. Himba women fetch water in the Purros district, Namibia.

1. Introduction

This study firstly aims to provide an introduction to the relatively new concept of linking payment for ecosystem services (PES) with climate change adaptation strategies, within the context of southern Africa. The study is one of a series of Knowledge for Adaptation titles published by the RCCP. This series is targeted at SADC decision and policy makers and aims to support their leadership in securing government commitments in the climate change, health and development contexts – including from influential institutions and other key stakeholders in the PES arena.

Simply put, PES is a contract between buyer(s) and user(s), with the 'commodity' being one or more defined benefits derived from an ecosystem. Payment can take the form of financial or non-financial incentives. The seller(s) undertakes to carry out a particular land use or activity on a continuous basis in order to secure the said ecosystem service (ES). In southern Africa, where many people rely heavily on natural resources and ecosystems, adaptation to climate change and the building of resilient livelihoods in the face of climate and disaster risks is intimately linked to the need to secure life-giving services such as the provision of water and food by conserving or restoring key ecosystems. Various types of PES schemes exist, including opportunities for watershed management, carbon sequestration, biodiversity conservation and sustainable land use.

The study goes on to analyse the potential of current PES or PES-related activities in the region to serve as climate change adaptation projects within a suite of approaches termed ecosystem-based adaptation (EbA). PES is characterised by its engagement with previously uninvolved communities (beneficiaries of ES) by providing incentives for conservation and restoration, whilst potentially simultaneously building the resilience of natural-resource-based livelihoods against changing climates and disasters.

As the impact of climate variability and climate change across Africa becomes increasingly evident, local solutions (based on multiple knowledge systems and experiences) and innovative mechanisms to achieve both adaptation to these impacts and some measure of climate change mitigation are being sought. Millions of livelihoods across the region depend on rainfed subsistence agriculture and the complementary use of a wide natural resource base for provisioning, regulating and cultural purposes. Africa boasts a wealth of ES, the most notable of which are provisioning of fresh water, food, biodiversity, wood fuel and cultural, spiritual, aesthetic and recreational services (Biggs *et al.*, 2004). These could provide essential safety nets and adaptive opportunities for many people as climate change unfolds, in addition to the better known carbon sequestration opportunities. However, unsustainable use and degradation of many ecosystems could threaten these services. A thorough understanding of the greater context surrounding ES is thus pivotal to any ecosystem based adaptation approach.

The African continent has contributed the least to global climate change; however, it is one of the most vulnerable regions globally to climate change (Boko *et al.*, 2007; Hope, 2009). Climate change poses a plethora of new challenges for southern Africa which will be wide-ranging and complex to address. A range of biophysical changes linked to shifting precipitation patterns and rising temperatures will see a growing strain on natural capital and ecosystem services. These shifts will also fundamentally affect social and economic systems, both within countries and at transboundary scales. Changes in the provision of key ES will affect where land development, production and human settlement occurs (Boyd, 2010). Ecosystem goods and services and their sustainable flow will support adaptation but could also be stressed by this adaptation (Boyd, 2010). Consequently, flexible adaptation strategies in southern Africa will need to focus on management of the natural capital and ecosystem services base, not simply in a protection or conservation frame, but in line with socioeconomic and development imperatives for the region (Colls *et al.*, 2009; World Bank, 2009; Midgley *et al.*, 2011). Adaptation needs to be dynamic when considering varying threats to ecosystem services, some induced by climate change and many further threatened by burgeoning populations in already vulnerable countries across the region.

Research in this area, specifically interrogating how development in the region coupled with climate change will affect and threaten ES, is only beginning to emerge. Ecosystem goods and services can be seen as the dependence of economic wealth and human well-being on natural systems (Boyd, 2010), a dependence which is particularly high in most parts of Africa. The fact that these ecosystem goods and services are not readily traded in markets makes this task of 'portraying value' to policy and decision makers and overlaying adaptation more complex. There is a need to capitalise on opportunities for payment schemes and a market-based response to adaptation.

The concept and mechanism of payments for ecosystem services (PES) has emerged, with countries such as Costa Rica taking the lead on robust strategies and a comprehensive project portal of lessons learned and emerging opportunities, primarily for Latin America (Huberman, 2008; Porras *et al.*, 2008). However, information on ES and PES projects in southern Africa is scarce, although some flagship projects such as Working for Water in South

Africa (payment for watershed services) are internationally acknowledged (Porras *et al.*, 2008, Turpie *et al.*, 2008). As a result, a baseline on how to address this complex issue and how to move towards integrating a clearer understanding of ES and PES into a climate-resilient development approach for the region does not necessarily exist.

The study presented in this report entails a detailed scoping of existing and emerging PES schemes and case study expertise from southern and eastern Africa. The concept and methodology was presented to a panel at the International Livestock Research Institute (ILRI) based in Nairobi, specifically the people's and ecosystems' working group, during a one-day workshop. ILRI case studies were discussed to interrogate the overlay between climate adaptation and traditional approaches to PES. A further case study from the Laikipia district in western Kenya was discussed with the Zeitz Foundation in Nairobi. This learning was integrated with key expertise and guidance from southern African experts, including researchers at the Nelson Mandela Metropolitan University and Prof Martin de Wit. This expert consultation reaffirmed the novelty of this approach in terms of where PES sits in relation to climate adaptation, as well as reiterating the need to update the current inventory of PES projects across the region. These meetings combined a detailed scoping phase, expert critical input and an appraisal of existing projects and key thought leadership in the region on PES.

The objective of this study is thus to provide a baseline analysis of understanding and a conceptual framework around ES and PES, mainly in southern Africa but also including information obtained from East Africa, within the context of current and future climate variability and climate change, the ecological and economic implications, and adaptive responses. The sustainable development of the southern African region needs to be founded on a management approach focused on development that addresses the current status of these vital ecosystem services that underpin the whole social-ecological system. The challenges climate change will impose, matched to the regional vulnerability and the inter-dependence between rural people and ecosystem services, demand that coherent adaptation policy frameworks need to be developed in the region. At an international level, the 'ecosystems approach' was spearheaded by the International Union for Conservation for Nature (IUCN) and the Millennium Ecosystem Assessment (MEA), and is now an acknowledged component of the multi-lateral negotiations under the United Nations Convention on Biological Diversity (CBD) and the United Nations Framework Convention on Climate Change (UNFCCC) (see Box 1). A good basis has been established for more locally contextualised research and action.

Through a literature review, interviews with project managers across the region and analysis of case studies, the report analyses the complex relationship between PES and climate change adaptation, identifies key gaps in regional knowledge, and what is required to ensure effective and sustainable policy framework development and management approaches.

Box 1: International policy developments regarding biodiversity, ecosystems and climate change

At the 10th Conference of the Parties to the United Nations Convention on Biological Diversity (COP 10), held in October 2010 in Nagoya Japan, over 200 countries were involved in the pivotal policy move towards integrating ecosystem valuation into national biodiversity strategies (Spurgeon *et al.*, 2011). Some of the key outcomes from the Nagoya agreement with regards to international governance of ecosystem services include:

- Aichi Targets – 20 principles agreed upon for protecting biodiversity over the next 10 years, which include targets such as restoration of 15% of degraded habitats;
- 'Resource Mobilisation strategy' – details under the agreement encourage market-based incentives for ecosystem services and a substantial increase to current levels of official development assistance in support of biodiversity; and
- A specific aspect of the 'Nagoya Protocol' on access and benefit sharing requires benefits from the utilisation of genetic resources for commercial purposes to be shared with host communities through agreement and prior informed consent.

This illustrates a firm international commitment to addressing biodiversity and ecosystem service loss and providing mechanisms and targets to halt this trend. This international commitment was further validated at the 26th session of the Governing Council/Global Ministerial Environment Forum held in Nairobi in February 2011 where a draft decision was approved regarding the International Science Policy Platform on Biodiversity and Ecosystem Services (IPBES). This shows a high level commitment to providing a robust scientific evidence base for the broader 'ecosystems approach', building on the seminal MEA (Carpenter *et al.*, 2009).

Within the climate change arena and the UNFCCC multi-lateral negotiations (Conference of the Parties [COP] and other meetings), adaptation is recognised as one of four pillars of the Bali Action Plan (December 2007), and was further cemented in the Cancun Agreements of December 2010 (UNFCCC 1/CP.16), notably through the establishment of the Cancun Adaptation Framework. The growing recognition of the important role of ecosystems and their services in adaptation led to an agreement that this approach would be subjected to a technical review and consideration under the Nairobi Work Programme on adaptation (NWP). This was tabled and guided negotiations at COP17 in Durban, South Africa, in December 2011.

Box 2: Definitions

Ecosystem approach: A strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way (CBD).

Ecosystem services: The benefits that people obtain from ecosystems (Biggs *et al.*, 2004).

Payment for ecosystem services: A voluntary agreement to enter into a legally-binding contract under which one or more buyers purchase a well-defined ecosystem service by providing financial or other incentives to one or more sellers who undertake to carry out a particular land use on a continuous basis, which will generate the agreed ecosystem service at specified levels (IUCN).

Climate change: any change in climate over time, whether due to natural variability or as a result of human activity (IPCC, 2007).

Vulnerability to climate change: The degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity (IPCC, 2007).

Adaptive capacity: The ability of a system to adapt to a changing climate (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (IPCC, 2007).

Resilience: The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change (IPCC, 2007).

Ecological resilience is related to a system's ability to absorb disturbance and change, while still maintaining the same relationships. It includes a system's 'capacity to reorganise while undergoing change, so as to preserve structure and function' (Eakin and Luers, 2006).

2. Ecosystem services, climate change and ecosystem-based adaptation

2.1 What are ecosystem services?

The Millennium Ecosystem Assessment (MEA) defines ecosystem services (ES) as 'the benefits people obtain from ecosystems' (Biggs *et al.*, 2004). These multiple benefits are supplied by natural ecosystems as a result of their structure and function – the conditions and processes through which nature sustains human life on Earth (Daily, 1997) – and include a range of goods and services which satisfy human needs directly or indirectly (De Groot *et al.*, 2002; Waage and Stewart, 2010).

ES can be divided into four broad categories (Table 1):

- provisioning, such as the provision of water, food, medicine, grazing, building materials, genetic resources and energy;
- regulating, such as the regulation of climate, water, sediment, waste, pests and diseases;
- supporting, such as nutrient cycling and seed dispersal; and
- cultural, such as spiritual and recreational benefits.

They operate across a range of geographical scales from local to sub-national, national, regional or global scale. For example, tropical rainforests and the services they provide in terms of sequestering carbon dioxide are viewed as globally important services, integral to human life. At the other end of the scale, local patches of forest surrounding human settlements in southern Africa provide edible fruits and products (such as honey) which support families. While the direct use of provisioning services is fairly straightforward to calculate, the values of regulating and supporting services are more indirect and thus challenging. Values provided directly or indirectly can also be estimated for each type of ecosystem (forest, wetlands, coral reefs, etc.).

2.2 Dependence of African livelihoods on ecosystem services

Human well-being and survival is dependent on the ecosystems in which we live and which support our food production and many forms of economic activity. Millions of people across southern Africa depend directly and indirectly on ecosystem services for their food, water and energy security, for materials used to build homes, as well as for their health and livelihoods, and thus the survival of their economic and social systems. Some 60–70% of the population engage in rainfed subsistence or smallholder farming or are otherwise dependent on natural resources for their livelihood. Agricultural, rangeland, forest harvesting and fisheries systems have evolved over long time periods. Human social systems have likewise evolved in relation to spatial and seasonal patterns of water availability and biological productivity across the landscapes which they inhabit. Communities manage ecosystems, and their capacity and motivation to manage them is critical (Fabricius *et al.*, 2007). Indigenous and local knowledge (ILK) is used to a great extent during times of stress, including frequent and severe impacts of climate variability and climate-induced disasters, and most existing coping mechanisms rely heavily on the natural resource base. Lessons from community-based management of forest, rangelands, wildlife, wetlands and their associated biodiversity indicate that ecosystems can contribute to reducing vulnerability and increasing resilience, thus improving the well-being of local communities dependent on natural resources.

In many parts of southern Africa, the availability per person and access to such life-sustaining ecosystem services is dwindling. This results from degradation linked to over-exploitation and unsustainable practices, and from growing population pressure on the system (Chapman, 2011; Midgley *et al.*, 2011). Some ecosystems are already threatened by human pressure; others are sensitive and will become increasingly vulnerable over the next few decades as human populations and use of resources increase (Rockström *et al.*, 2009). Estimated population changes will impact most severely in countries such as Democratic Republic of Congo (DRC), Tanzania, Madagascar and Malawi where population numbers will likely only stabilise after 2050 (Chapman, 2011). Future human well-being must be seen in the context of future socioeconomic conditions, overlaid on the biophysical reality.

The issue of population change in relation to ecosystem services is linked to the need to feed populations. The demand for agricultural production is rising rapidly and will drive landscape change and force decision-making around land use trade-offs (and increasingly between ecosystem services trade-offs) with continued declines of regulating services likely (Carpenter *et al.*, 2009). The feedback of these impacts needs to be considered very carefully, and the 'value' and importance of ecosystem services in land use planning recognised.

In developing economies it is usual for human and economic development to be heavily reliant on the natural resource base and associated primary economic activities such as farming, forestry and fishing. Southern African economies (with a few exceptions linked to rich mineral and oil resources) will remain reliant on these sectors for many decades, and thus the interactions between

Table 1: Categories of ecosystem services (ES)

Types of services		Description
Provisional services	Water	Provision of water for livestock or domestic use
	Food	Production of wild foods, seafood, game, crops
	Medicine	Pharmaceuticals, biochemicals and industrial products
	Grazing	Production of grazing for livestock
	Raw materials	Production of fuel, craftwork materials, construction materials
	Genetic resources	Medicine, products for materials science, genes for resistance to plant pathogens and crop pests, ornamental species
	Energy	Hydropower and biomass fuel
Regulating services	Climate regulation	Carbon sequestration, for example wetlands and forests are carbon sinks that contribute towards reducing carbon emissions and aid in climate regulation
	Water regulation	Flood attenuation – reduction of the amplitude and velocity of flood waters by wetlands, reducing downstream damage Groundwater recharge – differential recharge to groundwater relative to surrounding vegetation types Dry season flows – moderating the seasonality of downstream flows
	Sediment retention	Retention of soil and fertility within an ecosystem
	Pollination	Crop and natural plants are pollinated
	Waste treatment	Breaking down of waste, detoxifying pollution; dilution and transport of pollutants
	Regulation of pests and pathogens	Change in ecosystem health affects the abundance or prevalence of malaria, bilharzia, liver fluke, black fly, invasive plants, etc. Ecosystems integral to pest and disease control
	Refugia	Critical breeding, feeding or watering habitat for populations that are utilised elsewhere
Supporting services	Nutrient dispersal and cycling	Soil habitat is maintained and natural soil cycle ensures continued fertility
	Seed dispersal	Critical service of dispersing seeds to allow new fertilisation
Cultural services	Abundance, rarity and beauty of species, habitats and landscapes	Providing opportunities for: cultural activities and heritage spiritual and religious activities and wellbeing social interaction recreational use and enjoyment research and education spiritual inspiration scientific exploration

development priorities, human needs and the available ecosystem services must be addressed holistically and through an appropriate futures lens.

For example, the provisioning of water for domestic use and additional functions such as water purification, will be a vital service for burgeoning populations. Some countries in the region, such as South Africa, Swaziland and Zimbabwe, are already water-stressed owing to high rates of use of renewable water resources (Chapman, 2011). In these regions, the additional stress of climate change will have significant effects on services and goods derived from water, and on water-dependent development and economic growth, at scales ranging from small communities to watersheds at national and regional level.

Countries such as Zambia, Tanzania and Mozambique are placing heavy emphasis on hydropower expansion to meet energy demands and create revenue, hence creating a dependency on sustained water flows in river basins which are often shared between two or more countries. Similarly, massive irrigation schemes are likely to occur. Both are seen as critical developmental investments, and could in themselves serve as climate adaptation responses. Climate change, through increasingly variable rainfall in space, time and intensity, is likely to affect these flows with implications for existing and planned hydropower and irrigation capacity (Spalding-Fecher, 2011). In this example, regional cooperation and equitable use of shared water resources must be negotiated. This demands governments' appreciation of the services provided by a river system in both upstream and downstream locations.

Regulating services are easily forgotten or ignored, but are critically important for human society. For example, protection from natural hazards such as floods, landslides and droughts will be tested under the likely scenarios of climate change, particularly when combined with detrimental land use changes, but protection of such regulating services also mitigates against the impacts of such hazards. Fischlin *et al.* (2007) found that climate change impacts on the fundamental regulating services may have been underestimated.

2.3 Climate change trends and projections

Global warming is as evident in Africa as in other parts of the globe (Boko *et al.*, 2007). Mean annual temperatures have increased across southern Africa over the last 40–50 years, and the number of hot days per year has increased whereas the number of cold nights per year has decreased (Boko *et al.*, 2007). Regional climate change projections based on Global Circulation Models (GCMs) (Christensen *et al.*, 2007) indicate that southern Africa will warm by between 3.1˚C and 3.4˚C, with warming of up to 4.8C˚ possible towards the end of the 21st century (Figure 1). Heat stress events will likely be more frequent in future (Battisti and Naylor, 2009), with heat thresholds being exceeded more regularly. Warming could be higher during late winter and early spring. Strong warming before the start of the rains would significantly reduce soil moisture during this period through high rates of evapotranspiration from plants and soil. Warming also increases evaporation of water from surface bodies such as reservoirs and wetlands. Other impacts of warming include biome shifts and loss of biodiversity, and increased frequency and intensity of wildfires.

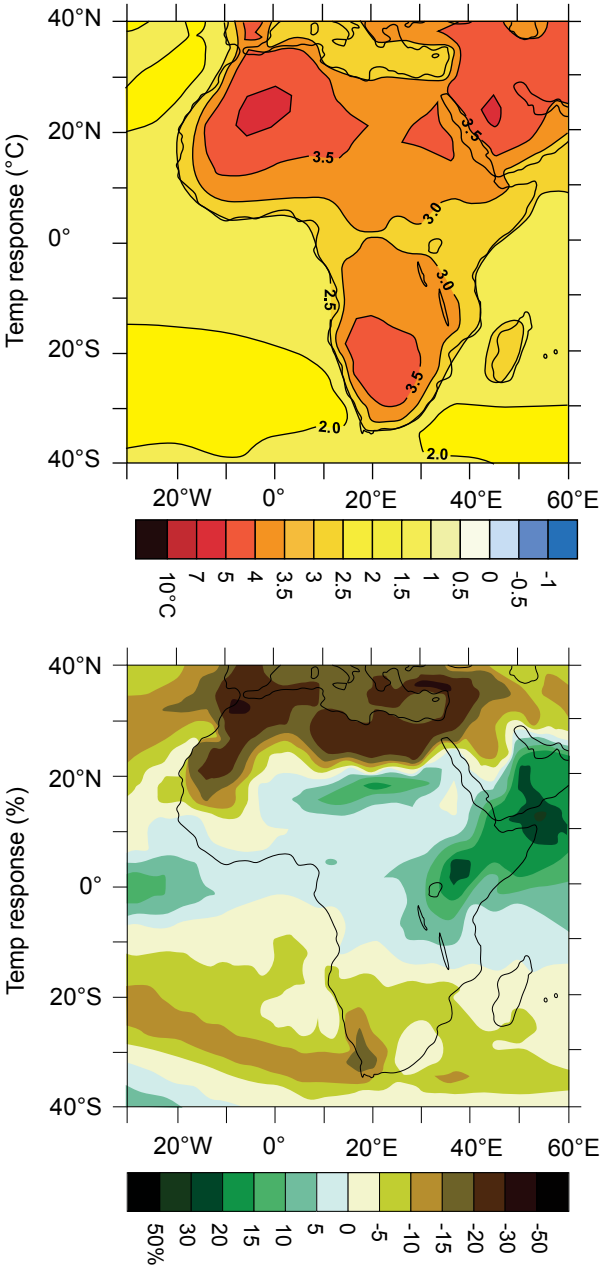

Figure 1: Multimodel aggregation of likely rainfall changes
Source: Christensen *et al.*, 2007

The climate change projections for the medium- to long-term show reduced rainfall for much of the region in winter (May–July) (Christensen *et al.*, 2007), leading to overall drying trends in the winter-rainfall south-west of the region (Figure 1). In mid- to late-summer (December–April), wetting is indicated in the eastern and northern parts of the region. Seasonal shifts in rainfall can be expected. In regions receiving most of their rainfall in summer, the arrival of the first summer rains is likely to become more unpredictable, and the intervals between

rainfall events could become longer. However, there is still considerable uncertainty over rainfall changes in the summer rainfall regions.

The climate of the south-central to eastern regions of southern Africa is characterised by high inter-annual, inter-decadal and multi-decadal variability, particularly with respect to rainfall. Rainfall is strongly influenced by the movements of the Inter-tropical Convergence Zone (ITCZ), and El Niño Southern Oscillation (ENSO) (Lindesay and Vogel, 1990). The southern African region is prone to climatic extremes of prolonged droughts, dry spells, strong wind, heavy rainfall, and severe floods including flash floods (EM-DAT, 2011); these extremes appear to be increasing in frequency and severity (Easterling *et al.*, 2000). Severe recurrent droughts and floods devastate crop and livestock production and thus escalate food insecurity, hunger and malnutrition. At such times of stress, people turn to their natural capital, the services provided by their surrounding ecosystems: these can provide food, shelter, and income (e.g. from firewood collection and selling, or charcoal production) when primary livelihood activities are compromised. The importance of regulating services is also critical during extreme weather patterns. Well-functioning riparian zones, catchments and wetlands protect water sources, while forest patches and wetlands act as fire breaks as well as post-fire refuge areas for livestock, wildlife and humans.

African fire-prone and fire-dependent biomes, such as grasslands, savannas and dry forests, could experience substantial changes in structure and functioning due to increasing frequency and intensity of wildfires (Fischlin *et al.*, 2007). Warmer and drier conditions increase the risks of breaching critical thresholds for ignition and spread of fires. Management regimes will play a critical part in reducing and mitigating fire risks and supporting post-fire recovery of biomass and ecosystem function.

2.4 Impacts and vulnerability

The reliance on rainfed agriculture and subsistence activities in the region means the flow of ES is directly related to water, food, energy and income security, and climate-related stressors are expected to have a severe impact on poverty and hunger. The rural poor are most directly dependent on resilient healthy ecosystems, and the same groups of people are often the most vulnerable and possess limited capacity to deal with the impacts of stressors. Climate change will add another layer of stress to existing climate-related risks and vulnerability in this region and test the adequacy of traditional coping mechanisms. Exacerbated by increasing population pressure, this signals a steady erosion of basic support systems for the majority of livelihoods. To make matters worse, loss of ecosystem regulating services increases vulnerability to climate events such as floods and droughts. The human response to the impacts of climate and other stresses on livelihoods, which in southern Africa frequently involves the greater use of wild natural resources as a livelihoods safety net, could place further strain on ecosystems. There is a need to understand how key climate induced pressures, such as those on food and water, interact with ecosystem services, and how human activities and responses in the future will change these dynamics.

Some examples of the possible impacts of climate change on biodiversity and ecosystem services in the context of food, water and energy security, health, and potential for conflict are shown in Figure 2. Three countries and two transboundary river basins are used for this example, based on their climate risk and vulnerability (Midgley *et al.*, 2011; Pegram *et al.*, 2011). More broadly, the main pathways include (from Chapman *et al.*, 2011):

- Rising temperatures will impact on the ecology and productivity of the region's many ecologically and economically important lakes and wetlands;
- High temperatures, carbon dioxide (CO_2) fertilisation and nutrient losses during floods will drive eutrophication and proliferation of aquatic invasive species;
- Heavy rainfall will exacerbate high rates of soil erosion and siltation of rivers, lakes and reservoirs. This will impact negatively on fisheries, forestry and hydropower production.
- Flood damage to riparian environments could reach tipping points, shifting rivers into new hydro-ecological states from which recovery is impossible;
- Potentially positive influences on forest net primary productivity are expected from CO_2 fertilisation, moderate warming and increased rainfall (if spread evenly). Certain forest and woodland types, such as those along the sub-tropical coastal zones, will likely expand at the expense of grasslands, with impacts on grazing. Supply of biomass for woodfuel could increase. However, this could be offset by greater frequency and intensity of wildfires, and continued high rates of deforestation;
- Estuaries and their ecosystem services could be severely impacted through reduced water flows, deteriorating water quality and sea level rise.
- Salt-water intrusion in shallow coastal groundwater aquifers will result in significant damage to coastal forest and wetland systems;
- Increased floods and cyclones will cause increasing damage to coastal infrastructure, fisheries and agriculture;
- Increased poverty and hunger, leading to greater reliance on natural resources will drive unsustainable harvesting of marine and terrestrial resources in the search for alternative livelihoods;
- The need for increasing food production will drive land use changes and encroachment of agriculture into species-rich and sensitive environments. Whilst this will achieve short-term food security gains, these could be offset by the longer term loss and further degradation of key ecosystems and their productive potential;
- The loss of wild food sources and medicinal species will exacerbate hunger, malnutrition and ill health;
- Land transformation, increased poaching and biodiversity loss could significantly affect

Figure 2: Pressures of climate change and the resultant impact on ecosystem services and countries in the region
Source: Own analysis

Climate change impacts on key sectors					
Types of pressure on ecosystem	**Food security**	**Water security**	**Health**	**Energy security**	**Conflict**
Loss of biodiversity	• Land use change • Loss of nutrients in soil • Loss of nurseries within mangroves	• Increase in sedimentation	• Impaired functioning of water system • Removal of mangrove trees → effect on filtration and nurseries, possible extinction of undiscovered medicinal pla	• Reduced access to wood-fuel • Increased sedimentation → reduced water flow	Diminished access to food (fish and other staple food sources)
Soil erosion	• Overexploitation of land • Land use change • Loss of soil fertility and productivity	Increased sedimentation → negative influence on water flow	Increased sedimentation → negative impact on water quality	• Unproductive land • Reduced access to wood-fuel • Increased sediment → negative influence on water flow	• Competition for wood-fuel, food, water • Land becomes less productive • Increased demand on other food sources (freshwater or ocean resources)
Water issues	• Invasive plant species → reduce water flow • Reduced access to food source • Overharvesting of fish → Invasive fish species dominate (may affect make-up of an ecosystem)	• Pollution, sedimentation, saline intrusion • Reduced access to quality water	• Water quality • Reduced flow → affects access to water downstream (less water for biodiversity and irrigation)	• Increased sedimentation • Invasive plant species reduce water flow → negative impact on hydro-electric power plants downstream	• Exploitation of land • Reduced flow (i.e. upper Okavango) • Adverse impacts on downstream users • Reduced access to water and staple food
Resource shortages	Increased competition for fewer resources → less food available	• Increased pressure on water sources • Increased pressure on mangrove trees → source of wood-fuel • Reduced filtration services in mangroves → influence on water quality	Reduced access to stable foods	• Increased demand on wood-fuel • Sedimentation and invasive plant species → downstream flow impaired (hydro-electric power)	• Less resources (fish, staple foods) for consumption • Drying up of water sources (drinking and source of fish) • Land use change (clearing biodiversity for agriculture)

Climate shocks					
	• Drought and flood → access to food • Drought → drying up of water sources • Floods → access to rivers and destruction of agriculture • Cyclones and sea temperature rise → affects access to food sources (ocean resources)	• Sea level rise → saline intrusion • Drought → drying up of water sources	• Flood → increase in incidence of disease • Rising temperature → increased exposure to disease • Extreme weather → access to staple foods	• Flood → impact on flood attenuation • Drought → Increased pressure on available water resources • Reduced water flow • Drought → pressure on wood-fuels	• Low adaptive capacity • Access to water and food (fish and other staple foods, land)
Population pressure					
	• Land use change → Slash and Burn agriculture • Loss of soil fertility and productivity • Reduced access to food	• Increased pressure on water resources • Increased pollution	• High population density • Competition for resources • Increased pollution	Increased demand for wood-fuel	More people competing for same resource base

Vulnerability hotspots	
	Malawi
	Madagascar
	Mozambique
	Okavango River Basin (Botswana)
	Zambezi River Basin (Zambia)

Likely impacted ecosystems	
	Biodiversity • *Protected areas, reserves and buffer zones* • *Biological corridors (ecological diversity)* • *Wildlife and plant species which support ecological processes*
	Carbon sequestration • *Forest ecosystems* • *Significant areas used as a carbon Sink*
	Coastal • *Coral reefs* • *Mangrove forests* • *Estuaries*
	Water • *Important rivers and streams for livelihoods and power production* • *Fish nurseries*

The corresponding table presents a range of ecosystem pressures for Malawi, Mozambique, the Zambezi River Basin and the Okavango River Basin. These areas have been chosen due to their significance as vulnerability hotspots within the Southern African Development Community (SADC).

The table illustrates the interaction and impacts between pressures on ecosystem services as well as the impacts from climate change.

The upper half of each square represents the ecosystems which are likely to be impacted by the relevant pressures, and also includes brief bullet-points that highlight ways in which ecosystems will be affected/influenced. To get a sense of which pressures are pertinent in each zone, risk and vulnerability GIS mapping of southern Africa, which incorporates development and climate futures, was consulted (Davies *et al.* 2010) as it provides a thorough representation and analysis of key socio-economic and environmental issues which are felt across the region.

The lower portion of the squares represents the nations which are predicted to experience the specific/applicable pressure.

This table thus presents a broad representation of the ecosystem pressures faced by nations that have been identified as hotspot areas. In terms of policy relevance, this snapshot gives an indication of which ecosystems are under the most stress within particular areas and how climate pressures influence the relevant ecosystem services.

nature-based tourism and revenue from the hunting industry; and
- What about the mitigating effects of technology and infrastructure? Infrastructure and technology will become increasingly important as vulnerability to droughts and floods increases.

Potential losses of vital ecosystem services and gradual biome shifts will have fundamental social and economic repercussions. The latest IPCC assessment (Boko *et al.*, 2007) states that for Africa: "Changes in a variety of ecosystems are already being detected, particularly in southern African ecosystems, at a faster rate than anticipated (very high confidence). Climate change, interacting with human drivers such as deforestation and forest fires, are a threat to Africa's forest ecosystems. Changes in grasslands and marine ecosystems are also noticeable. It is estimated that, by the 2080s, the proportion of arid and semi-arid lands in Africa is likely to increase by 5–8%. Climate change impacts on Africa's ecosystems will probably have a negative effect on tourism as, according to one study, between 25 and 40% of mammal species in national parks in sub-Saharan Africa will become endangered".

The role and value of ecosystem services in the climate change arena has traditionally been considered in terms of mitigation. This is through activities which serve to increase forested regions (afforestation programmes) and organic material in agricultural soils, both of which have the potential to sequester large amounts of CO_2 (Nkem *et al.*, 2007). There is a need to approach this also from a climate change adaptation perspective, encompassing climate resilient development pathways which consider local communities as well as the ecosystems they depend on, within an overall adaptation strategy and policy framework.

2.5 Ecosystem-based adaptation

An Ecosystem-based Adaptation (EbA) to climate change approach relates to "the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change" (CBD, 2009). We adopt the approach that EbA should operate within interlinked social-ecological systems, using the sustainable management, conservation and restoration of ecosystems to enhance ecological processes and services that are essential for strengthening climate resilience of populations at local scales (Piran *et al.*, 2009; Colls *et al.*, 2009; World Bank, 2009). In this sense, there is convergence with the community-based adaptation (CBA) and climate integrated conservation strategies (CCS) approaches, where EbA represents the intersection between biodiversity and ecosystem conservation, socioeconomic benefits and climate change adaptation (Midgley *et al.*, 2011, see Figure 3). The proposed EbA+ type project would include potential co-benefits for economic development, such as economic diversification and job creation, thus contributing to the building of a green economy (Midgley *et al.*, 2011). The multiple benefits

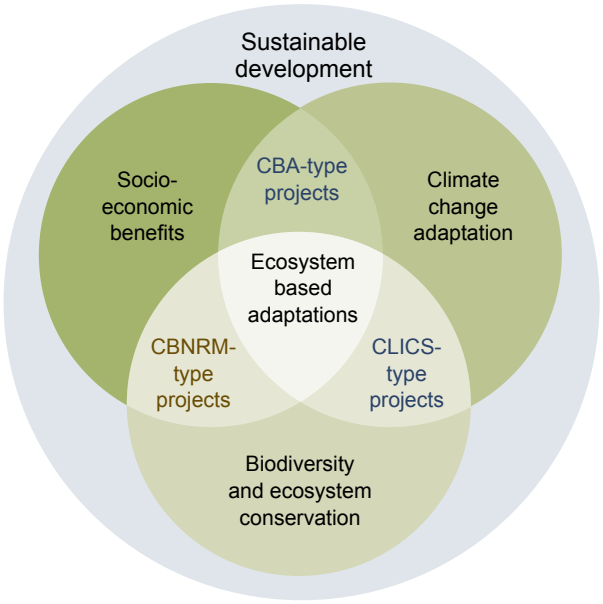

Figure 3: Ecosystem-based adaptation (EbA) conceptual framework. EbA+ builds on this further to deliver tangible and sustainable livelihoods benefits for affected communities.
Source: Midgley *et al.* (in prep)

of EbA+ have clear linkages to development priorities and the ambition to reduce poverty and food insecurity over the short- and long-term, whilst simultaneously dealing with the impacts of climate change.

The EbA approach is, however, highly dependent on healthy and resilient ecosystems, which are able to deliver a bundle of ecosystem services to support adaptation and well-being of societies. This is in the face of various pressures which can be internal to the social-ecological system, or external, such as extreme events in the short term or climate change in the longer term (Piran *et al.*, 2009). Consequently, the region requires strategies to managing ecosystems for the provision of services that help reduce vulnerability and increase resilience of socio-ecological systems within a comprehensive climate adaptation response. This also entails an assessment of non-climatic risks, such as those connected with population and development futures, in a bid to ensure multiple benefits to society and the environment.

The rationale for EbA in southern Africa includes (adapted from Devisscher, 2010):
- enhancing ecosystem resilience can restore natural protection against extreme climatic events, thus limiting losses and damages;
- economic gains from ecosystem or land use conversion may be outweighed by the potential benefits of conservation and/or restoration, especially as multiple ecosystem services are considered in the assessment (Piran *et al.*, 2009); and
- the multiple-benefits of EbA offer the opportunity to integrate adaptation priorities with development processes.

Investment in EbA has significant potential to lead to more resilient systems. The creation of new jobs may well arise as a result of new conceptual business models around ecosystem services. The EbA approach to adaptation allows strategies to address multiple objectives aimed at minimising stresses on sensitive and degraded critical ecosystems. This would enhance ecosystems resilience, thus reducing vulnerability and supporting development across the region.

However, potential trade-offs must be understood and factored in. For example, the increase in provisioning services over the past decades in many parts of the world has been achieved at the expense of decreases in regulating and cultural services and biodiversity (Carpenter *et al.*, 2009). Also, difficult trade-offs may need to take place between tangible and immediate, and longer-term benefits deriving from increased resilience, which may not pay for a while.

The EbA approach is certainly not a panacea, and in many cases it will need to be combined with other adaptation approaches to be effective. For example, EbA can be complemented with adaptive co-management (Fabricius *et al.*, 2007) as a potential way to bridge different knowledge systems, i.e. crossing the divide between indigenous and local knowledge (ILK) and formal, technical systems. In this context the blending of technology and 'hard' financial and legal processes, with local and traditional ways of doing, holds great promise. Local knowledge alone is incomplete in dealing with the challenges and issues facing communities due to climate change, since conditions could become unprecedented. Thus, combinations of 'soft' and 'hard' adaptation approaches will be called for.

2.6 Linking PES to climate adaptation

Under the broader umbrella of EbA, payment for ecosystem services (PES) is one approach which can be considered amongst a suite of adaptation options. PES represents a set of market-based approaches which have significant potential as part of an overall climate change adaptation strategy. PES creates an innovative option to reward communities (either through payments, compensation or exchange between a willing buyer and a willing seller) for ecosystem services or land use that sustains such services (SANBI, 2011). PES agreements could provide an income buffer and a source of income diversification, and thus aid communities in increasing their resilience to climate shocks. This is a complex task considering the heterogeneous composition of the region in terms of biophysical resources, ecosystem service flows and their economic and cultural value, farming and land use systems and socioeconomic systems across the region. However, it has been identified that land cover change is one of the most integral drivers of change to ecosystems and their services (Reyers *et al.*, 2009), and a focus on land cover change as a proxy would seem to be a contextually robust approach.

The beneficiaries of ecosystem services are the people who benefit from the food crops and other services provided by the ecosystem. Subsistence farmers in the Zomba district of Malawi.

3. PES financing considerations

3.1 PES payment systems

The beneficiaries of ecosystem services are usually considered to be a subset of people who benefit from either a purely private good (for example a food crop which an ecosystem generates) or they are exchanges in regular commodity markets. The beneficiaries of ES also benefit from non-provisioning services, which markets have as yet been inadequately able to capture (market failures) because of factors such a non-rivalrous consumption (i.e. consumption by one user does not affect consumption by another), significant externality effects and high exclusions costs (due to non-excludability – i.e. users cannot be prevented from using or benefiting from the good) (Swallow *et al.*, 2009; Tietenberg, 2006).

A range of payment systems exists (adapted from Swallow *et al.*, 2009):

1. Public payment schemes to private land, to maintain or enhance ecosystem services – for example initial government sponsorship for alien invasive clearing for the Working for Water (WfW) programme in South Africa.
2. Open trading between buyers of ecosystem goods and services, where a system of a cap or floor on the level of ecosystems services is provided. This tradable permit or credit system is most notably seen in developed country examples – for example the European Union Emissions Trading System (EU ETS) where carbon credits can be traded.
3. Self organised deals, usually small scale and private in nature, which normally link beneficiaries of ecosystem services directly with providers of services. These can be self negotiated or organised along a community scheme type arrangement.

The PES mechanism looks to bring the exploitation of the environment and natural resources to a socially optimal level by placing a value on these non-market goods and creating incentives for land owners to conserve their property/land which in turn should allow for the provision of ecosystem services. Essentially PES attempts to implement the Coase theorem (Coase, 1960), which theorises that the problems of external effects can (under certain conditions) be overcome through negotiations between the affected parties (Coasean Bargaining) (Engel *et al.*, 2008).

In most cases, establishment costs (i.e. securing start up funds) and transaction costs can be high in the initial phases when piloting a PES approach (Ghazoul *et al.*, 2009; Wunder, 2005, 2007, 2008). The issue of transaction costs is important as a successful PES scheme requires a sufficient number of buyers, useful in creating a source of funds which can then be provided as incentives to sellers. However, according to Coase (1960), the higher the number of parties involved in negotiations (on the side of both buyers and sellers), the higher the transaction cost and the more complex the bargaining process between

Box 3: Case study: 'Tree-preneurs'

A PES scheme seeks to develop financial mechanisms that create economic incentives for the maintenance of ecosystems and associated biodiversity by rewarding those who are responsible for provision of ecological services. While monetary payments constitute the usual, formal, means of providing incentives, other forms of compensation exist for rewarding the adoption/promotion of alternative land use practices which would ensure the provisioning of ecosystem services. For example, the Indigenous Trees for Life Programme (run by the Wildlands Conservation Trust, South Africa) encourages community members from the Buffelsdraai and Osindisweni community to become 'tree-preneurs', by planting indigenous trees in the buffer zone of the Buffelsdraai landfill site (sections of which were previously utilised as sugar cane plantations) in return for basic goods such as food, clothing, building materials and school fees.

This provides a case study example in which payments are not financial but rather come in the form of socioeconomic benefits. It is important not to stereotype PES in such a way that the approach centers on financial rewards. Rather, awareness needs to be created in terms of PES as an ecosystems-based adaptation (EbA) approach whereby land-use planning and management are utilised to build ecosystem resilience and additionally grant compensation for adopting these practices, which may come in the form of socioeconomic benefits. These methods emphasise the reduction of vulnerability by promoting environmental conservation as well as providing alternative 'income' generating activities.

buyers and sellers becomes which, in theory, leads to a social inefficiency/undesirable outcome. And yet one of the principles of adaptive co-management is that the key stakeholders must be involved and take responsibility, necessitating complexity.

A possible solution comes with the creation of a monopsony (the creation of an entity/body which represents the interests of all buyers involved) which has the potential to diminish transaction costs by reducing the 'number of parties' involved in negotiations (Kemkes *et al.*, 2009). Kemkes *et al.* (2009) note that the establishment of monopsony power effectively assists with the facilitation of processes between parties within a PES scheme. Bracer *et al.* (2007) comment on studies which have shown that when producers of services organise themselves into structured units (in the form of formal or informal associations), they are able to be represented by intermediaries which then help in the negotiation and implementation phases. This grouping attempts to reduce transaction costs by reducing the number of parties involved in the negotiation process. In the southern African context of cultural and socioeconomic diversity this could, however, be challenging in practice. Conflict resolution mechanisms would thus be important.

However as Corbera *et al.* (2007) highlight, while transaction costs are lower when engaging with groups rather than individuals, knowledge (amongst individuals in terms of the happenings within the initiative) is believed to be lower in such instances too. Vatn (2010) thus notes that there is a trade-off here between lowering transaction costs and reducing overall knowledge dispersal when bodies are used as representatives for the parties involved. This trade-off must be borne in mind when considering the establishment of monopsony power.

Other issues which arise when making use of a PES approach include evading leakage (transfer of environmentally destructive practices to other areas), circumventing the problem of free riding, ensuring additionality (ensuring the provision of ecosystem services would not have occurred unless conservation was established via the PES mechanism) and the guarantee of inclusivity of participation (Ghazoul *et al.*, 2009).

The overarching aim of a PES adaptation project would be the achievement of climate change adaptation; however, within this 'systems' approach the key factor is to ensure the flow of ES. This flow is fundamentally affected by ecosystem change, primarily anthropogenically induced but caused by a linked range of factors – namely economic activity, development, climate change and the alteration of natural processes.

3.2 Institutional arrangements and governance

The PES approach arises as a result of the inability of conventional market mechanisms to value environment and ES adequately (Corbera *et al.*, 2007). While in theory the market is the model legitimating PES, in practice it can be the state or more generally public payments which are the dominant mechanism within the PES approach (Vatn, 2010). However, this pattern has not emerged for carbon, which is essentially a commodity regulating the climate cycle that is traded on open markets. No matter how the system emerges, institutions are integral in some manner in regulating and monitoring actors and processes involved in a PES mechanism (Dietz *et al.*, 2003). For this study, we define institutions as a mode of conduct between actors and a set of relationships and arrangements that bind them together under different conditions. This means institutions vary widely over scales. The imperative in evaluating PES towards climate change adaptation is to look at the actors themselves, and their relationships and power differentials, to determine how such arrangements could work.

Governance essentially involves the establishment of social priorities and facilitating coordination (Vatn, 2010). Sound governance is characterised by institutions which possess the principles of openness, participation, accountability, effectiveness, coherence, democracy and integrity (Ashton *et al.*, 2005). In addition, effective governance is a key element of a healthy market (just administration, transparent judicial systems, informed judges, capacity for enforcement) and is thus pivotal for the success of PES initiatives (Bracer *et al.*, 2007; King *et al.*, 2003; Perrot-Maitre and Davis, 2001).

A crucial issue for the adoption of PES within southern Africa is that many of the nations in the region require strengthened institutional capacity to implement such an approach. Institutions are needed to engage with relevant actors, facilitate dialogue and, importantly, to ensure permanence of ideas and objectives throughout the duration of a PES initiative. A key barrier to PES in southern Africa is the fact that public bodies and local authorities usually assist as intermediaries in the process of transferring information, payments and support between parties. Consequently, where poor governance systems are in place, these crucial procedures may fail to the detriment of the initiative as a whole. This is important when considering PES as an adaptation strategy and larger scale initiative – for example the development of transboundary water management initiatives. It may not be feasible to implement a PES programme at this scale considering its inherent institutional complexity and capacity requirements.

The interplay between strong institutions and good governance practice is crucial in the functioning of a PES system. The issue of context and legitimacy is integral. Corbera *et al.* (2007) highlight the concept of organisational affiliations and detail how the familiarisation (local standing) of organisations within communities has the capacity to allow for a rapport to be built between parties and so facilitate negotiations and the establishment and running of PES programmes. The Naivasha project in Kenya is a case in point. Opinion leaders were incorporated by the Water Resources User Association (WRUA) in the process of mapping and initial evaluation of selected 'hotspot' farms. These leaders were well respected members of the community, thus allowing

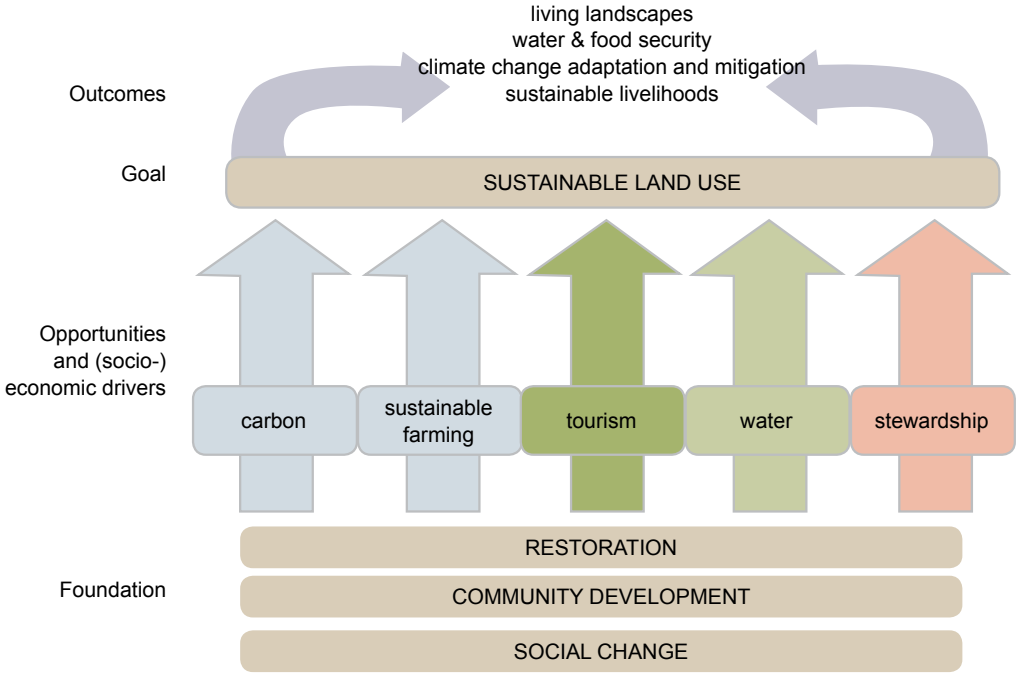

Figure 4: The PES framework for the Baviaanskloof
Source: Living Lands, 2010

for familiarity and supporting buy-in on the part of the local farmers and land owners (Ngigi and Njenga, 2010).

This familiarisation is influenced by the initial wider institutional context (i.e. the history between communities and the institution – as well as past interactions with other institutions) and the role of social perceptions, values and norms, and the role of skilled facilitators (Vatn, 2010). This is a pivotal concept considering the heterogeneity of the region, both socioeconomically and biophysically. It also recognises the shared vulnerability to climate change and the imperative to adapt cooperatively. The organisations and structures established provide an initial familiarisation and legitimacy to using a PES scheme.

Additionally, by integrating knowledgeable and respected members of the community within an institutional mapping process, contributions on 'value conflicts' (Vatn, 2010; Bracer *et al.*, 2007) and lack of agreement over what a resource means to people and its role in shaping their identities and relationships can be ascertained. Local knowledge is essential when considering how valuable resources are, framing this against the risks climate change poses to this resource 'flow', and consequently designing the most pragmatic adaptation strategy based upon this assessment.

The institutional structure is pivotal when evaluating how applicable the introduction of a PES is in relation to climate adaptation. As Bracer *et al.* (2007) point out: the multi-sectoral nature of institutional arrangements can complicate the issue of efficient legal frameworks. There needs to be an alignment between sectoral legislation relating to the particular resources concerned in the PES scheme as well as complementary legislation on contracts, appeals, standards, governance, and tenure and property rights (Bracer *et al.*, 2007).

3.3 Case study of carbon farming in the Eastern Cape

Linking climate adaptation to ecosystem services and payments for these services is not aimed at a complete regime shift or a radically different approach to management or interventions. Instead, it focuses on a holistic understanding of pressures and vulnerability, while assessing PES beyond a strictly conservation view and more towards a development agenda. Carbon farming in the sub-tropical thickets of the Eastern Cape (South Africa) provides a good example of where large tracts of degraded land, which are expected to be further impacted by climate change, can be innovatively managed through an ecosystem services scheme. Subtropical thickets afford a significant opportunity for sequestering carbon through the restoration of degraded landscapes and through the retention of intact carbon-rich vegetation structure. The drier forms of these thickets have historically been used for extensive grazing and have frequently been subjected to overstocking. This has led to severe degradation and loss of landscape carbon stocks. Under these conditions, resilience to further pressures caused by climate change is exceptionally low.

In response, the South African Department of Water Affairs (DWA) commissioned a pilot for the Subtropical Thicket Restoration Project (STRP) in the Baviaanskloof Nature Reserve (BNR), Eastern Cape, in December 2003, funded through the acclaimed National Working for Water programme (WfW) – a beneficiary of the poverty relief funding of the Expanded Public Works Programme (EPWP). The purpose was to investigate the feasibility of employing emerging markets or PES, principally the carbon economy, to restore the degraded areas of subtropical thicket (Powell *et al.*, 2004, 2006; Mills *et al.*, 2007, 2009). A key mandate at the onset of the project

was to build the scientific basis, which would ultimately lead to building the business case for the PES (Marais *et al*., 2009). A second key mandate was to launch a biome-wide movement for restoration and build sufficient momentum to allow the initiative to 'roll out' into the private sector.

A significant component to building the 'platform' for the PES (Marais *et al*., 2009) in the pilot project was to quantify carbon stock differentials across the degradation gradient. The degradation gradient included old abandoned agricultural lands at the one end of the spectrum, and pristine/intact subtropical thicket at the other end. Degradation begins with the loss of canopy cover, and end with the loss of soil and root carbon.

In the private sector, companies like AfriCarbon and Ecological Restoration Capital (ERC) are exploring opportunities to capitalise on the work undertaken by the STRP collective. ERC were the first company in South Africa to undertake a fully private carbon farming venture in South Africa with an offset project from a Dutch investor, by planting on 2 400 hectares of degraded subtropical thicket in the Somerset East area. The project employs 50+ people and stands to capture 117 000 – 235 0002 t CO2e. In this landmark achievement, carbon security is provided through a 30 year water-tight landowner contract, which prevents the restocking of the land with domestic herbivores. The landowners receive an annual rental payment for the opportunity costs, the natural capital is restored and viable alternative land use options are being investigated (such as game farming and ecotourism).

A significant emerging theme is that landowners have come to realise that agricultural production is operating under the law of diminishing returns, much of the natural capital has been lost through unsustainable land use management practices, and a new vision is required. Carbon farming as a stand-alone PES may be marginal in some areas. However, when PES is bundled (carbon, water, biodiversity, etc., Figure 4) the net returns make it economically, socially and financially feasible (Manders *et al*., 2010) and the probability for a successful transition is greatly enhanced.

In the PES feasibility study for the Baviaanskloof, it was found that carbon farming would probably provide R75 ha-1 yr-1, whereas pooling and bundling PES would provide R150 ha-1 yr-1 (Manders *et al*., 2010). This is particularly relevant to this region because:

- a willing and reliable buyer of the water PES is available (Nelson Mandela Bay Municipality);
- the carbon market has been established; and
- the proximity and landlocked position relative to the Baviaanskloof Nature Reserve (World Heritage Site) enables significant branding and marketing opportunities for ecotourism. The vision is to consolidate an area of ecologically sustainable and equitable resource management where private lands and the formidable Baviaanskloof Nature Reserve are managed and marketed as one entity (Powell, 2010).

The future hopes for restoration of subtropical thicket look promising. The private sector has become involved and looks to expand its interest. The imminent attainment of the voluntary carbon standard (VCS) validation will allow a rapid growth in the confidence of this form of land use, both for international and local investors and off-setters. Through continued investment in the STRP, the government is seeking to co-finance restoration efforts in key areas by means of a wage incentive programme. This will significantly improve the chances for carbon financiers to restore degraded subtropical thickets and provide the catalytic funding needed (Powell *et al*., 2006). Emerging opportunities through Reducing Emissions from Deforestation and Forest Degradation Plus (REDD+) are also under investigation.

Nevertheless, the success of this endeavour will require certain other conditions to be met. For example, good governance and cooperation between different provincial departments and full stakeholder participation are required, combined with holistic land use planning within clear conceptual and spatial frameworks, and integration with conservation planning (Powell *et al*., 2006).

The restoration of subtropical thickets, as well as the retention of intact subtropical thickets, is fundamentally aligned to the promotion of EbA. The decline of rural farming economies in the Eastern Cape (Nel and Davies, 1999) has been hastened by recent severe droughts punctuated with localised floods. The overlay of climate change on the land degradation problem needs to be urgently addressed, and indications are that the impacts can be countered, at least in the short- and medium-term, with restoration and carbon farming, and possibly future REDD+ initiatives. The permanence requirement for carbon credits (typically 30 years) is an ideal opportunity to give society and government the time to devise a more ecologically sustainable and equitable land use management system as part of an overall climate change adaptation strategy.

4. Ecosystem services management and PES in southern Africa

4.1 Ecosystem service projects

In order to evaluate significant issues which are specific to PES within the milieu of southern African nations (plus Kenya), discussions were held with ten individuals (project coordinators, project managers and projects assistants) who have either had experience with PES or are currently directly involved in PES or PES-related projects within this region (Figure 5, database of projects available on request).

Robertson and Wunder (2005) suggest that programmes such as REDD+ and Community-based Natural Resource Management (CBNRM) have similarities to a PES approach (see also Midgley *et al.*, 2011). Given this, where individuals contacted had insights into or have been involved in such initiatives, these were also discussed so as to get a rounded insight into the scope of PES within the region. The methodology consisted of telephonic interviews with the project managers of particular PES initiatives. These individuals were asked to rank their three greatest hurdles faced in the implementation of projects as well as suggest three operational changes they would make, taking into account climate change.

The location of these ecosystem service projects in relation to existing climate stress is illustrated in Figure 5 (map sourced from Midgley *et al.*, 2011), where red areas denote current high potential impact of climate stressors. The PES projects used in this study are primarily located in high impact areas, which are likely to be in greatest need of sustainable climate adaptation initiatives. This signifies a strong linkage between this approach and local vulnerability.

A sub-group of the full database of projects (Table 2) was subjected to multi-criteria analysis (MCA) to evaluate outcomes from the interviews and distil key themes. MCA is a methodology which is used to determine overall preference among alternative options. It compares and ranks different outcomes, even where a variety of indicators are used, since it allows for the inclusion of a full range of criteria. It further allows the construction of a decision tree to generate single overall preference scores for each project.

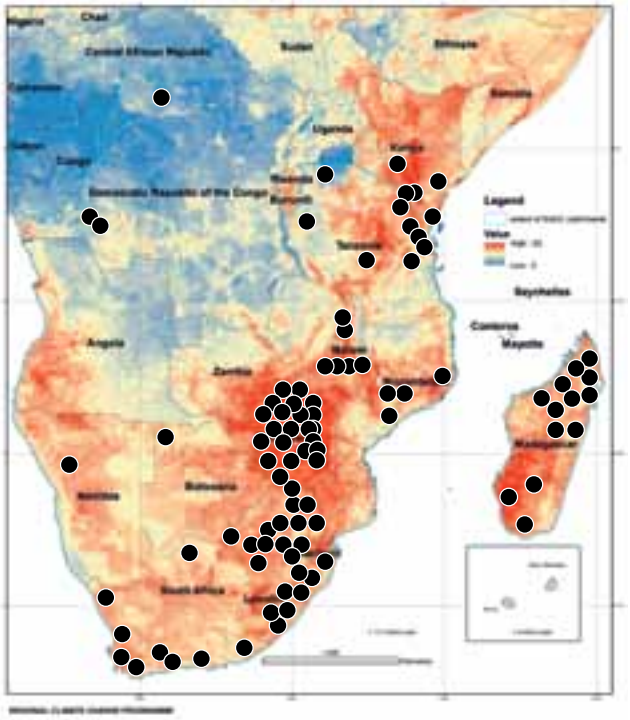

Figure 5: Location of selected PES projects from database overlaid on current potential impact arising from climate stress. Working for Wetlands projects in South Africa are shown, but not Working for Water and Working for Fire projects.
Source: Midgley *et al.*, 2011

Once all the interviews had been completed, the insights on the hurdles and operational changes were combined into a table. Recurring topics which hindered the implementation of projects and trends on suggested operational changes were assessed and used to produce key themes (Table 3). The themes were then used as criteria to appraise the relevance (impact) of all projects in terms of their applicability as climate adaptation strategies. Probability-weighted scores were then assigned to each theme based on research team consensus. In this way probability-weighted scores for each option give a clear overall preference ordering (i.e. significance) of options.

Table 2: Detailed information on PES-type projects in southern and eastern Africa that were used for the MCA analysis

Project name and location	Buyers and sellers	Payment flow	Hurdles	Operational changes	Recommendations highlighted by project managers	MCA Score
Naivasha-Malewa PES Project *Malewa River basin, Rift Valley and Central provinces of Kenya*	Flower farms, tourist establishments, government institutions – Upstream water users Land managers/ small scale farmers in communities along the river – Downstream water users	Mutual agreement in form of legal contract Fee/incentive paid by upstream users to intermediaries who act on the behalf of land managers/owners	Instilling understanding of concept of PES Securing 'buy-in' from beneficiaries Lack of legal framework for PES	Gaining commitment from the buyers and securing incentives		3.4
Mkuwazi Forest Reserve REDD Project *Northern region of Malawi, north of Chinteche (Nkhata Bay)*	Private organisations Forestry Department on behalf of and in collaboration with local communities	Payment was to be made to the Malawi Environmental Endowment Trust (MEET) which would then be disbursed to communities	The implementation of this project did not go ahead. Reason are: • pin-point project impact on livelihoods • proof that 'leakages' would not occur • lack of buyers	Assess feasibility of the proposed project Create awareness and understanding of PES Align objectives of the project with the correct funders/ donor		1.9
Maloti-Drakensberg Transfrontier Project *KwaZulu Natal, on the eastern border of Lesotho, near the Ukhahlamba Drakensberg Park, South Africa*	Various water users (this project has support from the Department of Water Affairs and Forestry – i.e. Working for Water) within the KZN province Maluti Drakensberg communities	Water users give their payments to municipalities or water user associations. This is then paid into the National WARMS system who acts as the central broker within the project. Working for Water programme is then given payments from this broker and WfW pays the money to the service providers	Reduced institutional capacity (forming business relationship, entering into contracts) Monitoring and evaluation practices needed Project Manager position 'not filled'	Dedicated project manager from the outset Assess and incorporate robust monitoring and evaluation techniques Engage with communities to ensure institutional capacity is present		2.7
Working for Water and Working for Wetlands *South Africa, National*	Various water users across South Africa – industrial and domestic water users; agriculture; forestry Land owners within certain regions across the nation	Water users give their payments to Municipalities or Water User Associations. This is then paid into the National WARMS system who acts as the central broker within the project. Working for Water programme is then given payments from this broker and WfW pays the money to the service providers	Valuation of natural resources using robust economic methods Appropriate institutions and governance structures The raising of awareness on the concept and benefits of PES on the part of both beneficiaries and service providers	Attempt to lower transaction costs Ensure appropriate monitoring of management efficiencies		2.8

Project name and location	Buyers and sellers	Payment flow	Hurdles	Operational changes	Recommendations highlighted by project managers	MCA Score
Equitable Payments for Watershed Services (ETWS) *Ulugurus Mountains, in the Kibungo, Lanzi, Dimilo and Nyingwa Villages, Morogoro District*	Companies which make bulk use of water (Dar es Salaam Water and Sewerage Corporation (DAWASCO), Coca-Cola, Tanzania Brewery Limited, etc) Individual villagers, village councils and village environmental committees	Payment of funds is made to intermediaries (CARE Tanzania in this particular instance). Payments are then made to farmers based on adoption of various technologies.	Project time frame too short to achieve aims Securing 'buy-in' from beneficiaries Inadequate policies and legal framework Investment cost for PES to take off is very high	PES design should consider time allocation for achievement of goals Project implemented in phases Place emphasis on policy change Gaining commitment from the buyers and securing incentives		2.7
LIVING Project *South Nguru mountains in Tanzania*	This is not considered to be a PES form of project as the main aim was to increase capacity in the marginalised areas of the south Nguru Forest so that these communities could adopt sustainable methods of utilising the forest to generate income	With reference to the note made in the adjacent section, there is not a formal system within which payments are made	Securing 'buy-in' from beneficiaries Lack of government support Appropriating financial benefits to communities	Engagement – instilling understanding of concept of PES Promote good governance Ensure equitable sharing mechanisms are in place		2
Zambia Wildlife Authority (ZAWA) CBNRM Programme *National*	This is a CBNRM programme which aims to better community involvement as stewards for the environment. This approach looks to devolve rights to communities to benefit from wildlife conservation.	With reference to the note made in the adjacent section, this is a CBNRM programme. ZAWA is the licensing authority (i.e. for regulated hunting and photographic safaris). Community Resource Boards (CRB) disburse benefits from regulated hunting and photographic safaris to communities	Correct guidelines needed to avoid the misallocation of funds Reduced institutional capacity Lack of permanent body/entity/staff to ensure continuity	Permanent staff to run operations Building of capacity within communities		1.975

Meaning of symbols as used in Table 2:

Theme	Related Symbol	Theme	Related Symbol
Stakeholder engagement (workshops, field days, seminars, site visits)		Land-use planning and management (in hotspot areas)	
Incorporate key individuals and entities		Capacity building and support	
Utilise relevant natural resources valuation techniques		Create synergy between relevant ministries/ departments	
Monitoring, assessment and evaluation to ensure correct practices are on-going		Address issues surrounding ensure and access rights (enabling environment for PES)	

Table 3: Themes, weighting and description of components in the MCA

Themes	Weighting	Description
Awareness: Buyers commitment	10%	Refers to the securing of 'buy-in' into the initiative usually dependent on buyers' understanding of: 1) the concept of PES, 2) why payments need to be made, 3) PES as a sound investment.
Awareness: Community understanding of PES	5%	Refers to the degree of knowledge and/or familiarity with PES within the relevant community
Awareness: Community engagement	7.5%	Efforts made to encourage community (at all levels) participation and involvement in PES programmes.
Institutional capacity within communities	10%	Refers to established organisations or entities that facilitate the understanding, implementation, and adoption of PES.
Capacity building	7.5%	Where institutional capacity needs to be strengthened, appropriate training is beneficial for continuity and effectiveness of an initiative.
Land tenure arrangement and legal access to resources	2.5%	These refer to the legal and policy framework within a nation. In some cases vague land ownership rights were a problem. Of more concern (noted in 30% of cases) was uncertainty of rights to utilise natural resources for commercial purposes.
Local government understanding of PES	2.5%	Refers to the degree of knowledge and/or familiarity of PES by relevant local authorities
Collaboration/synergy between relevant departments	2.5%	Degree of link between separate national departments and/or ministries which represent sectors that exhibit reliance/interdependence on similar ecosystem.
Valuation of natural resources and ecosystem services	10%	Importance of techniques and mechanisms in the estimation of the value of natural resources and ecosystem services (crucial in capturing true worth for both buyers and sellers). Appropriate valuation assists with ensuring use and non-use values are utilised in establishing equitable payments.
Permanence and continuity (funding, entities)	2.5%	Relevant to the sustainability of the initiative. Refers to the provision of funding, persistence of funding, constancy of supporting institutions and bodies.
Important project job positions/descriptions filled	2.5%	Linked to the point above. Refers to the establishment and adoption of a post which has the responsibility for facilitation of the project.
Monitoring, assessment, and evaluation	5%	Evaluation ensures project structures are maintained and monitoring and assessment guarantees conservation and adaptation methods are achieving the required objectives.
Land use planning and building ecosystem resilience	10%	Refers to practices that ensure the provision of ecosystem services. Given the importance of this theme to the provision of ecosystem services, it is interesting that this issue only came up in 40% of the discussions. This is important as land use planning is crucial for ecosystem-based adaptation.
Transferability / applicability: regional	2.5%	How easily the methodology/approach utilised can be replicated in other nations within the region.
Additional buy-in from buyers (after initial phases)	2.5%	Increased participation from ecosystem users, due to the realisation of effective provision of services as a result of the initiative.
Impact from areas that are not part of initiative	5%	Refers to instances where the provision of services is hampered by areas/ activities outside the project scope/area.

The results from the multi-criteria analysis (MCA) (Figure 6) indicate the potential impacts these projects have had, or could have on climate adaptation. Projects which achieved a higher score have greater relevance in terms of their impacts on climate change adaptation.

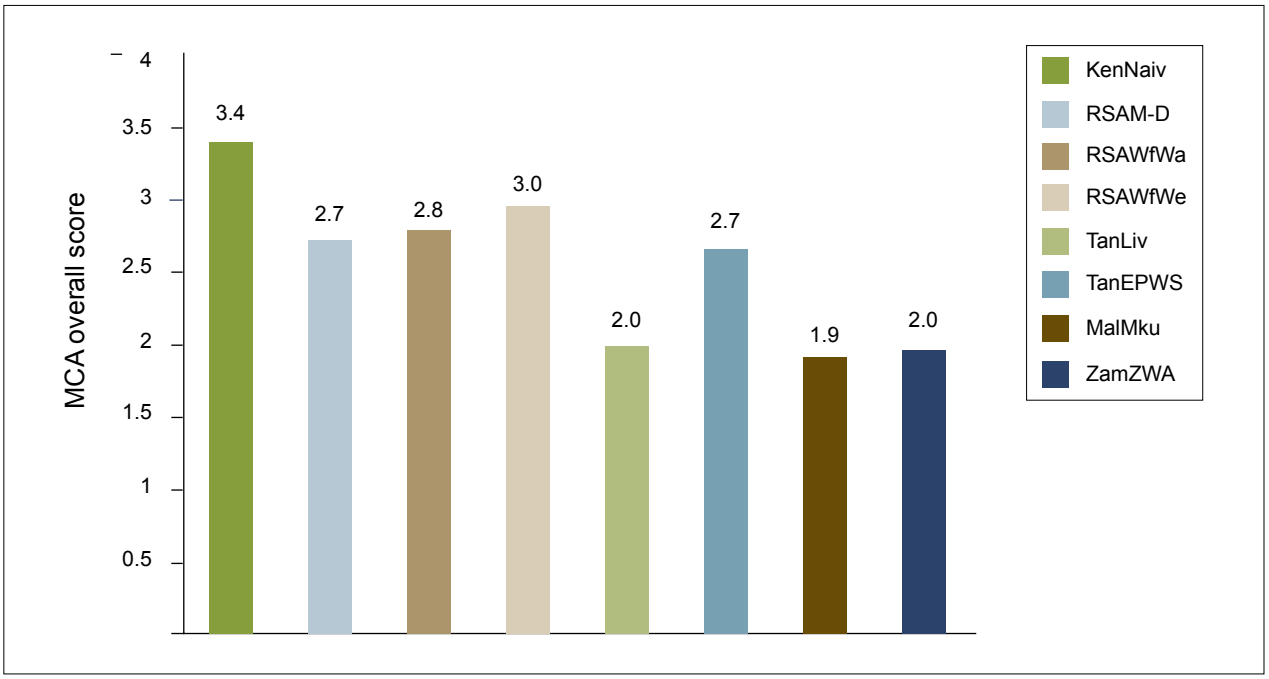

Figure 6: Overall MCA scores for the selected projects

4.2 Review of all regional projects

A theme raised in the majority of discussions was the need to increase the understanding of the concept of PES on the side of both buyers (beneficiaries) and sellers (service providers). It was noted that the understanding with regard to the mechanisms and benefits of PES at the 'grass-roots' (i.e. within rural communities) level is not extensive. The project managers contacted in Malawi, Kenya and Tanzania noted a low level of the understanding of the PES mechanism (on the part of both beneficiaries and service providers) within their respective nations. During discussions with project managers in South Africa, it was also expressed that a lack of awareness of the concept of PES was a hurdle to the effective implementation of a PES initiative. The recurrence of this theme gives some indication that a lack of understanding as well as clarity surrounding the PES mechanism is constraining the implementation of PES in the southern African region.

From the perspective of PES concept awareness on the part of services providers (i.e. community members), project managers of programmes in Kenya, South Africa and Zambia pointed out that community level understanding of PES was low. In addition, it was noted that there was a need to strengthen institutional capacity at the community level. This possibly suggests that there is some connection between a lack of capacity and a low level of understanding of the concept of PES. In terms of a lack of capacity, aptitude in regard to forming business relationships and understanding of the intricacies of entering into legal contracts were issues which were raised during discussions with one of the project managers in South Africa and one of the project managers in Tanzania. The importance of building capacity at all levels was noted by all project managers.

Literature on EbA (Vignola *et al.*, 2009; De Schutter, 2010) identifies that interaction and engagement with parties proposed to partake in PES is crucial. Engagement with communities (in the form of farmer field schools, seminars, workshops, and focus groups) allows for the collection of local knowledge on factors pertaining to land use and land management. This consequently facilitates the implementation of adaptation processes that take indigenous and local knowledge into account (Vignola *et al.*, 2009), and lead to awareness raising, which is a key aspect of adaptive management (Fabricius *et al.*, 2007).

In addition to the building of local knowledge, community engagement allows for the establishment of a degree of familiarity amongst community members and the organisations which are involved in facilitating the PES process (Vatn, 2010). With familiarity established, mutual trust is built and the assessment of local knowledge is easier, allowing for a transparent appraisal of the degree of vulnerability and for the identification of key needs within specific areas. Given that local actors are responsible for promoting EbA, it is important to provide such parties with knowledge on how effective PES operations and appropriate support will influence the effect such an approach has on building adaptive capacity (Vignola *et al.*, 2009).

Fabricius *et al.* (2007) identify the following key aspects which communities require for adaptive co-management: leadership and vision, the formation of knowledge networks, the existence or development of polycentric institutions, the establishment and maintenance of links between culture and management, the existence of enabling policies, and high levels of motivation in all role players. Within this framework, PES can provide the motivation, but usually not in a straightforward manner.

Community-based tourism interfaces effectively with the ecosystem-based adaptation approach. A guide from the San D'Kar community briefs tourists.

A lack of buy-in on the part of beneficiaries has been identified as a hurdle to the effective implementation and running of a PES approach. Gaining buyer and seller buy-in thus seems to be a constraining theme in PES initiatives in a southern African context. Securing commitment from buyers is necessary in order to guarantee the provision of payments (i.e. incentives). Schlamadinger *et al.* (2005) suggest that apprehension from buyers seems to stem from the fact that buyers are required to put forward funds (i.e. pay for services) even though it may take some time before the benefits (which are to be realised as a result of the provisions of ecosystem services) will be recognised. This presents a 'catch 22' where buyers are interested in participating in PES but are averse to providing payment before the realisation of ecosystem service provision. However, in order for the formally concepted PES mechanism to begin implementing measures to ensure the provision of ecosystem services, payment must be secured in the form of start-up funding.

In addition, the theme of payments relates to the valuation of natural resources and ecosystem services. This issue came up in discussions with project managers in Malawi and South Africa. For payment mechanism to work in a PES framework, the amount going to communities must be at a level that is equal to or greater than their opportunity cost of the land use which the PES programme is looking to avoid (Engel *et al.*, 2008). If this is not the case, there is more incentive to revert back to the socially (and often environmentally) suboptimal practice which is to be avoided.

One of the South African project managers noted that buyers need to be shown (in financial/ economic terms) the true environmental costs of their actions and the true value of the provision of ecosystem service to the sustainability of their business. However, the valuation of the environment and the services which it affords is a complex issue (UNECE, 2006; Martín-Lopéz *et al.*, 2008; Schläpfer, 2006; Nunes and Schokkaert, 2003).

In the case of the value of the environment to sellers (land owners within communities for example), pin-pointing the true value of the environment to these groups must involve both use and non-use values (by making use of robust estimation techniques). What is pressing in the case of sellers is the capturing of non-use values, for example regulating services, which communities may not realise are of great importance (Vatn, 2010). If such non-use values are not incorporated in the payments which are needed to incentivise a movement away from socially suboptimal practices, communities may be in a position in which they feel that the PES process is not providing appropriate benefits or compensation, and consequently the underpinning to an adaptation approach will fail. As a project manager from Malawi pointed out, the value of an environmental good needs to be placed in a context which can be understood in layman's terms. It should be borne in mind that the local community (and even the local ministries for such communities) may not entirely

recognise that programmes which ensure the provision of ecosystem services have the ability to fetch similar financial gains as that of extractive or productive activities (such as selling timber for economic revenue).

As a result, comparisons of revenues which can be achieved by different land use options must be provided so as to depict the 'profits' from each option. This assists in raising the understanding of the benefits which PES can attain and should in turn contribute toward the general backing of PES. *This is pivotal in adapting to climate change, as a key role of a PES initiative would be to buffer income streams and engage communities in more sustainable land use practices.* This sense of valuation therefore merits the implementation of smaller scale schemes, which stray from the conventional PES rigour with regards to true buyers and sellers, yet the underlying 'value' of the land provides the impetus for management changes.

Project managers in Zambia, Malawi, Mozambique and Kenya all identified a lack of an adequate legal framework for the creation of an enabling environment for PES. In the cases of Zambia and Mozambique for instance, the current legal and policy framework does allow for the use of natural resources for subsistence means; however, these frameworks are vague in terms of the right to make use of natural resources for commercial purposes. As a result, the legal and policy framework within many southern African nations does not seem to create an environment which is conducive for the establishment of a PES approach. Such a finding may place limitations on the feasibility of PES as an adaptation strategy to climate change.

A theme which came out particularly during discussions with project managers in Malawi and Mozambique is the apparent disconnect between national bodies that are responsible for different natural resources and in charge of separate sectors. Respondents noted that this disconnect refers to a situation in which, for example, entities such as the Department of Forestry and the Department of Water are placed in separate ministries and are thus unaware of the influence which their actions have on their respective sectors. Forests and watersheds are nonetheless reliant on each other for the provision of ecosystem services. A clear linkage therefore exists between the ministries which are in charge of such interrelated sectors. Both project managers were of the opinion that the lack of national guidance and policy coordination (as in the example given above) has the potential to diminish the effectiveness of climate change policies which are aimed at increasing adaption to climate change.

Low institutional capacity and weak governance structures were identified as hurdles to the implementation of PES initiatives in their respective nations. Appropriate institutions and governance structures are required to ensure that hurdles to the implementation of the PES approach are overcome (Bracer *et al*., 2007; King *et al*., 2003; Perrot-Maitre and Davis, 2001). Strong institutions are needed to facilitate PES activities while good governance practices are essential to assist in the involvement of community/traditional institutions in the PES market system (Dietz *et al*., 2003).

Monitoring and evaluation are easier to conduct when sound institutions and quality governance structures are in place (Vatn, 2010). Monitoring (i.e. ensuring that management is prioritising the original goals of the programme and that benefits are filtering down to the correct parties) and evaluation (i.e. appraising whether land use planning is maintained, testing water quality, assessing water flow) are important methods to ensure that climate change adaptation objectives are being executed and that conditionality is being met. Consequently, they build the resilience of ecosystems to climate impacts (De Schutter, 2010). The collection of information from monitoring and evaluation procedures also forms the basis of concrete evidence to support the case that PES schemes are successful – or not – in achieving conservation and promoting livelihoods (Vignola *et al*., 2009). In the discussions carried out, 63% of the contacted project managers identified that improved monitoring and evaluation practices would be beneficial to the success of PES initiatives in the future and should accordingly be prioritised. Given the early stage at which PES is being utilised within the region, such data will further contribute to the knowledge base surrounding the PES mechanism (Vignola *et al*., 2009). Both institutional capacity and strong governance are required to guarantee appropriate monitoring and evaluation take place. The lack thereof consequently has adverse effects on the use of PES as an adaptation strategy.

A surprising outcome of the interviews was the fact that a minority of respondents mentioned or alluded to issues concerning land-use planning and the importance thereof in building ecosystem resilience. Given the importance of this theme for the reduction of vulnerability and effective provision of ecosystem services, this is a concerning trend which needs to be addressed across the region. If insights into the climate adaptation element of land use planning and management are not fully appreciated, the gains of ideas such as ecosystem based adaptation cannot be fully realised.

5. Key aspects relevant to southern Africa

5.1 The role of indigenous and local knowledge systems

A key element in assessing how ecosystem services link to land use and policy planning is the rigorous integration of ILK elements. The integration of exchange or payment systems for a range of ecosystem services needs to be sensitive to the cultural underpinnings of both the beneficiaries and the sellers in an area. This is especially true in the context of contributing towards an enhanced adaptive capacity of these communities, most of them dependent on natural resources. This cultural understanding within any PES scheme ensures 'renewal' of the system. Essentially, ILK needs to be used to understand existing systems of exchange, how these are framed, and whether the understanding and mechanism of these can be enhanced to allow communities to adopt livelihoods more adapted to the implications of climate change. Figure 7 shows this approach to ecosystem management whereby PES links to adaptive processes with ILK and local systems sitting between them and creating linkages and feedback. A key issue is to find congruence between the different knowledge systems involved.

A good example of this concept in practice comes from the work of Elmqvist *et al.* (2010) in Madagascar. They found that the depth of ILK and heterogeneity of adopted livelihood strategies across the region meant it cannot immediately be assumed or expected that human activities have negative implications on the surrounding ecosystems. Instead, as Elmqvist *et al.* (2010) found in their Madagascar forestry example, informal rules acknowledged and made by the communities directly using the forest resources influenced the forest ecosystem condition, rather than formal legal definitions of protected area. This is an important consideration in conceptualising PES's role in aiding adaptation to climate change.

In areas where ecosystem protection and sustainable resource use are occurring, before considering PES as an income stream, a detailed understanding of informal 'taboos' or cultural norms of protection must be understood. As Elmgvist *et al.* (2010) reiterate some of the most enforced and strict rules are derived from informal taboos, such as not harvesting certain sections of forest, which have resulted in more enhanced state of the forest. In this sense, if PES or Compensation and Reward for Environmental Services (CRES) are applied,

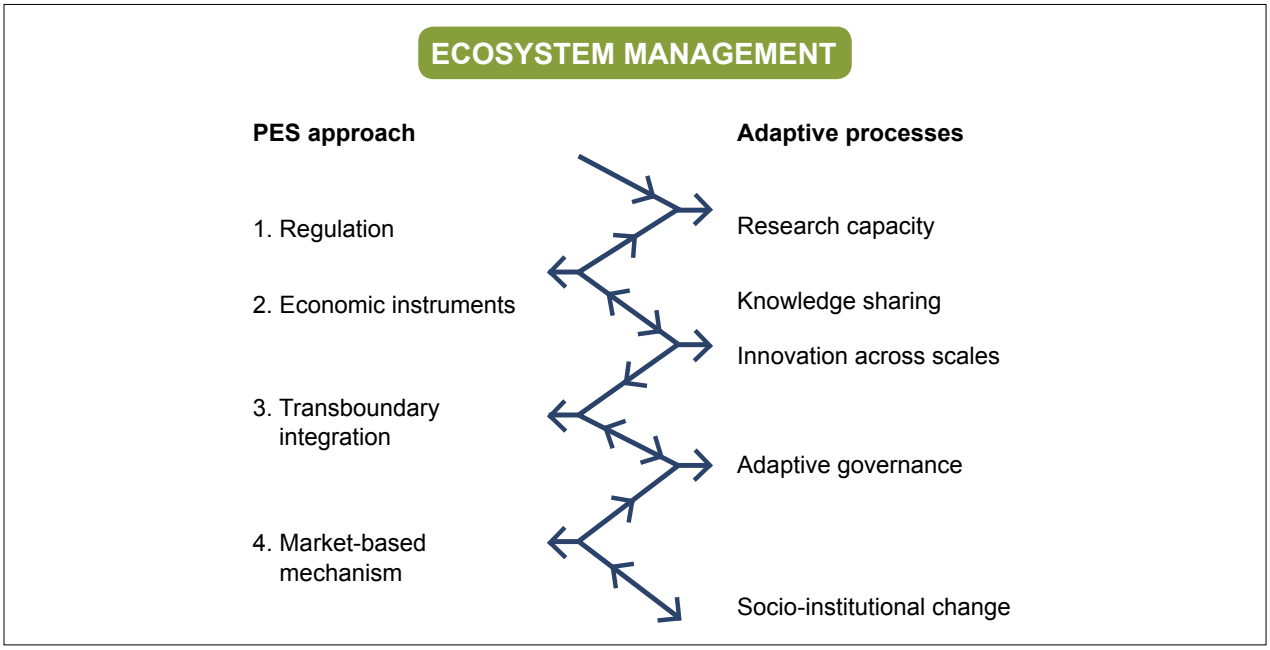

Figure 7: Concept of indigenous knowledge (symbolised by the arrowed line in the middle) linking PES to adaptive processes and creating feedbacks between them

Source: own diagram

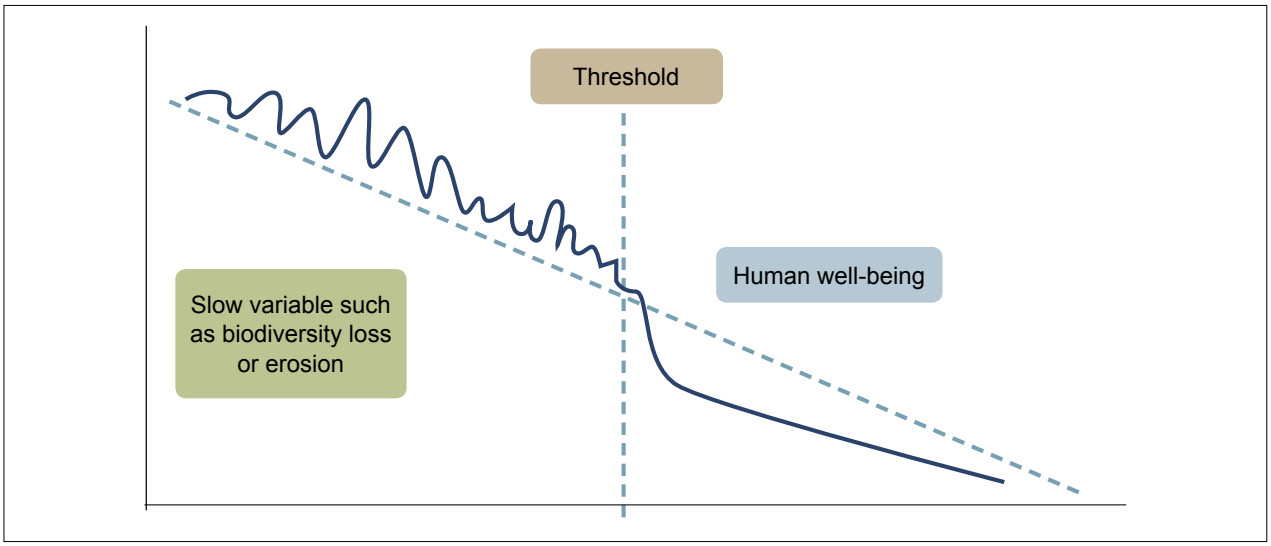

Figure 8: Impact of a threshold on a trajectory – in this case a composite of factors that make up human well-being

as shown through the case examples, a factor influencing the resulting ecosystem state in many cases will not likely be based on ecological constraint but rather on social variables influencing the system (Elmgvist *et al.*, 2010).

Therefore a balance needs to be struck in the management approach between historical patterns of human activities which may have been detrimental to ecosystem condition and the resultant dynamics. The interaction of social and ecological processes can create conditions of protection and a stable ecosystem function that is able to regenerate, even in the face of a range of climate change scenarios. By embedding science in social processes and solving problems collaboratively with a range of stakeholders, it is easier to ensure that new knowledge results in the desired action, behaviour and decision changes and, importantly, feeds into a robust policy re-framing (Reyers *et al.*, 2009). This requires new approaches to knowledge sharing and learning, and a realisation that both formal and informal knowledge are critical to success.

5.2 Social learning

Adaptation strategies for southern Africa need to achieve 'double and triple loop' learning, essentially ensuring there is an embedded process of dynamic feedback, be it within the scope of the conceptualised adaptation strategy or ideally within a more sustainable and embedded autonomous process of adaptation to climate stresses. In a practical sense, where existing environmental stress and degradation of environmental resources is evident, integrating climate change adaptation is more efficiently achieved within a local frame of management, utilising internal capacity of the system. For example, the implementation of compulsory water licensing for over-allocated water catchments in South Africa would be an example of a PES which would ensure maintenance of an ES that will be severely stressed with future development.

Key aspects to consider in assessing a scheme include:

1. thresholds (both biophysical and socioeconomic) which are being approached;
2. the range of positive and negative scenarios; what the future could look like versus the status quo; and
3. plausible policy changes and capacity which the system can realistically absorb.

This is shown in Figure 8, whereby when a threshold is reached for a certain ES, for example the soil nutrient status of an area of land, there follows a rapid decline in the service and momentous impact on human well-being.

Social learning and thresholds need to be taken into account when considering climate change adaptation. The achievement of suitable adaptation is linked directly to coherent policy directives and local adaptive capacity in terms of knowledge, infrastructure, capital and level of motivation of stakeholders. The analysis has illustrated the need to understand biophysical and socioeconomic thresholds in a system in order to adequately address a range of implications linked to climate change. Adaptation is a cohesive process that essentially follows a development pathway, and can be both planned and autonomous and occur over varying time scales. Consequently, understanding current thresholds through a process of social learning will contribute towards both planned and autonomous climate adaptation.

5.3 Land use planning

A key imperative in the region is to move towards more holistic land use planning which considers ecosystem parameters and conceptualises land management potentially along nested ecosystem areas. By aligning land use within ecosystem boundaries, although impossible to define explicitly, a framework is created to encourage ecosystem-based adaptation and land management and the resultant feasible systems of exchange or payment for services. Alignment of the scale of land use planning units with the scale of decision making is important (C. Fabricius, pers. comm.). If land use planning units are coarse, e.g. straddling several villages, for example, and decision making takes place at the village level, then a mismatch ensues which bedevils decision-making and adaptation.

A relevant case study around land use planning is presented in Box 5 (on the following page).

Box 5: Case study – systematic biodiversity planning in South Africa

A case study can be drawn from systematic biodiversity planning in South Africa which entails the representation of biodiversity patterns (Driver *et al*., 2003) and an evaluation of persistence of evolutionary processes over time (Petersen and Holness, 2010). Systematic biodiversity planning in the South African context is not focused on specific species but rather on threatened terrestrial and aquatic ecosystems, and thus looks to identify "ecological support areas important for ecosystem functioning as well as critical biodiversity areas important for biodiversity pattern and ecological process" (Petersen and Holness, 2010).

Systematic biodiversity planning underpins land-use guidelines which provide an indication of focal areas for conservation. It can also highlight the implications of different land-use options for biodiversity (Petersen and Holness, 2010). This data is utilised in the expansion of protected areas with the aim of strengthening ecosystem resilience (Petersen and Holness, 2010). This methodology also integrates climate change design principles. These include, for example, prioritisation of vital biodiversity corridors; refugia areas where species can avoid adverse climate impacts; and slopes with marked altitudinal changes in climate. In this way, climate change adaptation may be seen to be a key element of land use planning in South Africa. However this methodology needs to be applied within the context of national development priorities.

In South Africa, local authorities have a legal obligation to develop an Integrated Development Plan (IDP), to be updated every five years and supported by a Spatial Development Framework (SDF) which includes 'a strategic environmental assessment'. This can be described as "an indicative spatial plan that reflects the IDP priorities and shows the current and future patterns of land use by all sectors" (Petersen and Holness, 2010). These documents have been instrumental in highlighting key biodiversity patterns and ecological processes for adapting to climate change, which assists in prioritising appropriate strategies for 'biodiversity stewards' (Petersen and Holness, 2010).

This combines to allow for a more systematic approach for guiding land-use planning and decision-making by all sectors which impact upon biodiversity. It creates an institutional framework that can address decision making in the context of climate change policy and adaptation. However, the legal framework in South Africa, as well as institutional capacity (in terms of government and civil society support) and a sound knowledge base (in terms of academic and research institutions) from which information can be drawn, are not equally strong in all provinces. Capacity is lacking within many local authorities, most notably in more agriculture-focused provinces. Consequently, a generic recommendation when considering the impact of land use planning is to raise awareness with regard to methodologies as well as stimulating partner organisation and capacity building at a national scale.

The Systematic Biodiversity Planning framework from South Africa shows the need to assess existing institutional and planning frameworks. In addition it highlights how these can be best tailored to focus on ecosystem resilience and, through capacity building of institutional actors, to enable a better outline of ecosystem service flows in an area and how these are valued and utilised. The lack of capacity in many institutions, especially outside of South Africa, negates the potential impact of trying to implement further natural resource governance. Instead a pragmatic approach to adaptation requires an assessment of the existing institutional baseline from which options for climate change adaptation and the integration of ecosystem services can be evaluated. This process in itself needs to feed into land management planning along ecosystem boundaries, in order to facilitate some measure of a system around key ecosystem services.

6. The way forward and recommendations

The result of the interviews provided a useful baseline of the current situation surrounding PES projects in the region. The operational changes suggested by the project managers were particularly valuable to highlight key changes that need to be made. This is to make PES a more effective structure to ensure equitable payments. Recommendations with regards to PES in southern Africa are detailed below. They form some of the core components of the systems-based approach to ecosystem management in a changing and uncertain future, as illustrated in Figure 9.

6.1 Tenure rights

Well-defined land tenure rights facilitate the incorporation of local communities into a formal PES approach. Legislation needs to guarantee that there are policies in place which:

i) allow the seller to be compensated for adopting alternative land uses (i.e. structures to allow these groups to enter into contracts and agreements); and
ii) protect the right of buyers to receive the provision of ecosystem services (monitoring ensures conditionality; enforcement and conflict mechanisms address disputes and non-compliance).

Where it is possible to address issues surrounding tenure rights, procedures should be in place to ensure clarity on ownership rights to land and access rights to natural resources. Legal consultation at both a local and government level will give context to where the shortfalls are in the system. With this identification, steps towards feasible restructuring of the policy framework can be undertaken.

6.2 Governance

Sound governance is a necessary condition to allow for the appropriate regulatory frameworks (i.e. a shift away from outdated regulations) to be developed and disseminated. Furthermore, transparency and accountability (both elements of good governance) are needed, and the entire process monitored (Corbera *et al.*, 2009). For example, where land use planning and management frameworks have been developed, monitoring and evaluation ensure that best practices are occurring and the most vulnerable groups are being targeted. The presence of strong governance structures arises from a strong policy framework.

6.3 Stakeholder engagement

Linkages must be created between all parties in the management of ecosystem services. Engagement with communities allows for the creation of awareness around the PES and EbA approaches (mechanisms, rewards, benefits, service provision). A better understanding of these approaches allows for familiarity with the systems and institutions involved in the implementation of the initiative, which in turn should achieve some degree of commitment from the entities that are party to the programme. Project managers noted that a lack of commitment on the part of buyers to provide incentives is a constraining factor to a PES approach. It was pointed out that future operational changes which would be beneficial to the process of PES would secure such buy-in. Thus engagement with communities creates awareness around the incentives which can be achieved; this develops enthusiasm from communities to ensure their activities allow for service provision. This may provide some comfort to buyers and may assist in securing their buy-in.

The incorporation of institutions which have the capacity to facilitate the development of a sound scientific evidence and knowledge base is of importance to successful PES initiatives. Practitioners have noted that robust valuation techniques are necessary to ensure that the true significance of natural resources and ecosystem services are estimated. These estimations allow for the translation of environmental services into economic impacts and place decision makers in a better position to make comparisons between different options of land use. This facilitates decision making (i.e. shows feasibility of different options) as it provides information which can easily be understood.

Incorporating local knowledge into these estimation methods, and communicating scientific findings in layman's terms, provides, a basis for the development context-specific, evidence-based solutions. The emphasis here is on developing specificity (i.e. who is the most vulnerable) and then implementing PES and EbA strategies accordingly.

At the national government level, where dependencies on ecosystem services are usually seen in a sectoral 'silo', the building of synergies between these entities is crucial. Project managers with experience in PES in a southern African context allude to the poor collaboration and coordination between ministries and the need for greater public support as hindering the effectiveness of PES in the

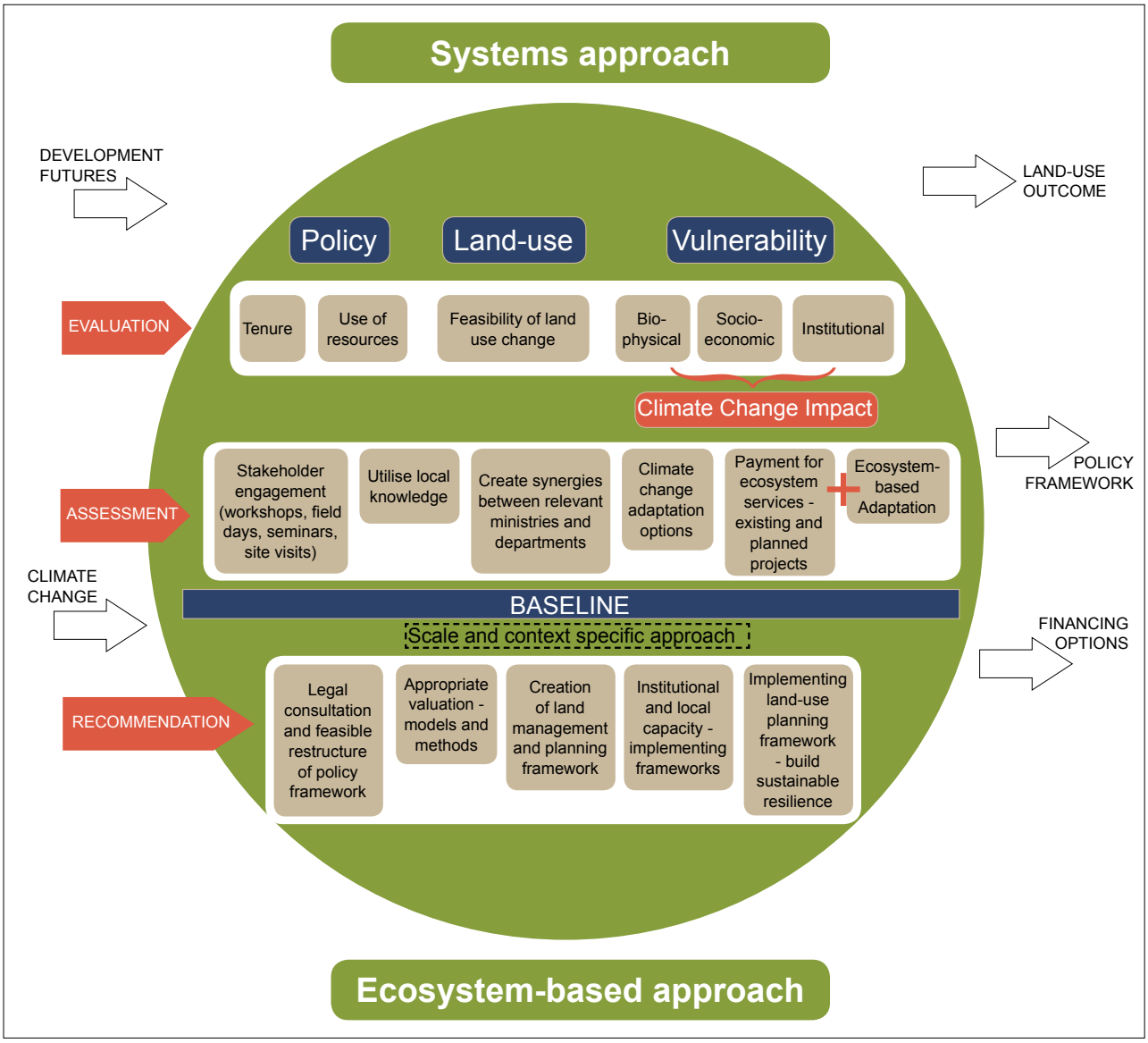

Figure 9: Systems approach to ecosystem management

region. More dialogue between scientists, stakeholders and public bodies, and engagement with the scientific evidence of the inter-relatedness of ecosystems and the services they provide, is required. This would help to develop synergies and collaboration between ministries and departments, and thus strengthen institutional capacity and effective policymaking, drawing on local knowledge and context. Furthermore, a clearer understanding of the realities of vulnerability should encourage public support for approaches such as PES and EbA, either in terms of capacity or financial means, which should assist in minimising the risk of liquidity constraints.

For adaptation approaches to be flexible and able to respond to the highly complex socioeconomic and environmental contexts, a systems-based approach needs to be adopted. Concepts are multi-layered and interconnected but are often pursued and applied individually. A systems approach to ecosystem planning should be considered in the development of coherent and integrated climate change adaptation strategies for southern Africa, where multiple services and ecosystems interlink (Figure 9). The region can gain significant value from assessing land management along the lines of ecosystems, thereby making it easy to see how ecosystem service flows occur, thereby moving towards a more concentric ecosystem based adaptation approach.

6.4 Recommendations

The analysis of ecosystem services in the context of climate stress and climate change requires a sensitive approach and one taken at a local level. This study has looked at small scale schemes, where transaction costs are low and adaptive capacity is built up through an income buffer. Such schemes are most likely to be the most pragmatic adaptation responses for southern Africa. Although the region needs to conceptualise the impact that large scale PES programmes can have, especially in line with transboundary water resource management, at this stage weak institutional and governance capacity for PES schemes may render the development of full scale adaptation programmes too ambitious. Instead, conceptualisation of key services (e.g. forest biodiversity)

and the establishment of an institutional baseline is required to assess the requisite capacity to implement PES schemes, and ensure local knowledge underpins this.

Key recommendations in line with PES and climate change adaptation for the region include the need to:

- engage key policy and decision makers across the region to increase understanding and awareness around EbA and PES;
- improve the scientific baseline around ecosystem services;
- improve the knowledge base around valuation frameworks especially where multiple ecosystem services are at play;
- build institutional capacity and aid in the development of sound ecosystem governance;
- create an enabling environment for PES through the establishment of national and local legal and policy frameworks.

As the analysis of PES and PES-related projects in the region has shown, there are existing examples that can be replicated elsewhere within a development pathway. Income diversification, combined with a more systematic exchange, will allow beneficiaries to increase their adaptive capacity. This is not direct adaptation *per se*. Rather, it is a re-framing of a response, where new knowledge of the synergies that can be achieved can aid transition from vulnerability to a more transitional pathway. The learning process involves building knowledge among a diverse stakeholder group across different decision-making frameworks in response to environmental feedbacks (Olsson *et al*., 2004). This requires that the adaptation strategy has a strong focus on understanding the dynamics between ecosystems, the enhancement of goods and services, and the social process amongst key stakeholders. As Berkes *et al*. (2003) recognise, the institutional and governance landscape needs to be approached as carefully as the ecological one to move towards system resilience.

The interview results also showed that project managers implementing PES projects did not value good land-use planning highly, or its importance in building ecosystem resilience. This further vindicates the need to encompass and develop regional, national and local frameworks for implementing EbA across southern Africa. The EbA approach needs to be considered at an appropriate scale and nested within the local context and capacity. The example of land use planning frameworks in South Africa showed the need to assess existing institutional and planning frameworks. Through capacity building of institutional actors, a better outline of ecosystem service flows in an area and how these are valued and utilised is attainable. Agroecology illustrates a good example of this. Although straying from a traditional view of PES, such initiatives and a systems approach are integral in achieving adaptation. The fact that agroecological practices are resource-conserving, yet are also low-external-input methods, is the most attractive element of these activities. The intervention has high applicability in this region, where livelihood options and capacity are low.

The lack of capacity in many institutions in the region negates the potential impact of trying to implement a highly complex and financially rigorous PES system. Instead, a pragmatic approach to adaptation requires an assessment of the existing institutional baseline from which options for climate change adaptation and the integration of ecosystem services can be evaluated. This process in itself needs to feed into improved land management planning along ecosystem boundaries, in order to facilitate a systems approach to increasing climate resilience of key life-supporting ecosystem services such as water, biodiversity and carbon.

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8. Appendix: Database of eastern and southern African PES projects

Country	Project name	Institutions involved	Project activities	Links to climate change adaptation
Carbon sequestration				
DRC	Ibi Bateke Carbon Sink Plantation		Afforestation, convert natural grassy savanna into an abundant and sustainable fuel-wood supply for charcoal production - clean energy project	• Carbon finance • Mitigation • Ecosystem resilience • Resource-based income
Madagascar	Mantadia Corridor Initiative (reforestation of corridors which link the Analamazaotra Special Indri Lemur Reserve, the Maromizaha Private Forest and Mantadia National Park complex in east-central Madagascar)	Ministry of Environment Water and Forest World Bank Wildlife Conservation Society	Afforestation or reforestation Native and exotic plantings: more than 50% native Planting of fruit gardens Forest management, and conservation of protected area and habitats, stabilisation of land-use is under way.	• Community resource management • Food security • Forest management • Ecosystem resilience • Energy security • Resource-based income • Carbon finance
Madagascar	Holistic Conservation Programme for Forest	French Foundation GoodPlanet WWF	Afforestation or reforestation Transfer of natural resource management Development of sustainable agricultural practices Development of social and economic infrastructure	• Food security • Sustainable agriculture • Carbon finance • Ecosystem resilience • Natural resource use
Madagascar	Makira Forest Conservation Project	Ministry of Environment Water and Forest World Bank Wildlife Conservation Society	Afforestation or reforestation Forest management, and conservation of protected area and habitats, stabilisation of land-use are under way.	• Mitigation • Forest management • Community resource management • Water flow/water quality
Madagascar	Ankotrofotsy Afforestation Project	Fondation Tany Meva Délégation Intercooperation (DIC) Fanatsarana ny Farimpiainan' ny Ambanivohitra (Association for the Farmers' Livelihood Improvement) (FFA)	Planting and maintenance (i.e. no harvesting) of trees	• Forest management • Resource-based income • Community resource management
Madagascar	Antanetikely Afforestation Project	Fondation Tany Meva Office National des Forêts Internationales (ONFI)	Planting and maintenance of trees	• Forest management • Resource-based income • Community resource management

Madagascar	Vhodrazana Mantadia corridor conservation and restoration carbon project		Reforestation, wood-fuel plantation, agro-forestry	• Energy security • Species loss • Community resource management
Malawi	Trees of Hope in Neno and Dowa District	Clinton Hunter Development Initiative Environmental Affairs Department (EAD)	Competing vegetation removed, foliage left to act as organic fertilizer Indigenous and naturalised hard wood tree species to then be planted Harvesting of incidental moisture	• Sustainable agriculture • Water security • Water flow/water quality • Forest management
Malawi	Sustainable Management of Indigenous Forests in Mwanza East	German Agency for Technical Cooperation (GTZ) SADC Forestry Sector Technical Coordination Unit (SADC- FSTCU) Wildlife Society of Malawi Department of Forestry of the Ministry of Forestry, Fisheries and Environmental Affairs	Increase awareness on deforestation Creation of community clubs and committees to administer forest management and bolster awareness and training initiatives Creation of by-laws to control illegal practices Promote diversification of forest product use Harvesting and marketing of non-timber forest products (NTFPs)	• Community resource management • Forest management • Market incentive • Resource-based income
Malawi	Peace Parks Foundation (Climate Change Fund)	National Park Peace Parks Foundation Wentezel Bowers (WWB) law firm	Avoided deforestation, fire management	
Mozambique	Sofala Community Carbon Project (previously - N'hambita Community Carbon Project)	Envirotrade Mozambique Limitada	Afforestation or reforestation and agricultural management Developing sustainable land use and rural development activities in communities (reduction of soil erosion, increase tree cover)	• Sustainable agriculture • Forest management • Community resource management
Namibia	Ondangwa Namibia Reforestation (http://www.carboncatalog.org/projects/ondangwa-namibia-reforestation/)	PrimaKlima-weltweit Bäume für Menschen	Reversing the clearing of forests for grazing land and firewood.	• Forest management • Mitigation
South Africa	Baviaanskloof	South African National Biodiversity Institute (SANBI) Cape Action for People and the Environment (CAPE) Department of Water Affairs and Forestry UN Development Programme World Bank	Planting of indigenous trees Remove alien species Promote sustainable land use and land management Vegetation restoration	• Sustainable agriculture • Water security • Water flow/water quality • Forest management • Resource-based income
Tanzania	Emiti Nibwo Bulora Woodlot	Vi Agroforestry	Further Local knowledge on tree planting and other sustainable land use and management methods boost yields and productivity Increased soil carbon storage Community involvement	• Mitigation • Community resource management • Sustainable agriculture • Forest management • Water flow/water quality

Tanzania	The International Small Group Tree Planting Programme (TIST)	World Bank CarbonFund Clear Air Action Corporation Ukuzaju Maendeleo Endelevu Tanzania (UMET)	Tree planting in and around villages – Dodoma and Morogoro regions Further local knowledge on agroforestry and conserving medicinal plants Adoption of improved sustainable soil management techniques Educating communities on nutrition and other health issues such as HIV/AIDS.	• Mitigation • Community resource management • Forest management • Natural resource use • Market incentive • Sustainable agriculture
Tanzania	The Participatory Environmental Management Programme (PEMA) – Eastern Arc Mountains	CARE and Tanzania Forest Conservation Group (TFCG), World Agro-Forestry Center (ICRAF)	Planting of native and exotic (non-native) trees Forest maintenance	• Forest management • Community resource management
Tanzania	Hifadhi ya Misitu ya Asili (HIMA) Project	CARE and Tanzania Forest Conservation Group (TFCG)	Piloting of carbon financing for REDD Secure property rights, equitable rewards for providing ecosystem services and other livelihood benefits Promote gender equality	• Mitigation • Community resource management • Forest management • Resource-based income • Market incentives
Biodiversity				
DRC	Ecomakala		Avoided deforestation Biodiversity conservation	• Natural resource use • Food security
DRC	Reforestation project in Maringa-Lopori-Wamba region		Reforestation (using native species) Establishment of the 'Bonobo Peace Forest'	• Community resource management • Conflict resolution • Natural resource use • Food security
Madagascar	Masoala National Park	Wildlife Conservation Society (WCS) Association Nationale pour la Gestion des Aires Protégées (ANGAP)	Afforestation or reforestation Conservation of protected area and habitats Stabilisation of land-use is under way.	• Community resource management • Food security • Forest management • Ecosystem resilience • Energy security • Resource-based income
Madagascar	Conservation Cotton Initiative	Wildlife Conservation Society (WCS) Association pour le Développement de l' Economie Rurale de Port Bergé (ODER)	Reforestation and avoided deforestation Planting of trees Promote conservation of protected areas – Mikea Forest (i.e. no use of bio-pesticides and other chemical products, no slash and burn practices)	• Food security • Sustainable agriculture • Community resource management • Natural resource use/species loss • Carbon finance • Market incentive • Resource-based income
Madagascar	Ankeniheny-Zahamena Corridor		Reforestation Conservation of forests	• Mitigation • Food security • Community resource management • Carbon finance • Market incentive • Forest management

Madagascar	Eco Eco Project - Ankazobe Ambohi		Rehabilitation Revegetation and promotion of agroforestry	• Natural resource use/species loss • Mitigation • Food security • Resource-based income • Ecosystem resilience
Madagascar	REDD Project of the Forest Community Ampanihy-South West Region		Reduced deforestation	• Mitigation • Market incentive • Forest management • Community resource management
Madagascar	REDD and reforestation oriented preservation of the forest in Makirovana Tsihomanaomb -Sava Region		Reduced deforestation	• Mitigation • Market incentive • Forest management • Community resource management
Malawi	Mkuwazi Forest Reserve and Nyika National Park Conservation Project	Malawi Environmental Endowment Trust (MEET) Community Partnership for Sustainable Resource Management in Malawi (COMPASS) Department of National Parks and Wildlife (DNPW) Forestry Department Leadership in Environment and Development (LEAD) USAID	Maintenance of biodiversity and prevention of soil erosion Avoided deforestation and forest degradation via planting of wood lots Maintenance of forest cover	• Water security • Water flow/water quality • Forest management • Food security • Sustainable agriculture • Ecosystem resilience • Resource-based income
Malawi	Mount Mulanje MOBI+LISE	Mulanje Mountain Conservation Trust (MMCT)	Promote conservation by encouraging alternative land use to support livelihoods (i.e. bee-keeping as opposed to charcoal/fuel-wood sales)	• Sustainable agriculture • Ecosystem resilience • Forest management • Community resource management • Resource-based income
Mozambique	Gorongosa Forestry	Sofala Provincial Government Climate Action Envirotrade Plan Vivo The CarbonNeutral Company	Reforestation, agroforestry	• Mitigation • Carbon finance • Market incentive • Forest management • Natural resource use/species loss
Mozambique	Zambezi delta carbon livelihoods project	WWF Envirotrade	Avoided deforestation, reforestation, sustainable agricultural systems	• Mitigation • Community resource management • Sustainable agriculture • Ecosystem resilience • Resource-based income

Mozambique	Quirimbus livelihood carbon project	Quirimbas National Park Envirotrade	Avoided deforestation, reforestation, sustainable agricultural systems	• Mitigation • Community resource management • Sustainable agriculture • Ecosystem resilience • Resource-based income
Namibia	The Kunene Region Torra Conservancy			
Namibia	Revitec		Control and reduce deforestation Promote sustainable land use and planning strategies	• Community resource management • Sustainable agriculture • Ecosystem resilience • Forest management • Water security
Tanzania	LIVING Project South Nguru Mountains	CARE	Strengthen capacity Empower Natural Resources Committees (VNRC) Inclusive governance of forest resources so that communities acquire legal mandate to manage and use local resources in their proximities	• Community resource management • Forest management
#Tanzania	Misali Island Conservation and Community Development (MICODEP)	CARE		
Zambia	Kawaza Village planting	Robin Pope Safaris Flying Forest	Planting of a variety of fast-growing indigenous trees, slow-growing hardwoods and fruit tress	• Community resource management • Forest management • Food security
Zimbabwe	Communal Area Management Programme for Indigenous Resources (CAMPFIRE)	WWF ZimTrust Department of Wildlife and National Parks	Conservation of biodiversity and wildlife through payments for avoided deforestation and reduction of encroachment/expansion of agricultural and settlement activities. Raising awareness on impacts on environmental resources and how this relates to livelihoods	• Food security • Market incentive • Resource-based income • Ecosystem resilience • Forest management • Sustainable agriculture • Community resource management
Water				
Angola	Natural Resource Management Project			• Carbon finance • Food security • Mitigation • Water security

Kenya	Lake Naivasha-Malewa Watershed Management Project	WWF	Promote conservation activities (rehabilitation and maintenance of riparian zones, establishment of grass strips and terraces, tree planting reduction of fertilisers and pesticide use) by upstream users to ensure the flow and quality of water	• Forest management • Food security • Mitigation • Water security • Carbon finance • Resource-based income
Kenya	Western Kenya integrated ecosystems management project		Promote conservation activities to control sediment and nutrient flow into Lake Victoria	• Forest management • Food security • Mitigation • Water security • Carbon finance
Kenya	Busia local community initiative		Afforestation, reforestation, agroforestry	• Forest management • Food security • Mitigation • Water security • Carbon finance • Community resource management • Species loss
Kenya	Kwale forestry initiative		Planting of trees	• Forest management • Mitigation • Food security
Kenya	Machakos and Kitui local community Forestry initiative		Forest management, reforestation and preservation	• Forest management • Mitigation • Water security • Carbon finance • Community resource management
Kenya	The Kasigau Corridor REDD Project	Wildlife Works	Biodiversity conservation and avoided deforestation	• Forest management • Mitigation • Water security • Carbon finance • Community resource management • Market incentive
Kenya	Dakatcha Woodlands		Avoided deforestation	• Forest management • Mitigation • Water security • Carbon finance • Community resource management
Madagascar	JIRAMA Project	Jiro sy Rano Malagasy (Malagasy Electricity and WaterCompany) (JIRAMA) l' Autorité Nationale de l' Eau et de l' Assainissement (ANDEA) (Department of Water)	Conservation of water catchment and forests in the Andekaleka, Haute Matsiatra, and Lac Alaotra Water treatment and measures to ensure and regulate the flow of the water system Efficient and equitable supply/distribution of water to communities	• Food security • Water security • Ecosystem resilience • Energy security • Sustainable agriculture • Resource-based income • Water flow/water quality

Madagascar	Eau Vive		Treatment of water source Use of new technology (probably ensure efficient extraction of the water)	• Water security • Water flow/water quality • Market incentive • Resource-based income • Natural resource use
Madagascar	AQUAMAR Project		Conservation of water source	• Water security • Water flow/water quality • Market incentive • Resource-based income • Natural resource use
Malawi	Mpira dam catchment area project	Local Catchment Management Trust	Afforestation for carbon sequestration Control soil erosion, reduce deforestation (attempt to promote rainwater retention) Raise awareness of human pressures on the environment	• Mitigation • Forest management • Sustainable agriculture • Food security • Water flow
Malawi	Lake Chilwa Wetland Project			
South Africa	Working for Water	Department of Water Affairs and Forestry	Removal of alien invasive plant species in order to improve water flow and supply Local capacity development	• Water security • Resource-based income • Community resource management • Ecosystem resilience • Water flow/water quality
South Africa	Maluti-Drakensberg Transfrontier Project Area (KZN)	Department of Water Affairs and Forestry Ezemvelo KZN Wildlife	Framework for co-operation between Lesotho and South Africa Conservation, sustainable resource use, and land-use and development planning.	• Ecosystem resilience • Water flow/water quality • Water security • Mitigation • Resource-based income
South Africa	Working for Wetlands	Department of Water Affairs and Forestry	Removal of alien invasive plant species in order to improve water flow and supply Local capacity development	• Water security • Community resource management • Ecosystem resilience • Water quality
South Africa **Limpopo Province, Loskop dam catchment**	Blue Ridge Mine	Department of Water Affairs and Forestry	WfW to remove alien invasive plant species in order to improve water flow and supply to the mine	
Tanzania (Pangani River Basin)	IUCN – Water and Nature Initiative (IUCN - WANI)	International Union for the Conservation of Nature Pangani Water Basin Office (PWBO)	Equitable, efficient and sustainable wetland management (teaching, dissemination and application of environmental economic techniques, i.e. valuation and assessment of water resources) Conserving water basin quality and quantity Conserve catchment river banks (planting of trees and other measures to control erosion)	• Food security • Water security • Energy security • Water flow/water quality • Resource-based income • Conflict resolution • Ecosystem resilience • Sustainable agriculture • Community resource management

Tanzania **Ruvu and Sigi River basin**	Equitable Payment for Watershed services programme	CARE WWF The International Institute for Environment and Development (IIED)	Reforestation along river banks Soil erosion control measures Re-location of farms illegally encroaching on stream banks Reduce the sediment load Adoption of methods for improved soil management	• Sustainable agriculture • Community resource management • Water flow/water quality • Ecosystem resilience
Zimbabwe	The Zimuto_Mshagashe integrated catchment rehabilitation and sustainable development project		Wetlands rehabilitation and conservation Integration of conservation measures with livelihood activities such as the integration of agroforestry activities in farming systems for soil fertility and erosion control	• Sustainable agriculture • Water flow • Community resource management
Bundled services				
Tanzania **Tanga, Morogoro, Kilimanjaro and Arusha Regions**	Community-based forest management	Tanzania Forest Conservation Group (TFCG) Wildlife Conservation Society of Tanzania (WCST) CARE WWF Africare Maendeleo Endelevu ya Mazingira (Sustainable Development for Conservation) (MEMA)	Monitor and maintain the forest Patrolling, reporting and sanctioning illegal activities Government foresters play a facilitating role as coordinators and technical advisors	• Market incentive • Resource-based income • Community resource management • Forest management • Natural resource use

Acronyms and abbreviations

BNR	Baviaanskloof Nature Reserve
CBA	Community-based adaptation
CBD	United Nations Convention on Biological Diversity
CBNRM	Community-based Natural Resource Management
CCS	Climate integrated conservation strategies
CO_2	Carbon dioxide
CRES	Compensation and Reward for Ecosystem Services
CVM	Contingency Valuation Method
DFID	Department for International Development UK
DWA	South African Department of Water Affairs
EbA	Ecosystem-based adaptation
ENSO	El Niño Southern Oscillation
EPWP	Expanded Public Works Programme (South Africa)
ERC	Ecological Restoration Capital
ES	Ecosystem services
EU ETS	European Union Emissions Trading System
GCM	Global Circulation Model
IDP	Integrated Development Plan
ILK	Indigenous and local knowledge
IPBES	Intergovernmental Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Inter-tropical Convergence Zone
MCA	Multi-criteria analysis
MDGs	Millennium Development Goals
MEA	Millennium Ecosystem Assessment
NTFD	Non timber forest developments
NWP	Nairobi Work Programme (on adaptation)
PES	Payment for ecosystem services
RCCP	Regional Climate Change Programme for southern Africa
REDD+	Reducing emissions from deforestation and forest degradation, including forest restoration, rehabilitation, sustainable management and/or afforestation
SADC	Southern African Development Community
SDF	Spatial Development Framework
STRP	Subtropical Thicket Restoration Project
TEV	Total economic value
UNFCCC	United Nations Framework Convention on Climate Change
VCS	Voluntary carbon standard
WfW	Working-for-Water Programme
WRUA	Water Resources User Association (Naivasha project in Kenya)
WTP	Willingness to pay

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