Consortium on Ecosystems and Poverty in Sub-Saharan Africa (CEPSA)

Links between Ecosystem Services and Poverty Alleviation:

Situation analysis for arid and semi-arid lands in southern Africa

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EXECUTIVE SUMMARY

I. Aim and objectives

This report presents the findings of a situation analysis, covering the arid and semi-arid lands of southern Africa, presenting evidence of the links between ecosystem services and human well-being, and especially the opportunities for poverty alleviation through the provision and management of ecosystem services. It was conducted between late September 2007 and January 2008. The specific requirements were to:

- provide *evidence* of the importance of ecosystem services for human well-being, especially in terms of poverty alleviation, and beyond just provisioning services;
- explore the *linkages* between ecosystem services and poverty (including vulnerability) and the factors that influence these linkages (such as drivers of ecosystem change and trade-offs);
- identify *knowledge gaps* that would need to be filled through a longer term research and advocacy programme, so that appropriate policy and management interventions could be implemented to prevent and reverse poverty through sound ecosystem manage-ment; and
- identify strengths and weaknesses in *management capacity* in the region for ecosystems and their services.

In meeting this brief it was recognised that there are many seminal works investigating poverty/development and natural resource use, but relatively few are situated within an ecosystem services paradigm. Secondly, the links between the two are complex, frequently non-linear, and are spatially and temporally variable. Such complexity requires innovative analytical frameworks, but also at times, of necessity, simplification and examination of individual components in isolation. These can then be integrated once the basic building blocks are understood and synergies and scenarios examined. Consequently, the focus areas of the situation analysis were divided into six key questions for ease of analysis and communication, but the reader needs to be constantly aware that they are intimately linked, and dealing with them sequentially at times trivialises the inherent complexity.

- Which ecosystems services are important, and in what way, for the well-being of the poor?
- What are recent trends in the supply of these ecosystem services?
- What factors are driving such trends?
- What knowledge gaps exist that limit the implementation of policies and practices to manage ecosystems better to contribute to human well-being, especially of the poor?
- What capacity exists in the region to manage ecosystems to optimise benefits to the poor?
- What success stories exist from the region where ecosystems have been managed with poverty alleviation as a key goal?

II. Arid & semi-arid lands of southern Africa

The focus area of the situation analysis was on the arid and semi-arid lands of southern Africa. These were defined as those southern African countries for which at least 50 % of their land area had a ratio of mean annual precipitation to potential evaporation of less than 0.5, namely Botswana, Mozambique, Namibia, South Africa, Swaziland and Zimbabwe.

Across all these selected countries, a broad gradient of decreasing aridity is evident at a sub-continental scale from the west coasts of Namibia and South Africa to the east coast of Mozambique. Across this gradient two major ecoregions are evident. The drier west (including the Karoo, Namib and Kalahari regions) is characterised by deserts and dwarf shrublands. The relatively moister east is dominated by arid and semi-arid savannas. There is a broad transition zone between the two. Although the rainfall is limited and strongly seasonal in both these ecoregions, the lower variation in the moister east and the consequent increasing presence of trees and tree products, means that the major landuse patterns of the two ecoregions differ markedly. The desert and dwarf shrubland ecoregion is used primarily for extensive livestock and wildlife grazing (and mining), whereas the semi-arid savannas are dominated by a mix of commercial and subsistence agriculture and grazing. Human population densities and har-vesting practices increase accordingly. Situat-ed within and cutting across each ecoregion are major rivers and water bodies. These are key resource areas for people and productive activities, and frequently support livelihood activities that differ from the two broad patterns described above. Thus, fishing, ecotourism and more intensive agriculture and grazing are possible along the edges of lakes, dams and rivers. In all three ecoregions, ecosystem services are supplied by intact as well as human-modified environments.

III. Approach

A number of different methods were employed to locate and summarise the data and information for this situation analysis as well as raise awareness in the six countries:

- Preparation of a summary list of all ecosystem services and their categorisation as provisioning, supporting, regulating or cultural. At least one ecosystem service was selected per category for detailed examination, finally being:
  - Provisioning services:
    - Natural products
    - Fuelwood
    - Fodder
    - Water
  - Regulating services
    - Soil fertility
    - Water
  - Cultural services
    - Cultural and spiritual
    - Tourism
  - Supporting
    - Biodiversity
- Desktop synthesis of existing information. Key literature and key informants who could identify less accessible literature and grey reports were identified early on, and consulted. Emphasis was placed on literature from the last ten years, although not exclusively so.
- Within the literature we specifically sought data and information that provided *evidence* of the links between ecosystem services and the poor.
- In-depth, location specific case studies that integrated several of the core aspects were identified and then summarised for cross-reference throughout the project.
- Key experts and officials in the six countries were identified early on and then approached. A total of 85 face-to-face meetings were held. These meetings also served to create awareness about the project.

To facilitate integration of the different components, the design of the project and interpretation of the literature was guided by (i) a conceptual framework of the links between ecosystems and poverty drawn from the sustainable livelihoods framework and the Millennium Ecosystem Assessment frame-work, and (ii) a number of central and integrative themes, including:

- Factors driving changes in the capacity of ecosystems to deliver services.
- Evidence of thresholds having been crossed.
- The vulnerability of the poor to changes in the availability of services.
- Trade-offs in policy and management options that affect the supply of different ecosystem services relative to one another.
- The dynamic nature of the relationship between humans and ecosystems.

IV. Methodological challenges

Throughout the process a number of challenges were apparent:

- The project required that at least one ecosystem service was selected per category, i.e. provisioning, supporting, regulating and cultural. However, most work to date in southern Africa has been on provisioning services, and consequently information on the others is relatively sparse.
- The short time frame of the project restricted much of the literature search to readily available literature. In-country consultations with experts were done in parallel, and consequently it was difficult to access and incorporate any literature pointed out by them during the later consultations.
- Of the existing information, relatively little has been captured or reported within a framework that links ecosystems and poverty. Consequently, much of the integration of the two spheres was done by the project team, and at times was intuitive rather than based on the hard evidence required.
- There was a large differential in the volume and availability of literature and information between the six countries covered.
- It was often difficult to differentiate between drivers, trends and interventions. Often all three interact to produce a particular result. Thus, the conceptual framework is less clear-cut than it appears at first glance.

V. Provisioning services

Across the four provisioning services examined, ample evidence was found of their importance in supporting the livelihoods of the poor, and consequently, any restrictions in the supply of these services could lead to increased vulnerability and deepening poverty. The reverse situation was also commonly found, namely poor households using provisioning services for income generation and a means out of poverty. More commonly however, was the use of provisioning services as part of a wider portfolio of livelihood strategies. On average, provisioning services were seen to account for between one-quarter and one-third of household income, although this was variable, being over 50 % for some households and less than 10 % for others. This applies equally across the three broad ecoregions. There are sufficient case studies demonstrating that that the poorer sectors of society make greatest use of provisioning services, both for home consumption and income generation. The safety net function of provisioning services is particularly crucial as a fall-back or insurance during times of unexpected shock or added stress to the usual livelihood activities. Richer households have options to mobilise other assets during such periods, whereas poorer households turn to the natural resource base. This frequently prevents them from falling deeper into poverty. Thus, degradation of local environments undermines the crucial safety net function leaving poor households extremely vulnerable in the event of a shock.

VI. Regulating services

Given that regulating services are not consumed directly nor can be sold to generate income, their role in supporting livelihoods and buffering against poverty is less easily demonstrated than for provisioning services. Their role in local livelihoods is less direct, but the case studies and evidence show that it is as equally important. Because the poor frequently reside in marginalised areas, both in rural and urban localities, they are most susceptible in situations where regulating services are diminished, for example flooding, drought, poor air quality, areas with higher disease incidence, and degraded or exhausted soils. They also lack the resources to adequately address any decline in regulating services, or move away to more amenable sites. That said, they are not passive victims, but employ a number of strategies in an attempt to limit the degree of impact from declining regulating services. But these strategies require time, energy and resources, which at times may be limiting, especially for the poorest. Thus, they are constantly striving to maintain some position of compromise, such as building protections against floods, buying fertiliser or manure to buffer against declining soil fertility, but rarely having sufficient resources to permanently over-come the decline in regulating services. Proper ecosystem management to ensure adequate regulating services does not directly lift the poorest households out of poverty, but it reduces the frequency and severity of shocks to which they are subjected, and hence reduces their vulnerability, allowing them to invest their meagre resources into other livelihood activities with more surety.

VII. Cultural services

There is very limited information from the region pertaining to the use and value of cultural and spiritual services. Consequently, their role in poverty alleviation is largely speculative. There is excellent qualitative information documenting local people's rituals and respect for the environment, and their concerns and fears of the resulting consequences when such services are diminished or lost; but these are seemingly compromised when poverty is at the door forcing people to resort to using culturally important species or sites for food production or sale.

In contrast, the tourism potential of the region is high, and is attracting a growing number of international and domestic tourists for cultural and eco-tourism experiences. Tourism is now within the top three contributors to national GDP for three of the six countries surveyed. Whilst it is clear that often the share of tourism receipts reaching the poor is very small, this has been recognised and attempts are being made to improve the situation. Thus, whilst a few poor households are beneficiaries of tourism developments, most are indirect beneficiaries through revenue and tax flows via government.

VIII. Supporting services

Biodiversity was the only supporting service examined. It is readily apparent that it is a vital foundation for many other services and goods on which many livelihood activities rely, and the poor moreso than the less poor.

Habitat diversity is crucial for supplying the wide range of resources required by rural people. Even more importantly, it provides key resource areas and species for times of ecosystem stress, such as droughts or

disease. Loss of habitat diversity through land transformation and homogenisation reduce the buffering capacity and resilience of ecosys-tems. However, there is no direct evidence, as yet, that loss of habitat diversity unambiguously results in deepening poverty.

With respect to species diversity there is a great deal of information reporting the wide number and diversity of species used by rural and urban populations. Accessibility to these free resources is obviously more important for poorer households than richer ones, and having a diversity of species available adds to local knowledge, nutrition and is an insurance for situations or times when specific species may be in short supply, then alternatives are available. Given the high diversity of species in the region, there is considerable potential for benefit sharing agreements with local communities to exploit biodiversity resources for commercial gain, either in the form of intellectual property rights or cultivation agreements. There are some examples of fledging initiatives in this regard, but the potential currently remains largely untapped, and so their viability as a vehicle for poverty reduction remains unknown.

The loss and erosion of genetic diversity, particularly where poor farmers are concerned, is associated with reduced food security, increased economic uncertainty, increased vulnerability to pests and diseases, reduction in the possibilities for adaptation and for future generations and accelerated loss of local knowledge about diversity. These conseq-uences, and the need for conservation of genetic diversity, are especially critical given the looming threat of climate change, genetically modified crops and the need to build resilience and adaptability.

IX. Drivers of ecosystem change

Numerous drivers of ecosystem change were identified for each of the ecosystem services examined. However, understanding drivers is complex because of the differing spatial and temporal scales, as well as the blurred interface between drivers and reactive policies. At times a policy can be a driver, and at other times it is an intervention to address a specific driver.

It is clear that many drivers are locally specific both in history, nature and/or magnitude. Consequently, any proposed interventions to address negative drivers will need to be based on local contexts. The more ubiquitous drivers across most sites and scales included:

- Rainfall and climate change
- Land transformation
- HIV/AIDS
- Over-use of resources (harvesting, grazing, abstraction)
- Land tenure policies and weakened governance
- National and international policies and processes, and
- Urbanisation and expansion in peri-urban areas

X. Trends in ecosystem services

As was the case with drivers, the trends in ecosystems services at local scales are variable across the different ecoregions and specific localities. However, there is relatively little monitoring of most services or resources, and consequently identification of trends is relatively subjective and at times anecdotal. What is clear, however, is that although the rates and causes of change are open to interpretation, the net general trend at broader scales is negative for most ecosystem services, other than tourism. But there are many local exceptions to this general trend. Given the evidence presented that some ecosystem services are particularly crucial for the poorer sectors of society, this net negative trend needs to be viewed with concern. The decline in water quality and quantity is particularly disquieting, which is likely to be exacerbated by climate change.

Although explicitly sought, there is almost no evidence of thresholds of ecosystem change having been crossed, except in areas exper-iencing bush-encroachment, alien species infestations, loss of aquatic biodiversity, and over-grazing which has resulted in loss of perennial species. However, it remains unclear whether the absence of such evidence is because (i) thresholds have not been crossed, or rather (ii) that no previous research in the region has tried to identify them and thus there is no literature on which we could draw.

XI. Management interventions

There are several examples from the region of management interventions that have succeeded, to some extent, in consciously promoting simultaneous benefits between ecosystem restoration or improvement and poverty alleviation. However, the more common situation encountered was a sectoral approach in which interventions or programmes focus on one or the other, i.e. poverty alleviation or ecosystem management, and any overlap is fortuitous rather than by design. This is particularly so with poverty alleviation programmes, which very rarely have any consideration of their environmental impacts (either positive or negative). It was also noted that monitoring of the impacts (either poverty or ecosystem attributes) of interventions was particularly weak, consequently hindering any meaningful evaluation of their relative strengths and weaknesses to help design future interventions.

A core aspect of management interventions is dealing with trade-offs. Frequently the trade-offs have not been recognised or dealt with. There is a dire need for appropriate tools, that are usable at all levels of decision-making, to help identify trade-offs and then make defensible decisions with that knowledge.

XII. Capacity gaps

Capacity gaps existed in all countries at different levels. A lack of critical mass in human resources capacity was evident in Botswana, Namibia and Swaziland, probably a reflection of their small population sizes. This does not mean they lack successful program-mes, but more that they have limited capacity to take on new programmes or react to evolving international or regional trends and ideas. The local pools of scientific expertise are particularly small in these countries, resulting in much research being conducted by outside agencies, especially international ones. This is especially problematic regarding monitoring of ecosystem services and of specific programmes. The civil unrest in Zimbabwe over the last decade has resulted in an exodus of many skilled and experienced officials and scientists. Furthermore, the economic crisis has meant that those remaining are incapacitated by the lack of operating budgets, and demotivated by insecure futures and payment structures. Several themes under capacity gaps are discussed, including:

- Improving policy and institutional environ-ment
- Need for greater high-level awareness, understanding and commitment
- Limitations of the skills base
- Capacity at district and local level
- Lack of integrated planning and management
- Capacity in civil society
- Capacity for monitoring
- Lack of action on climate change
- Capacity to manage selected ecosystem services for poverty alleviation.

XIII. Research gaps and priorities

Any situation analysis covering several quest-ions, six countries and multiple ecosystem services will be able to identify numerous research needs and implementation gaps. However, we focussed on those relating to the interface between poverty alleviation and ecosystem services. Twenty-six gaps or research areas were identified, categorised into four themes, namely:

- Establishing an integrated and compre-hensive picture
- Developing appropriate methodologies/ approaches
- Institutional and governance issues
- Biodiversity as the key underlying supporting service.

XIV. Communication & outreach strategies

If research is to be effective it needs to be translated into appropriate policy and management knowledge, which then needs to be communicated (in appropriate form) to the relevant stakeholders so that the necessary actions can be taken. Key ingredients of a communication strategy include:

- Demand led research
- A ‘political’ champion
- A long-term vision
- A dedicated communication strategy and budget.
- Repeated messages
- Ownership and a sense of pride in the project by local people and officials.

- Participatory research
- Significant scale
- Cross-disciplinary communication
- Make ideas real
- Understand the context
- Local language
- Clear messages to land managers and planners

XV. Concluding statements

The most important overarching conclusions (in no specific order) include:

- Investments in managing and securing ecosystem services alone will not eradicate poverty. It needs to be part, but a significant part, of broader poverty alleviation initiatives.
- There is inadequate consideration of poverty alleviation issues by ecosystem management agencies, and there is practically no consideration of ecosystem resources and impacts by social welfare or economic development agencies (other than tourism projects).
- Provisioning services are a significant component of diversified livelihood portfolios, both for home consumption and income generation. Poverty alleviation initiatives need to build on the inherent diversity of rural livelihoods rather than constrain it, through promoting a diversity of options, of which provisioning services should be seen as only one component of a suite of options.
- Unlike most poverty programmes and interventions, ecosystem services are pervasive at all spatial and temporal scales. Consequently, support and management for delivery of ecosystem services will benefit all inhabitants of the region, including the poor. Since the poor are more directly reliant on ecosystem services for a larger share of their livelihoods, then an investment in securing ecosystem services will be of greater benefit to them than other sectors.
- There is growing evidence in the region and internationally that land use practices promoting multiple use and sustainable use of resources usually have an equivalent or greater return than converted landscapes when all costs and benefits are accounted for. Thus, unsustainable uses, or intensive production of single resources without quantifying the trade-offs on other services frequently cannot be defended in economic terms.
- As human well-being diminishes there tends to be a concomitant increase in immediate dependence on ecosystem services. The resultant increased pressure often has a negative feedback on the capacity of the ecosystems to deliver services. This can create a downward spiral of increasing poverty and ecosystem degradation.
- Analysis of the drivers of change in ecosystem state is complex because of the temporal and spatial variation, as well as in relation to the scale of analysis. Nonetheless, in most instances there have been large changes, with the net direction of change being negative (other than for tourism). In other words, ecosystem services are being compromised on a wide scale and to a significant extent.
- Local projects to secure ecosystem services can certainly be useful, but the functional scale of ecosystems and their drivers is typically at larger spatial and temporal scales than at which such projects operate. Consequently, better management and appreciation of ecosys-tem services and their role in alleviating poverty will be best achieved by interventions at the policy level, that serve to change the understanding, attitudes and values that policy-makers, planners and land managers have towards ecosystem services. Participatory Poverty Assess-ments as well as national Poverty Reduction Strategy Papers need to explicitly include environmental compo-nents. Local experts stated that poverty alleviation programmes or projects rarely consider environmental dimensions. The importance and value of ecosystem services needs to be mainstreamed into planning and decision-making processes.
- The poor are at the mercy of many external drivers and trends, including those impacting the delivery of ecosystem services, against which they are relatively powerless. Therefore, policies and interventions need to support and build the capacity of the poor to adapt and create and build their own opportunities, rather than imposing external prescriptions or uni-dimensional opportunities.
- HIV/AIDS is a major scourge that is devastating the region especially through the way it drains household assets and resources, and consequently deepening poverty. It is also undermining ecosystem management through loss of skilled people and managers, and increasing short-term exploitation of environmental resources. The effects will be felt for decades, if not millennia. Robust, comprehensive and extensive interven-tions are required immediately throughout the region based on shared knowledge and practice from the successful programmes in the region.

- Whilst all ecosystem services are important to a greater or lesser extent, water is a particularly important ecosystem service in arid and semi-arid areas. Yet projections indicate that several districts and countries in the region will be severely water stressed within two or three decades. The poor are already at the forefront, having least access to bulk water supplies, and are most prone to water-borne diseases. Dams and redistribution of water from areas of higher rainfall serve to delay the onset of local shortages, but not without impacts on other ecosystem services. Consequently, there is an immediate and pressing need for comprehensive and extensive interven-tions to increase water use efficiencies, recycling and rainwater harvesting to reduce absolute demands per capita and per unit of production.
- The bulk of information pertains to rural environments. There is a significant dearth of information on environmental services generated in urban environments and consumed by urban residents. This presents a potentially dangerous miscon-ception that urban communities can exist relatively independent of ecosystem services other than water and food from surrounding areas.
- Trade-offs are inevitable in all decisions, at all scales, pertaining to land use, develop-ment and ecosystem services. Future programmes need to arm decision-makers (at all scales) with the information, knowledge and skills to make informed decisions based on an awareness and analysis of such trade-offs.
- The capacity to manage ecosystem services varies from country to country, region to region, and for specific services. However, other than for water as a provisioning service, there is a perception in most countries that national budgets should focus on infrastructure develop-ment and social services. The share of national budgets allocated to ecosystem management functions is pitifully small because national decision-makers have not been made aware of the value of ecosystem services (in both financial and non-financial terms) in supporting all human endeavours and in supporting the poor. Consequently, as a very generalised assessment, insufficient budget is avail-able for capacity development and maintenance of that capacity.
- There is an inadequate understanding and appreciation of the importance and value of ecosystem services, even provisioning ones, on behalf of planners, beaurocrats and policy makers, resulting in many avoidable negative trade-offs. Conse-quently, there is an urgent need for better research and communication of that research to these agencies.

1. INTRODUCTION AND AIMS

1.1 BACKGROUND

Humans have always depended upon natural ecosystems to supply a range of services useful for their survival and well-being. However, with widespread urbanisation, modernisation, and globalisation, along with the primacy of capitalist economic models, the obvious reliance of humans on ecosystems has become diluted for many, and difficult to maintain for others. The importance of ecosystems in providing the services that underpin every single productive and spiritual activity of humankind has been suppressed in the consciousness of many, and so ecosystems are mismanaged, abused and degraded. So too, the struggle for daily survival of others, many of whom may have a keen appreciation of the importance of ecosystem services in their everyday lives, means that they have to make constant short-term trade-offs between the environment and their next meal. If these trends persist, the spiritual and material well-being and survival of humankind is at risk. Because of the disproportionally greater direct reliance of the world's poor on ecosystem services, and their reduced capacity to compensate when ecosystems services are impaired, they are most at risk and in shorter time-scales (WRI 2005).

Yet the world has committed itself to fighting poverty, most frequently articulated via the Millennium Development Goals (MDGs), but not restricted to them. Governments across the world have policies and protocols, strategies and plans, and targets and projects to reduce poverty. But relatively few explicitly acknowledge the relationship between human well-being and ecosystem services, or include it in their policies, plans and protocols.

The Millennium Ecosystem Assessment (MA 2005a) made huge contributions in documenting, communicating and developing understanding of the importance of ecosystem services to human well-being. It spanned a range of ecosystem services, in multiple regions, and at different scales. It communicated findings to policy-makers and international agencies, and identified gaps in understanding that need to be addressed. It made a call for international effort to develop further understanding, but also to act on that understanding.

Whilst the MA was a landmark international effort, it cannot stop at just the presentation of the final report to decision-makers in international agencies and national governments. The future and well-being of humankind requires that the links between ecosystem services and the well-being of humans is understood better, the message communicated more loudly, mainstreamed into decision-making, and the policies and actions implemented more soundly, especially with respect to addressing global poverty. Achievement of all of the Millennium Development Goals to diminish global poverty depends upon environmental sustainability and strategies to assure the supply of ecosystem services. Whilst re-conscientising researchers and decision-makers to the links between ecosystem services and human well-being, the MA's focus was broader than just poverty alleviation; namely how are the poor affected by a decline in specific ecosystem services?, what trade-offs specifically disadvantage the poor?, how is the supply of ecosystem services affected by poverty? and what opportunities exist to alleviate poverty through better ecosystem management?

Because of the pressing need to build on the successes of the MA, three research and aid agencies in the United Kingdom (the Department for International Development, the Natural Environment Research Council and the Economic and Social Science Research Council) recognised the need to develop further understanding in this context with a specific focus on (i) poverty alleviation, and (ii) a greater range of ecosystem services beyond just provisioning ones. They consequently combined together to fund six situation analyses internationally which could be used to motivate for and inform the design of large and longer-term strategic investment in research and advocacy around the links between ecosystem services and strategies for poverty alleviation, especially in developing regions. Within this project, a situation analysis is taken to

be the gathering and evaluation of information to identify the target group and strategic direction of a programme (www.toolkit.centres.ngfl.gov.uk).

One of the six regions selected was the arid and semi-arid lands of sub-Saharan Africa because of its unique susceptibility to environmental and climate change and current high levels of poverty. This report presents the findings of the situation analysis conducted between late September 2007 and January 2008. For convenience, the project domain, i.e. sub-Saharan Africa, was divided into three sub-regions, viz. west, east and southern Africa. This situation analysis pertains to the southern African region. The specific requirements were to:

- provide *evidence* of the importance of ecosystem services for human well-being, especially in terms of poverty alleviation, and beyond just provisioning services. If such evidence is available it will provide a solid platform with which to engage decision-makers to design and implement policies that halt and reverse ecosystem degradation and transformation. In other words, an investment in ecosystem management could then be construed as the same as implementing a poverty alleviation programme;
- explore the *linkages* between ecosystem services and poverty (including vulnerability) and the factors (such as drivers of ecosystem change and trade-offs) that influence these linkages;
- identify *knowledge gaps* that would need to be filled through a longer term research and advocacy programme, so that appropriate policy and management interventions could be implemented to prevent and reverse poverty through sound ecosystem management; and
- identify strengths and weaknesses in *management capacity* for ecosystems and their services.

In meeting this aim two challenges need to be appreciated. Firstly, other than the Southern African Millennium Ecosystem Assessment (2003), there is limited research in southern Africa that has explicitly examined the links between ecosystem services and poverty alleviation within the contextual framework of complex socio-ecological systems as prompted by the MA. Indeed, this also applies internationally, with Dasgupta *et al*. (2005) lamenting the paucity of robust empirical studies rather than conjecture and commentary. There are many seminal works investigating poverty/development and natural resources (for example the literature on CBNRM), but relatively few are situated within an ecosystem services paradigm. Thus, the project team was constantly tasked with building the conceptual links between ecosystem services and poverty based on either information that was often designed and written or presented in a unidisciplinary fashion, i.e. with either a poverty focus or an ecosystem focus, or that covered only some aspects of human-environment interactions. Secondly, the links between the two are complex, frequently non-linear, and are spatially and temporally variable. Such complexity requires innovative analytical frameworks, but also at times, of necessity, simplification and examination of individual components in isolation (but with the risk of contrasting results (Dasgupta *et al*. 2005). These can then be integrated once the basic building blocks are understood and synergies and scenarios examined. Consequently, the focus areas of the situation analysis were divided into six key questions for ease of analysis and communication, but the reader needs to be constantly aware that they are intimately linked, and dealing with them sequentially at times trivialises the inherent complexity.

- Which ecosystems services are important, and in what way, for the well-being of the poor?
- What are recent trends in the supply of these ecosystems services?
- What factors are driving such trends?
- What knowledge gaps exist that limit the implementation of policies and practices to manage ecosystems better to contribute to human well-being, especially of the poor?
- What capacity exists in the region to manage ecosystems to optimize benefits to the poor?
- What success stories exist from the region where ecosystems have been managed with poverty alleviation as a key goal?

1.2 DEFINITIONS AND CONCEPTS

1.2.1 Poverty and well-being

Understanding what is means to be poor, and how poverty and well-being are defined, is crucial to interpreting and analysing how ecosystem services can play a role in combating poverty. In this situation analysis we use a multidimensional, all-encompassing notion of poverty/well-being that takes particular cognisance of issues of vulnerability and risk.

Poverty, in its broadest sense, is seen as the pronounced deprivation of well-being related to a lack of material income or consumption (the conventional measures of poverty), low levels of education and health, poor nutrition and low food security, high levels of vulnerability and exposure to risk, and a profound lack of opportunity to be heard (Chambers 1988, World Bank 2000, Sunderlin *et al.* 2004). The inability of the poor to give voice to their needs can be related to their powerlessness within existing social, economic, political and cultural structures (Chambers 1988, Sen 1999). May *et al.* (1998), in writing about poverty in South Africa, define it simply as "the inability of individuals, households or entire communities to command sufficient resources to satisfy socially acceptable minimum standards of living". Both definitions recognise that poor people's concerns go beyond just adequate income to include aspects of security, capability, independence, choice, health and well-being, and the ability to devise appropriate coping strategies when faced with shocks and crises.

Participatory poverty assessments internationally have revealed how poor people perceive alienation from the community, food insecurity, crowded homes, the use of unsafe forms of energy, and fragmentation of the family as critical dimensions of poverty, additional to a lack of material needs and income (May *et al.* 1998). Other participatory studies have shown that being poor often means suffering sickness, chronic pain and exhaustion; enduring difficult social relations; having little access to information; living in dangerous and degraded environments; being vulnerable to violence and natural disasters; not knowing how to cope with crises; being dependent on what the immediate environment can supply; and suffering numerous forms of psychological stress (WRI 2005). In addition, there are a diversity of social and spatial considerations which further complicate our understanding of poverty. At one level there is the obvious difference between rural and urban areas, in terms of which the cost of living in rural areas should be less than in urban areas and there should be access to natural and subsistence products which are difficult to quantify. By contrast, in urban areas easier access to social services and poverty relief creates an urban advantage. Other issues which complicate the matter include what are often stark gender differences and the reality that averaged statistics often mask what can be extremes of wealth and poverty in a country, district or community.

The concept of human well-being is often used as an alternative for poverty because of its multidimensional nature and that fact that, despite the above understanding, poverty is still often described, viewed and measured in narrow income and consumption terms (Kingdon & Knight 2003). In particular, recent studies designed specifically to explore the links between ecosystems and the welfare of the poor have focussed on various constituents or determinants of human well-being (Table 1). These constituents essentially capture the same broad elements of human welfare as discussed above – with poverty basically being the lack of adequate access to these constituents thus preventing full participation in the economic and social spheres (DEAT 2006). The UNEP/ISSD (2004) list of determinants of well-being was conceptualised with particular reference to the benefits that poor people derive from ecosystem services and makes a deliberate effort to include Sen's notion of capabilities. There is a large degree of complementarity between all the constituents listed (e.g. access to clean water will also contribute to the ability to be free from disease), such that addressing one constituent is likely to provide synergies to achieving others (UNEP/IISD 2004).

Table 1: Concepts and constituents of human well-being (conversely poverty can be defined as a lack of adequate access to these constituents)

Instrumental freedoms of Sen's capabilities approach (Sen 1999)	**Millennium Ecosystem Assessment (MA 2005a)**	**Human well-being, poverty and ecosystem services: Exploring the links (UNEP/IISD 2004)**
▪ Participative freedom - ability to participate in decisions through such institutions as free speech and democratic elections ▪ Protective security - safety nets against adverse effects of disasters ▪ Economic facilities - ability to participate in trade and production ▪ Social opportunities - ability to access education and health services ▪ Transparency guarantees - culture of openness and trust	▪ Material minimum for a good life (adequate livelihoods, sufficient food, shelter, access to goods) ▪ Health (strength, feeling well, access to clean air and water) ▪ Good social relations (social cohesion, mutual respect, ability to help others) ▪ Security (personal safety, secure resource access, security from disasters) ▪ Freedom and choice (opportunity to be able to achieve what an individual values doing and being)	▪ Ability to be nourished ▪ Ability to be free from avoidable disease ▪ Ability to make a livelihood ▪ Ability to live in an environmentally safe shelter ▪ Ability to access adequate clean water ▪ Ability to have clean air ▪ Ability to have energy to keep warm and cook ▪ Ability to use traditional medicine ▪ Ability to continue using natural elements found in ecosystems for traditional spiritual and cultural purposes ▪ Ability to cope with extreme natural events ▪ Ability to make sustainable management decisions that respect natural resources and enable the achievement of a sustainable income stream

1.2.2 Risk and vulnerability

Vulnerability is a critical dimension of poverty that seldom receives adequate attention (World Bank 2000, Aliber 2003). Vulnerability, as a concept, encompasses aspects of both exposure to risk (harmful livelihood impacts) and the lack of capacity or capability to respond to its consequences (Wiegers *et al*. 2006), and is both a condition and determinant of poverty (IUCN *et al.* 2003). Vulnerability is, thus, of particular relevance for this situation analysis, as people living in drylands have a disproportionately higher exposure to risk and uncertainty (due to climatic extremes), and demonstrate a greater dependence on ecosystem services for their needs, than other ecosystems (MA 2005b). Furthermore, southern Africa, in particular Botswana and South Africa, has the highest rates of HIV/AIDS infection in the world (UN AIDS 2007). In South Africa it is believed that HIV/AIDS will contribute of the chronic impoverishment of 26-33 % more households than would be the case in its absence (Aliber 2003).

Living with risk is a part of daily life for poor people. The poor tend to be the most vulnerable in society because they face the widest array of risk and insecurities and lack the assets, savings, insurance and alternative options/choices necessary to deal with shocks and crises when they arise. Vulnerability essentially measures resilience against shock, i.e. the ability to avoid or cope with crises, and the likelihood that shock will result in a decline in well-being or a deepening of poverty (World Bank 2000). For the very poor and vulnerable, a shock can send them on a downward spiral into deeper poverty that becomes increasingly difficult to escape. More resilient individuals and households will have the ability to avoid adverse impacts on their well-being or recover more quickly. Vulnerability and resilience levels differ within and amongst households, and certain groups of poor people or households tend to be more vulnerable than others, for example women and the elderly, and HIV-affected households (Wiegers *et al*. 2006). Similarly, households in particular geographic locations or socio-economic contexts may be more vulnerable than others due to differential exposure to risk and the presence or absence of social support systems and other safety nets and fall-back options such as access to freely available wild resources or the ability to migrate. The risks, shocks and adverse trends and events that poor people face can relate to external or internal factors including environmental hazards and extreme events, climatic uncertainty and drought, environmental change, disease, death and illness within the family, job loss, social disruption and war, oppressive political systems, etc.

Ecosystem services are essential in mitigating against risk and vulnerability and building resilience, while changes in these may result in increased exposure to risk and consequently greater vulnerability.

1.2.3 Indicators and measures of poverty and well-being

The poverty line is one of the primary measures of income poverty and refers to the income required to meet minimum household consumption requirements, and may be expressed on a per person or per household basis (Hunter *et al.* 2003, World Bank 2004). There is much debate, which cannot be entered into here, about how to derive an appropriate poverty line. The poverty line varies from country to country, with the Millennium Development Goals (MDGs) using US$1 and US$2 per person per day in 1993 Purchasing Power Parity terms as the minimum global standard (World Bank 2000b, UNDP South Africa 2003). Households can be said to have been 'lifted out of poverty' if their incomes climb above this pre-defined poverty line (Angelson & Wunder 2003, Meth & Dias 2004). The Gini Coefficient helps provide an indication of wealth distribution in a society and by implication the degree to which significant sections of a population live in poverty (Potter *et al.* 2004, Willis 2005, Table 2). Standardised measures such as the Human Development Index (HDI) provide a more comprehensive picture of human well-being by incorporating a range of variables, which if absent or only available at low levels, detract from overall quality of life, locking people into poverty (Potter *et al.* 2004). In terms of developing a more balanced understanding of what poverty is and how to measure it, the UNDP developed the Human Poverty Index (HPI): one for OECD countries and one for developing countries. The measures used in the index are: the probability of not surviving to the age of 40; the adult literacy rate; the percentages of the population without access to treated water supplies; and the percentage of the population under five who are underweight (Willis 2005).

Table 2: Comparison of the six study area countries in terms of key indicators of poverty (Source: UNDP 2006)

Country	HDI Score	HDI Rank /177	HPI % pop	HPI Rank /102	%>$1/day
Botswana	0.570	131	48.3	93	23.5
Mozambique	0.390	168	48.9	94	37.8
Namibia	0.626	125	32.5	57	34.9
South Africa	0.653	121	30.9	53	10.7
Swaziland	0.500	146	52.5	97	23.5
Zimbabwe	0.491	151	46.0	88	56.1

1.2.4 Ecosystem services

Box 1: What are ecosystem services? (Daily 1997)

"Ecosystem services are the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfil human life. They maintain biodiversity and the production of ecosystem goods such as seafood, forage, timber, biomass fuels, natural fibre and many pharmaceutical, industrial products and their precursors. In addition to the production of goods, ecosystem services are the actual life supporting functions, such as cleansing, recycling and renewal, and they confer many intangible, aesthetic and cultural benefits as well."

Ecosystem services are the range of benefits that people obtain from ecosystems (Biggs *et al*. 2004, Box 1). These are more than just goods, but include critical buffering, regulating and life-supporting services or processes, which are commonly forgotten or taken for granted by society. Ecosystems also provide less tangible benefits such as recreational, aesthetic, cultural and spiritual values that are important in fulfilling people's emotional and psychological needs (UNEP/IISD 2004). Whilst Box 1 refers specifically to natural ecosystems, ecosystem services are also produced by modified, agricultural and urban ecosystems, albeit with particular trade-offs between specific services (see section 1.2.5).

In this situation analysis, we have adopted the MA (2005a) typology of ecosystem services (Table 3), which includes (Appendix 1 provides a comprehensive list of these services):

- provisioning services (products/goods obtained from ecosystems)
- regulating services (benefits obtained from regulation of ecosystem processes/buffering capacity of ecosystem services)
- cultural services (non-material and enriching benefits), and
- supporting services (services necessary for the production and delivery of other ecosystem services).

Table 3: Classification of ecosystems services

Type of service	Examples
Provisioning	▪ Fodder ▪ Fuelwood ▪ Natural resource products and foods ▪ Water
Cultural	▪ Spiritual and social ▪ Recreation & tourism
Regulating	▪ Water regulation & flood control ▪ Drought mitigation
Supporting	▪ Biodiversity ▪ Maintenance of soil fertility

Some services, such as biodiversity, can fit into more than one category. Biodiversity is a necessary condition for ecosystems to function and thus can be classified as a supporting service (UNEP-WCMC 2007). But, in many instances, it is also listed as a provisioning service, since the diversity of species that make up 'biodiversity' supply a wide range of important natural products (crops, wild foods, building materials, etc.) and genetic resources (land races, varieties, etc.), while the maintenance of biodiversity, particularly at a landscape level, can be thought of as a regulating service. Biodiversity is also often classified as a cultural service because of its importance for nature-based tourism, and traditional cultural beliefs.

Many services across categories are also closely linked and interdependent, for example the provision of clean water depends on the water purification service provided by wetlands. Indeed, many provisioning services are highly influenced by the state of regulating services. The reverse is also true, in that overexploitation of ecosystem goods (provisioning services) can have negative impacts on the regulating services that maintain water, soil and air quality. This makes it difficult to discuss and assess the importance of any single service in isolation from others. Furthermore, because of the links that exist between services, actions directed at improving one service often have synergistic effects on other services, e.g. the protection of natural forests for biodiversity can also reduce carbon emissions and regulate water supply (MA 2005a).

In terms of making the conceptual link between ecosystem services and poverty (or well-being) more work has been done on provisioning services than any of the other categories (see Appendix 2, Case Study 7 for an illustration of this). This is probably because provisioning services are more obvious in their role in assisting poor people meet their immediate everyday needs for food, energy, shelter and income (Appendix 2 - Case Study, in-country consultations). Regulating, supporting and cultural services, on the other hand, are more indirect in their benefits and consequently have rarely been valued in terms of their contribution to society and to poverty reduction. Cultural services, in particular, are seldom considered, and were rarely mentioned during the in-country consultations process.

1.2.5 Trade-offs

Trade-offs between ecosystem services are common (also see Section 4.4 - interventions), and probably represent one of the most challenging areas when considering the links between services and poverty reduction. For example, the conversion of natural vegetation to arable land to expand food production, often one of the most immediate needs of poor people, may result in the loss or decline in a number of other ecosystem services related to biodiversity and land cover. The building of a dam for water storage may increase the supply of fresh water, but could disrupt some of the hydrological processes necessary for a healthy river, as well as flood productive lands and cultural sites. The common practice of burning rangelands to provide an early flush of nutritious forage compromises the supply of other goods such as thatch grass or some medicinal plants. It has been argued that we have not yet begun to fully understand the implications of these trade-offs, in particular their impacts on regulating and supporting services and how these changes might impinge on poverty (UNEP-WCMC 2007, Appendix 2 - Case Study 1). Often the effects of trade-offs are expressed in areas distant from the original site or may be displaced in time and so are not immediately obvious (MA 2005a). Furthermore, the poor are often 'losers' in the trade-off process, particularly where areas are converted to commercial activities (UNEP/ISSD 2004), because they lack the power to oppose them.

Trade-offs typically come about when trying to harness, regulate or increase the supply of one or two services specifically, which potentially diminishes the supply of others. As the magnitude of the potential benefits from habitat transformation increase, so does the magnitude of the potential trade-offs. However, since most ecosystem services are currently not accounted for in conventional accounting and cost-benefit analysis of development, there is inadequate information to objectively weigh up the choices associated with particular trade-offs resulting from land management or transformation options.

Trade-offs need not always be negative, but do require (i) recognition, (ii) appraisal and (iii) management to enhance the positive dimensions and limit the negative ones. Many human activities can enhance the supply of targeted ecosystem services or reduce their variability, so that the total volume of services supplied is improved, even though some might experience an acceptable reduction. But if the magnitude of change or regulation in a target service results in large-scale reduction in one or critical services for that region it will have negative impacts elsewhere in the system, either in time or space, which may in time undermine the efforts to manage or regulate the key service in mind. For example, large-scale agriculture optimises the supply of food, a beneficial service. But if the agricultural activities are carried out in a manner that diminishes soil fertility, water infiltration and pollination services, the long-term sustainability of the agriculture itself is in jeopardy. Another example might be the development of tourism enterprises or homesteads along coastal areas of high aesthetic appeal. But if the development is at the expense of the coastal vegetation, the buffering capacity against disaster from storm fuelled high tides from storms is diminished and ultimately threatens the very development.

1.2.6 Drivers

Biggs *et al*. (2004) define a driver as any factor that can change the structure and/or function of an ecosystem. These changes may in turn lead to reductions in biodiversity and ecosystem services, with major adverse implications for human well-being. Drivers can operate at all scales from local to global depending upon how widespread they are and at what level they can be addressed (Table 4).

The changes in ecosystem structure or function may be either positive or negative, i.e. some drivers serve to increase ecosystem services (or a single one) whilst others lead to a decrease. This is also dependent upon the state of the ecosystem. Drivers of change in largely unimpacted ecosystems are usually negative for several ecosystem services. Drivers of change in an already degraded ecosystem may act to degrade it further, or to reverse previous degradation.

Table 4: Classification of scale of driver relative to how common/widespread it is and the ability of local communities to address it

		Ability of local communities to change it	
		Low	High
Global pervasiveness of the driver	Low	Regional driver	Local driver
	High	Global driver	Local driver

Additionally, drivers can be direct or indirect (Figs 1 and 2). Direct drivers cause direct changes in ecosystem services whereas indirect drivers exert their influence by affecting direct drivers. The drivers are further classified into endogenous and exogenous. Endogenous drivers are within the control of policy makers while exogenous drivers are outside their control (MA 2003). Direct drivers include climate change, species introductions and removals, changes in land use, external inputs, technology adaptation and use, harvest and resource consumption, and natural, physical and biological agents or events (MA 2005a). Indirect drivers are usually complex, long-term and anthropogenic in origin (Nelson *et al*. 2006). Interactions between direct and indirect drivers often result in unpredictable changes in ecosystem services.

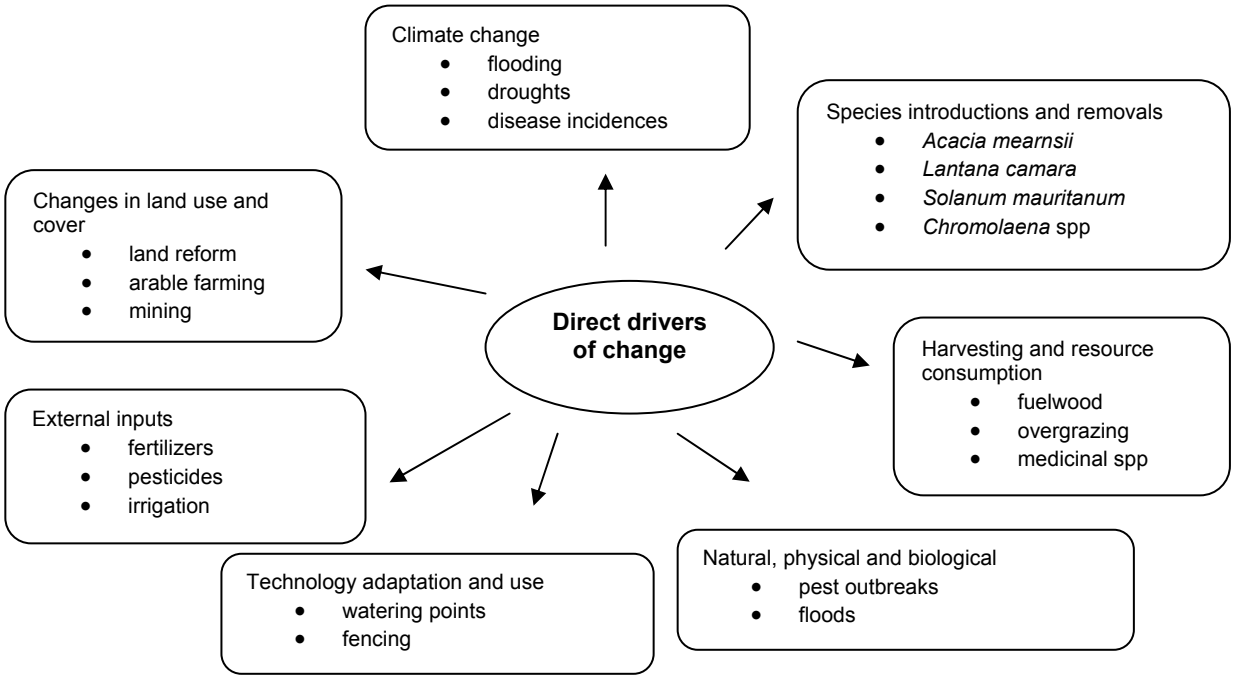

Figure 1: Examples of global direct drivers influencing ecosystem changes (adapted from MA 2005a)

Changes in ecosystems and thus ecosystem services often result from interactions among drivers across space, time and levels of biological organisation. Nelson *et al*. (2006) give examples of these interactions that result in unpredictable and non-linear changes in ecosystem services. An example of interactions among drivers in southern Africa is the practice of assisting poor farmers after severe droughts. Many governments in the region usually assist poor small-scale farmers to re-stock after severe droughts such as the one that occurred in the early 1990s. Unfortunately, these policy actions interact with the adverse impacts of droughts on rangeland ecosystems to cause further rangeland deterioration and thus hamper their natural recovery. This example demonstrates the interaction between a direct driver (drought) and an indirect driver (policy action) that influences rangeland condition and thus the supply of ecosystem services such as forage. For example, Danckwerts and Stuart-Hill (1988) showed that re-stocking after drought reduced the rate of recovery of communal rangeland compared to large-

scale commercial farms where re-stocking was gradual. There are many other policy initiatives that have unintended consequences on ecosystems.

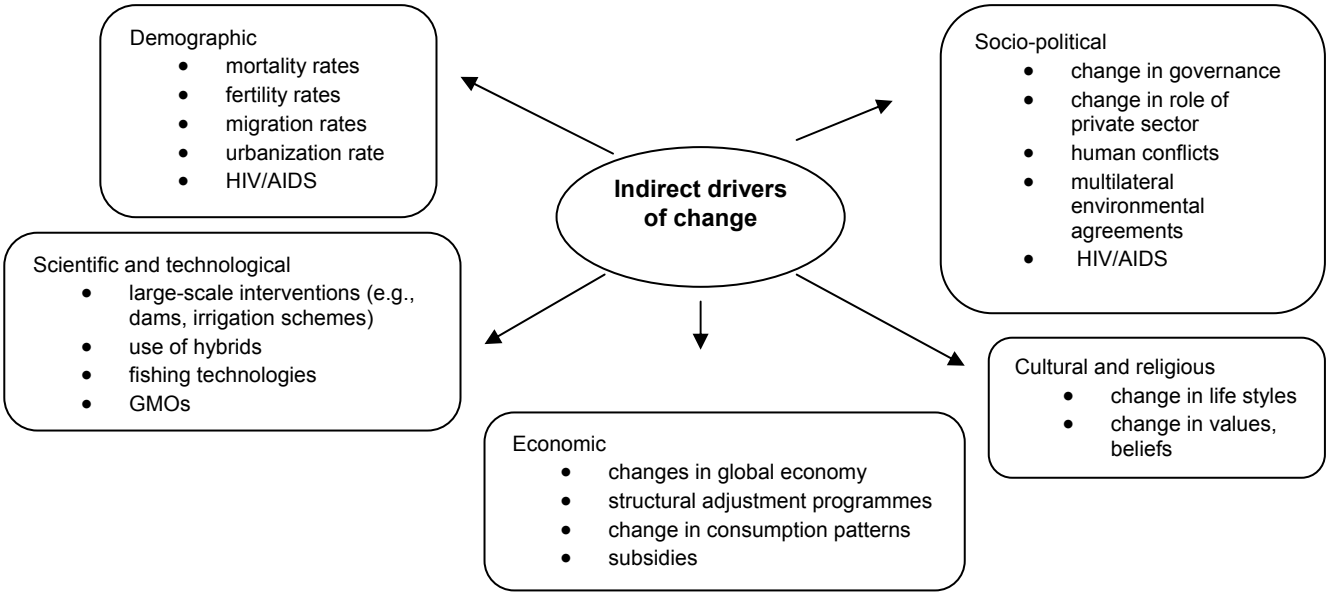

Figure 2: Examples of global indirect drivers influencing ecosystem changes (adapted from MA 2005a)

1.2.7 Thresholds

A threshold is defined by Walker & Meyers (2004) as "a breakpoint between two regimes of a system", and consequently refers to a situation in which a social and/or ecological system changes or 'switches' from one state to another, having crossed a threshold. Typically they are not well known in advance. The changed state need not mean that it is irreversible. The new state can be a result of gradual or rapid change in a particular driving force, or suite of driving forces, or be a consequence of the results of synergistic interactions of two or more driving forces. Thresholds and regime shifts are not an attribute solely of ecological systems, but also social and economic systems, as well as linked environmental systems.

Whilst it is easy to appreciate the value of thresholds in understanding and managing systems, identification is complex. Often it is only observed once the threshold has been crossed, and management agencies attempt to reverse the situation by diminishing the magnitude of the perceived driver, only to find the condition or state does not easily return to the original. Detection is certainly harder for slow variables than fast ones, it is also harder for small-scale changes than larger-scale ones, and detection is influenced by scale of examination. This is complicated further because the position of a threshold is not static, but is context specific depending on the nature of the system, its history of disturbance and resilience, and the type of driving forces. However, recently it has been hypothesised and modelled that a key precursor to detecting a potential or impending change of state, often termed a regime shift (Scheffer & Carpenter 2003) is increasing variability in ecosystem services (Brock & Carpenter 2006).

Additionally, Kinzig *et al*. (2006) illustrate some examples of where the crossing of a threshold at one spatial scale inevitably results in crossing of other thresholds at other scales, what they term as, cascading effects. However, in some of the examples provided it is not clear that the original threshold examined is indeed a threshold, in that it is not clear that the system has moved to a new and irreversible state. Nonetheless, the notion of cascading thresholds is intuitively sound, and something worth looking for in the CEPSA case studies and reviews.

2. ARID AND SEMI-ARID LANDS OF SOUTHERN AFRICA

2.1. BROAD ECOREGIONS OF SOUTHERN AFRICA

The focus area of the review is on the arid and semi-arid lands of southern Africa. These were defined as those southern African countries for which at least 50 % of their land area had a ratio of mean annual precipitation to potential evaporation of less than 0.5 (UNEP 1991). This includes six countries, namely Botswana, Mozambique, Namibia, South Africa, Swaziland and Zimbabwe (Table 5).

Table 5: Proportions of southern African countries classified as semi-arid or drier

Country	% hyper-arid	% arid	% semi-arid	Total % with a MAP/PE ratio of <0.5
Namibia	9.3	44.1	46.6	100.0
Botswana	0	19.3	80.7	100.0
Zimbabwe	0	0	82.7	82.7
Swaziland	0	0	81.2	81.2
South Africa	0.9	29.8	44.4	75.1
Mozambique	0	0	64.1	64.1
Tanzania	0	0	33.4	33.4
Angola	0	0	19.5	19.5
Zambia	0	0	16.9	16.9
Malawi	0	0	4.0	4.0
Lesotho	0	0	0	0

Across all these selected countries, a broad gradient of decreasing aridity is evident at a sub-continental scale from the west coasts of Namibia and South Africa to the east coast of Mozambique, with obvious local-scale exceptions typically in response to increasing relief. Across this gradient two major ecoregions (or biomes) are evident as described by Olsson *et al*. (2001) (Fig. 3). The drier west (including the Karoo, Namib and Kalahari regions) is characterised by deserts and dwarf shrublands. The relatively moister east is dominated by arid and semi-arid savannas. There is a broad transition zone between the two. Although the rainfall is limited and strongly seasonal in both these ecoregions, the lower variation in the moister east and the consequent increasing presence of trees and tree products, means that the major landuse patterns of the two ecoregions differ markedly. The desert and dwarf shrubland ecoregion is used primarily for extensive livestock and wildlife grazing (and mining), whereas the semi-arid savannas are dominated by a mix of commercial and subsistence agriculture and grazing. Human population densities and harvesting practices increase accordingly (Table 6).

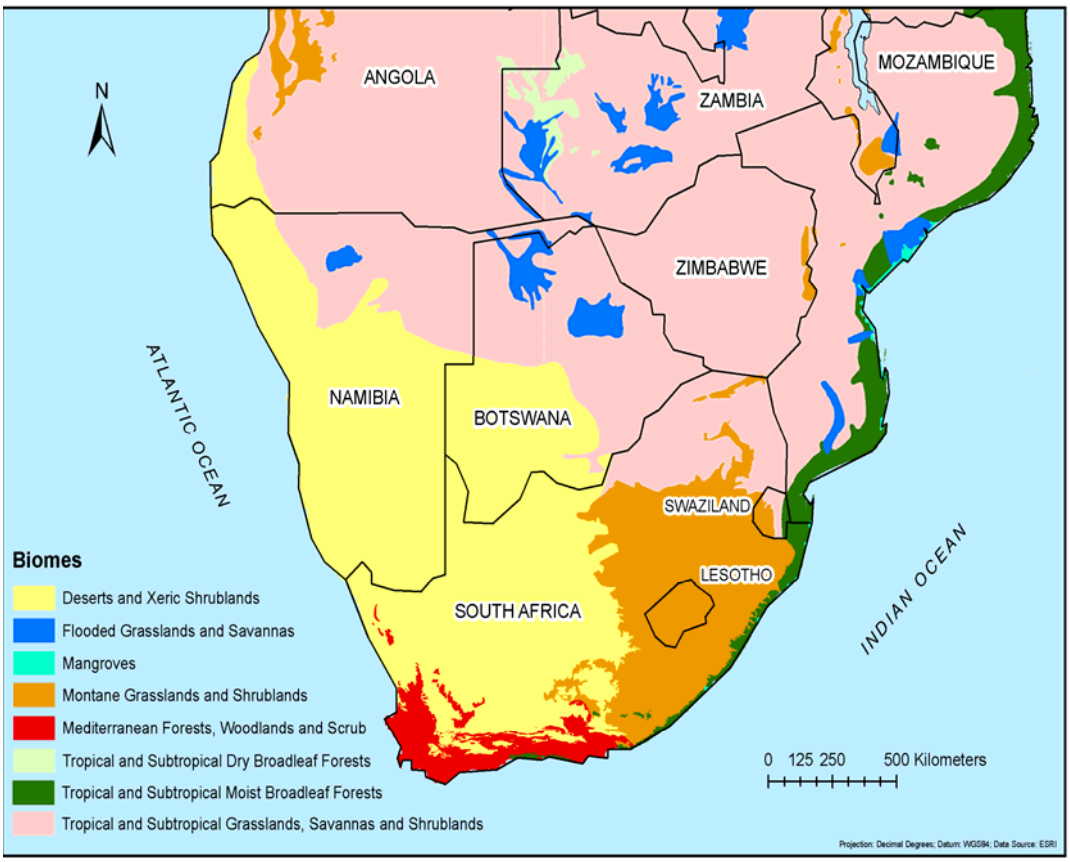

Figure 3: Major ecoregions in southern Africa (from Olsson *et al*. 2001)

Situated within and cutting across each ecoregion are major rivers and water bodies. These are key resource areas for people and productive activities, and frequently support livelihood activities that differ from the two broad patterns described above. Thus, fishing, ecotourism and more intensive agriculture and grazing are possible along the edges of lakes, dams and rivers (e.g. Richtersveld communal farmers, Basarwa in the Okavango Delta, the Etosha, Zambezi, and Limpopo systems, Lake Kariba, to mention some of the larger ones). This provides an apt illustration of how rural people adapt to the ecosystem services available in their immediate environment, and fashion appropriate livelihoods to optimise the benefits from those services. The presence of reasonably reliable water sources at a local scale breaks the fetters imposed by the aridity of the broader landscape.

Whilst many ecosystem services are best provided by relatively intact systems, not all are restricted to such. Consequently, it is important to appreciate that human activities can impact ecosystem services in many ways, and it is not always negative, and that even when negative, the degree and nature of impacts vary enormously. There is no doubt that the net effect of human activities on many services is negative, and perhaps accelerating (see Section 4). Nonetheless, human dominated or modified ecosystems, which dominate the landscapes of southern Africa, continue to provide ecosystem services, some at an enhanced rate when compared to relatively unimpacted areas, and some at a declining rate; – it is a continuum rather than an “all or nothing” situation. For example, urban habitats are highly modified relative to the previous state, and despite many negative attributes, impacts and large ecological footprint, they still can contain much indigenous biodiversity, produce some food and forage via urban agriculture, receive rainfall and contribute to the recharge of aquifers, maintain and even enhance areas of high aesthetic appeal. The total yield of all ecosystem services is less than for largely natural ecosystems, but the services provided in urban areas nonetheless require consideration and management. This is especially so in light of the growing urbanisation in the region (see Table 36). Similarly, agricultural landscapes and mosaics, which dominate much of the region, continue to offer a wide range of services, albeit at impaired levels, but often at a

level sufficient to meet most livelihood needs, depending on the conscious trade-offs made, and the possibility of thresholds. The typology of Wiersum (2004) is useful in this regard, placing management and benefits from ecosystems along a continuum from casual and opportunistic harvesting from relatively wild or intact systems through to intensive management of domesticated species.

The six countries present a diverse array of political and economic systems, infrastructure development, ecosystems and hence poverty profiles (Table 6). By most economic indices, South Africa, which is the largest country, is the regional powerhouse. Which country occupies the opposite end of the spectrum depends upon the index selected, but is typically Mozambique or Swaziland. But political strife in Zimbabwe over the last decade or so has severely undermined economic performance and social stability resulting in escalating poverty.

Table 6: Key statistics and indicators for subregion countries

Indicators	Botswana	Mozambique	Namibia	South Africa	Swaziland	Zimbabwe
DEMOGRAPHIC						
Population (x 10^6)	1.7	20	2	45	1.13	13
Population density (km^{-2})	3	25	3	37	66	34
% Urban	56.6	33.7	34.5	58.8	23.9	35.4
% Rural	43.4	66.3	65.5	41.2	76.1	64.6
Natural increase (% p.a.)	0.1	2	1.4	0.5	1.6	0.6
Fertility rate (children/female)	3.2	5.5	4	2.8	4	3.6
% 0-14 yrs old	38	44	42	33	41	40
Male life expectancy (yrs)	36	41	47	44	43	38
Female life expectancy (yrs)	35	42	48	45	42	37
POVERTY AND WELL-BEING						
HDI	0.57	0.39	0.626	0.653	0.5	0.491
Infant mortality (/1000)	116	152	63	67	108	129
HIV preval. (%)	24.1	16.1	19.6	18.8	33.4	20.1
Poverty (% on >US$1/day)	23.5	37.9	34.9	10.7	-	56.1
Rural poverty (%)	-	71.3	-	-	-	35.8
Urban poverty (%)	-	62	-	-	-	3.4
Undernourished (%)	30	45	23	-	19	45
Gini index	63	39.6	74.3	57.8	60.9	50.1
ECONOMIC						
GDP (US$ billions)	9	6.6	6.1	240	2.4	3.3
GDP growth (% p.a)	3.1	8.6	4.6	3.7	3.6	-6.1
GDP per capita (US $)	9 945	1 237	7 418	11 192	5 638	
GNI (US$ billions)	9.1	6.1	6.1	224.1	2.5	4.5
GNI p.c. $	5 180	310	2 990	4 960	2 280	340
GDP growth per capita (%)	4	5.7	2.4	5.6	0.8	-7.6
Unemployment rate (%)	-	0.6	18.2	25.4	5.8	-
Adult literacy (%)	81	33.5 (in 1990)	85	82	80	-
Human vulnerability score 100-0	-	5.4	38.5	57.7		39.2
ENVIRONMENTAL						
Rainfall (mm p.a.)	416	1 031	285	495	788	657

Indicators	Botswana	Mozambique	Namibia	South Africa	Swaziland	Zimbabwe
Renewable water resources ($x10^9$ m^3 p.a)	14.4	216	17.9	50	4.5	20
Irrigation potential ($x10^3$ ha)	13	3 072	47.3	1 500	93.2	366
Wooded land (%)	21.9	39.0	9.8	33.3	30.3	49.2
Deforestation rates (% p.a)	-0.9	-0.2	-0.9	-0.1	1.2	-1.5
Annual forest loss ($x10^3$ ha)	-118	-64	-73	-8	6	-320
Water Poverty Index	Medium	Severe	Medium	High	High	High
LAND USE						
Arable land ($x10^3$ ha)	377	4 350	815	14 753	178	3 220
Cropped land ($x10^3$ ha)	3	320	5	959	14	130
Total land area ($x10^3$ ha)	58 173	80 159	82 429	121 909	1 736	39 076
POLITICAL						
Government system	Republic[a]	Republic	Republic	Republic	Monarchy	Republic
Key Ministries/ Departments tasked with ecosystem services	Agriculture Environment, Wildlife & Tourism Mines, Energy & Water Resources	Agriculture & Fisheries National Directorate of Water Forestry	Agriculture, Water & Forestry Environment & Tourism Fisheries & Marine Resources Rural Development	Agriculture Environmental Affairs & Tourism Land Affairs Water Affairs & Forestry	Agriculture & Cooperatives Natural Resources Tourism, Environment & Communications	Agriculture Environment & Tourism Lands, Land Reform & Resettlement Water Resources

Sources: United Nations Development Programme, 2005; Human Development Report, New York; World Bank, 2007: World Development Report, Washington 2005; Millennium Ecosystem Assessment 2005; State of the World's Forests, Rome FAO, 2007; Aquastats, Rome www.fao.org/na/water/aquastat [22/0/2007]

[a] Republics are characterised by having representative democracies, constitutions and elected Presidential heads of state. In Swaziland, although there is an elected legislature, supreme power rests in the hands of the hereditary Monarch. In terms of politics, Zimbabwe is currently characterised by controversial economic and land reform policies and extreme tension and civil strife between political parties. Swaziland has been characterised by very evident tensions between the Monarchy and trade unions and there have been disagreements over the new constitution. Conditions are more stable in the other countries where democratic processes prevail.

2.1.1 Deserts and dwarf shrublands (arid ecoregion)

Lying broadly to the west and south-west of the semi-arid savanna ecoregion are the desert and dwarf shrublands of the Namib, the Karoo and the Kalahari. The largest of the three areas, the Kalahari (900 000 km^2) is characterised by the distinctive soil profile of the Kalahari Sands. The area covers much of Botswana and extends into Namibia, South Africa and western Zimbabwe and Zambia. The Namib is a sand desert lying parallel to the Namibian coastline spanning 50 000 km^2. The Karoo (380 000 km^2) is found within the borders of South Africa and is distinguished by its unique geological history and thousands of endemic plant species (Shugart *et al*. 2004). It is commonly divided into two biomes, the Succulent Karoo and the Nama Karoo.

The broad ecoregion is characterised by variability in plant communities largely in response to the abundance and seasonality of rainfall. Soils tend to be weakly developed which limits vegetation cover and carrying capacity. Most of the Succulent Karoo receives winter rainfall, ranging between 100 mm and 200 mm p.a. (Mucina *et al*. 2006a). In coastal areas fog is an important source of moisture for plant growth. One of the key features of the Succulent Karoo is the high unpredictability of the rainfall which is thought to have resulted in high plant diversity of the biome (Cowling *et al*. 1999). The mean annual temperature is 17°C. The occurrence of frost is a function of distance from the sea and altitude (Mucina *et al*. 2006a), being rare in low-lying

coastal areas whereas its incidence in deep valleys surrounded by high mountains ranges between 15 and 30 days per year. The vegetation is dominated by dwarf succulent herbs and shrubs. Grasses are rare. Globally, the Succulent Karoo is the only arid region biodiversity hotspot (Mucina *et al*. 2006a). The high diversity of dwarf succulent shrubs (1 700 species) is the biome's most distinctive character.

The climate of the Nama-Karoo is continental (Mucina *et al*. 2006b), with summer rainfall, ranging from 70 mm p.a. in areas bordering the Desert biome to 500 mm p.a. in the southeast. The rainfall is erratic and highly variable (40 % CV). Droughts are unpredictable and at times prolonged. Temperature extremes range from -5^{o}C in winter to 43^{o}C in summer (Mucina *et al*. 2006b). Frost occurs in all areas of the Nama-Karoo except the southeastern parts of the biome. The vegetation is typically a mix of annual grasses, dwarf herbs and shrubs, geophytes and some succulents. It is generally low in floristic diversity (Mucina *et al*. 2006b).

The Desert biome is extremely arid, with mean annual precipitation generally less than 70 mm. Fog is an important source of water in the coastal Namib Desert, but not so in the Kalahari. Many climatic variables show high spatial variability due to topographic variation, mountain barriers and distance from sea (Jurgens 2006). The plant species richness of the Namib Desert is higher than that of other deserts of similar aridity (Jurgens 2006). The high diversity of flora in southern African deserts is attributed to their age and existence of two distinct centres of endemism (Western Gariep Centre of Endemism and East Gariep Centre of Endemism) (Jurgens 2006).

In terms of land management, the ecoregion shows significant diversity, varying from communal grazing lands in the Kalahari, to conservancies and protected areas in the Namib and Kalahari and extensive tracts of commercial rangeland in the Karoo, where some 80 % of all land is privately owned (Dean & Milton 1999). The bulk of the ecoregion is under extensive grazing systems, with small patches of arable cropping in areas near sufficient water. The total area of arable land is small (Table 6). Livestock serve subsistence and cultural functions in communal areas, with relatively low rates of offtake or sale. Parallel to these are significant commercial enterprises, serving regional, national, and international markets for meat and wool. In the Karoo the main livestock are goats and sheep, whilst the Kalahari and Namib systems also have cattle. Significant areas are under game, both in conservation and ecotourism areas, as well as game ranching and hunting. Human settlement densities are extremely low, often less than 3 persons km^{-2} in Namibia and Botswana, which reflects the general aridity of the environment and consequently restricted prospects for intensive agricultural production (FAO 2007). The urban settlement pattern is based on widely scattered small settlements, with few centres being above 50 000 people. While the Karoo has been subjected to extensive grazing practises since the 19th century (Dean & Milton 1999), the same cannot be said of the Kalahari, where significant human impact, often as a result of grazing pressures, has become a more recent phenomenon. Regular drought is a major inhibition to commercial activities (Shugart *et al*. 2004). One of the key rangeland management debates in the general area has centred around the perceived increasing desertification. Notions of overgrazing and associated erosion, loss of farming livelihoods and impoverishment have featured prominently in land management debates. Successive rounds of state intervention and the subsequent perceived recovery of the area have been the subject of numerous studies (Dean & MacDonald 1994, Dean *et al*. 1995, Beinart 2002, Archer 2004, Keay-Bright & Boardman 2006).

2.1.2 Semi-arid savannas

The semi-arid savannas of southern Africa have been extensively researched and described, and are broadly divided into eutrophic and dystrophic savannas on the basis of rainfall and geology (Werger 1978, Huntley 1982, Scholes 1997). Of the six countries included in this review, the semi-arid and arid parts of Mozambique, Zimbabwe and Swaziland are situated squarely in the semi-arid savanna ecoregion. Whilst large parts of Botswana, Namibia and South Africa also fall in the savanna ecoregion, they also have vast areas in the desert and dwarf shrubland

ecoregion (the Kalahari, Namib and Karoo, respectively). Whilst recognising that there is large variation at the local scale, the appearance, structure and function of the semi-arid savannas is largely dependent upon the interplay of geology and rainfall, with grazing, fire regime and intensity of human use being secondary determinants (Scholes & Walker 1993).

Mean annual rainfall in the savanna ecoregion ranges from about 350 mm to approximately 900 mm across the six countries (Table 6), and annual variation is high (coefficient of variation in the savanna ecoregion being 30 – 40 %), resulting in frequent droughts of varying magnitude. For example the probability of drought in the north-east savanna ecoregion of Botswana in any given year is 0.35 – 0.50 (Tsheko 2003), and in north-east South Africa every 4 - 5 years on average (Rouault & Richard 2003). Rainfall is highly seasonal, with 70 – 80 % concentrated into the summer months of October to April/May. Typically, summer temperatures are hot, and winters are mild. For example, the mean maximum daily temperatures in January and July (peak summer and winter respectively) in Harare are 26^0 C and 21^0 C, Mbabane they are 28^0 C and 19^0 C, and Gaborone, 32^0 C and 23^0 C.

With established grass and tree components savannas are well known to provide a wide variety of ecosystem services. Thus, primary landuses include grazing of livestock (mainly cattle, but also with some goats), subsistence agriculture, small- and large-scale commercial agriculture, State and private game reserves and ranches, as well as harvesting of wild resources (such as medicinal plants, wild fruits, edible insects, honey, carving timber, mushroom, reeds, etc.) for domestic use and trade on local and international markets. Mines and mining infrastructure interject into these largely agrarian landscapes. Agriculture, in one form or another, contributes > 10 % of gross domestic product in all the countries, other than Botswana and South Africa (Table 6). The relative mix of these different uses varies from place to place, and typically the landscape is a fine mosaic of the different land uses. Between 50 % and 78 % of the population is rural (Table 6), and so obtain the significant majority of their livelihoods from land-based activities. For example, several studies in the savanna ecoregion have shown that approximately 75 % of total household incomes are from agriculture and the natural environment combined (Cavendish 2000, Dovie 2001, Shackleton *et al*. 2001, Campbell *et al*. 2002, Crookes 2003), demonstrating the local importance of ecosystem services to local livelihoods. Formal employment is sourced through migrant labour in national and regional centres, opportunities in local towns, as well as rurally situated mines, ecotourism enterprises and commercial farms.

Tenure regimes are varied, with large areas of customary or communal land interspersed with private commercial or State lands, often game reserves or corporate agricultural schemes for crops such as sugar, tobacco, maize, or subtropical fruits. The proportion of communal land ranges from 80 % in Mozambique to 14 % in South Africa (UN-ECA-SA 2003); Zimbabwe and Namibia are both close to 43 %. In several countries and districts in the savanna ecoregion there is an inequitable distribution of land, with land redistribution a pressing issue for regional and national governments (UN-ECA-SA 2003). In many areas there is also gender inequity with women having limited land rights (UN-ECA-SA 2003). Poverty levels are equally variable, and statistics unreliable. At a national level approximately 30 - 40 % of the populations subsist on less than US$1 per day (Table 6). But formal poverty is a lot greater in rural areas, although such statistics rarely take into account own consumption of wild and cultivated produce.

Rural livelihoods in the savanna ecoregion are vulnerable to a range of local and more general shocks. The most frequent is drought, typically every 4 - 5 years, which affects the primary landuse activities associated with livestock and arable agriculture. The pervasive effects of drought can be mitigated with local level access to perennial or reticulated water sources. Agricultural pests and diseases to either livestock or crops can be another major shock. Fire is endemic in savannas and poses a threat to lives and infrastructure. However, high levels of land transformation and heavy grazing serve to limit the accumulation of fuels for fires, and so devastatingly severe fires are rare (but not unheard of) in the human dominated landscapes. In areas with low human population densities and game reserves typical fire frequency is 4 – 8 years. With low formal skills the rural populations secure a significant proportion of their total

livelihood incomes from agriculture and the natural environment (Shackleton *et al.* 2001, Campbell *et al*. 2002). With scarce cash income they are vulnerable to national changes in commodity prices, and international exchange rates.

2.1.3 Rivers and wetlands

The rivers and wetlands ecoregion is a composite of linear systems that cross the previous two ecoregions. Moreover, these linear systems may have their origins outside the two specified ecoregions, originating in more humid zones. Rivers thus represent important transfers of water (and other materials) from humid upland zones into the drier regions.

Rivers can be classified according to their flow regime and include perennial, seasonal and ephemeral or episodic rivers. The services provided by a river will be highly dependent on the flow regime as defined by these three classes. The main river basins in the study area are given in Table 7, ranked by mean annual flow volume.

Table 7: Major rivers of the study region

Basin	Basin area (km2)	River length (km)	Mean Annual Runoff (x106 m3)	Basin states
Zambezi	1 400 000	2 650	94 000	Angola, Namibia, Botswana, Zimbabwe, Malawi, Tanzania, Mozambique
Rovuma	155 500	800	15 000	Tanzania, Malawi, Mozambique
Orange	850 000	2 300	11 500	Lesotho, South Africa, Botswana, Namibia
Okavango	570 000	1 100	11 000	Angola, Namibia, Zimbabwe, Botswana
Save	92 500	740	7 000	Zimbabwe, Mozambique
Limpopo	415 000	1 750	5 500	Botswana, South Africa, Zimbabwe, Mozambique
Cunene	106 500	1 050	5 500	Angola, Namibia
Incomati	50 000	480	3 500	South Africa, Swaziland
Pungue	32 500	300	3 000	Zimbabwe, Mozambique
Maputo	32 000	380	2 500	South Africa, Swaziland, Mozambique
Buzi	31 000	250	2 500	Zimbabwe, Mozambique
Umbeluzi	5 00	200	600	Swaziland, Mozambique
Cuvelai	100 000	430	ephemeral	Angola, Namibia

By far the largest river system in terms of both area and flow volume is the Zambezi. This perennial river has its source in the Angolan Highlands and Zambia, runs east along the borders of Zambia, Zimbabwe and Namibia, into the Indian Ocean in central Mozambique. Numerous rivers draining Botswana, Zimbabwe and the Shire River from Malawi add to the Zambezi's flow. Although perennial, like all rivers in this region the Zambezi exhibits strong seasonality, with peak flows in March to May and lows in October to December. The Zambezi basin contains a number of important wetlands. The Zambezi Floodplain wetlands and Kafue Flats in Zambia are among the most important in terms of supporting local subsistence communities. In Namibia the Caprivi wetlands of Namibia and the Chobi Enclave of Namibia and Botswana also support large numbers of people as well as being important conservation areas. In the lower Zambezi the landscape opens out and the Zambezi is typified by a broad floodplain, with many parallel channels and shifting sandbanks. The Morremeu Complex is important wetland in both

ecological and socio-economic terms that lies along southern bank of Zambezi River. The river ends in the Zambezi Delta.

Two of the largest dams in Africa are constructed across the main Zambezi - Kariba and Cahora Bassa. Lake Kariba has a capacity of 160 000 million m^3 and a surface area of 5 000 km^2. Cahora Bassa has a capacity of 52 000 million m^3 and a surface area of 2 660 km^2. There are many other smaller dams constructed on tributaries within the basin supplying water to numerous small towns, commercial irrigation agriculture and mines. Zimbabwe has twenty large dams and many more smaller ones. While these dams create new wetland areas they also destroy the original riverine habitat that is now inundated and have largely negative impacts on downstream riverine and wetland ecosystems.

The Gariep, Okavango and Kunene are all important rivers in the west of the subcontinent that are strongly seasonal. They provide important water resources for dryland areas in their downstream reaches. The Gariep River rises in the Lesotho Highlands and provides a crucial water resource for the dry regions of the northern Cape of South Africa, for southern Namibia and, through inter-basin transfer schemes, the Eastern Cape of South Africa. The riparian areas are important for cropping, especially when irrigated. There are a number of large dams constructed across the river, the Katse and Mohale dams in the upper reaches in Lesotho and the Gareip-Vanderkloof Dams in the middle reaches of the river. These impoundments have cut flows in the lower river by nearly two-thirds (FAO 2007). The Gariep River Mouth Wetland is a Ramsar site, which is threatened by local and upstream impacts, leading to a reduction in bird numbers.

The Okavango River has a similar catchment area and flow volume to the Gariep. It rises in the Angola Highlands, crossing Namibia before it flows into Botswana, ending in the Okavango Delta, one of southern Africa's most valued wetlands. The Okavango has two major tributaries, the Cubango and the Cuito. Flows in the Cuito are unreliable and drop to very low levels in dry years. The delta is an area of open water, swamps and seasonal wetlands. It includes 6 000 km^2 of permanent swamp, and between 7 000 and 12 000 km^2 of seasonally inundated swampland (FAO 2007). During high floods the waters of the delta spill over into the Chobe River in the Zambezi basin.

The Kunene River also rises in Angola; in its lower reaches it forms the border between Angola and Namibia. Rainfall over the catchment is variable and during the dry season the lower reaches of the river are almost dry (FAO 2007). The river supplies a significant amount of water to northern Namibia, supporting approximately 700 000 people or over one third of the population (FAO 2007).

The dry areas of western Namibia are drained by a number of ephemeral rivers including the Huab, Ugab, Omaruru, Swakop and Kuiseb Rivers with a total area of 264 160 km^2. These rivers are effluent flood driven systems. Flood waters generated in the uplands are absorbed by the sandy river beds, recharging alluvial aquifers. The size of the floods determine how far down the river the flood wave reaches. A number of wetlands occur within these ephemeral systems. These rivers are divided into three landuse zones. The higher rainfall upland areas comprise commercial livestock farms; the middle reaches comprise communal areas while conservation areas are found in the lower coastal zone. Wildlife conservation and rural communities in the middle catchments are both highly dependent on the riverine resources, which themselves are highly dependent on flooding. Numerous dams in the upper reaches of these rivers impact negatively on floods, reducing the recharge potential of alluvial aquifers and wetlands.

Pans are another important category of wetland in Namibia and Botswana. Flow into these pans is episodic and for long periods they consist of large expanses of salt flats. Well known examples are the Etosha Pan in Namibia, fed by the Cuvelai River and the Makgagdikgadi Pans in Botswana, both of which are the focus of conservation areas and tourism. The Cuvulei River enters Namibia from Angola as a 130 km wide delta of ephemeral watercourses, known as

oshanas, which converge to form the Etosha Pan. The flow in the Cuvelai River is erratic; it was observed to reach a maximum annual flow of 0.1 km^3 in 1995 (FAO 2007).

The Karoo of South Africa is drained by a number of naturally ephemeral or strongly seasonal rivers: the Doorings, Gouritz, Groot, Sundays and Great Fish. These rivers suffer from occasional excessive flooding, as evidenced by the Gouritz River in January 1981 and the Great Fish and Sundays Rivers in March 1974.

To the east the Limpopo River forms the boundary between South Africa and Zimbabwe before crossing the dryland areas of southern Mozambique. The Limpopo has numerous tributaries in Botswana, southern Zimbabwe and north-eastern South Africa, all relatively dry regions. Due to the arid to semi-arid nature of the basin, the flow in the Limpopo is markedly seasonal - in dry years flow may be limited to 40 days or less and no-flow periods of up to 36 months are not unknown (ARC-Institute for Soil, Climate and Water; ARC-Institute for Agricultural Engineering, 2003). A number of wetlands can be found in the lower Limpopo basin. The whole Limpopo basin is arid to semi-arid and has a high rate of poverty, unemployment and the environment is stressed due to a lack of planning and unbalanced utilisation of natural resources.

The Incomati and Maputo basins are shared between South Africa and Swaziland and Mozambique. Water of the Incomati is intensively used in South Africa and Swaziland, mainly for irrigation, and Mozambique has some important irrigation schemes too. The flows in the main river have been very much reduced in the last 15 years. There are several relatively small dams in the basin including the Maguga Dam in Swaziland. The Maputo River flows through an area of rich biodiversity recognized by UNEP and having the status of a world conservation area (FAO 2007). The wetlands of the Pongola River have both social (fishing) and conservation importance.

While it is surface water that provides the bulk of water related ecosystem goods and services, it is also important, however, to consider groundwater resources, at least briefly. Groundwater, widely used throughout the region for domestic water supply and livestock watering, provides a buffer against drought in many areas. It is vulnerable to over abstraction and pollution. The rural areas of Botswana are dependent on groundwater for livestock watering and domestic supplies. In Mozambique groundwater is widely used for both urban and rural domestic supply and to a very limited extent for smallholder irrigation. In the Karoo of South Africa groundwater associated with dolerite intrusions provides water for domestic use and livestock watering.

Groundwater can be accessed from a number of different sources. Botswana relies on deep fossil groundwater which is not dependent on current rainfall conditions whereas shallow groundwater aquifers associated with river courses and adjacent wetlands can be recharged periodically by flood waters, as in the west coast rivers of Namibia and in Caprivi. These shallow aquifers are easy to access, but are prone to pollution and are less well buffered against prolonged drought. Salinity and nitrate contamination are common problems affecting the quality of groundwater.

Groundwater is closely linked to surface systems. Table 8 shows the relationship between groundwater and surface water for the countries in southern Africa. It can be seen that in Botswana and Zimbabwe groundwater makes a significant contribution to surface water. In Zimbabwe groundwater seepage maintains the high water levels of dambos in headwater areas; these dambos are important areas of cropping. In these areas overexploitation of groundwater can impact directly on surface water resources. In Namibia and South Africa surface water is less dependent on groundwater. Non the less abstraction of groundwater from near surface aquifers can have serious implications for groundwater dependent wetland ecosystems.

Table 8: The relationship between internally produced surface water and groundwater for countries in southern Africa. (Data from the FAO for 1961 to 1990).

Country	Mean annual precipitation (mm)	Annual groundwater recharge (km^3)	Annual surface water runoff (km^3)	Contribution of groundwater to surface water (km^3)	Contribution of groundwater to surface water (%)
Botswana	415.7	1.7	1.7	0.5	29
Mozambique	1 031.9	17.0	97.0	15.0	15
Namibia	285.5	2.1	4.1	0.0	0
South Africa	495.4	4.8	43.0	3.0	7
Zimbabwe	692.2	5.0	13.1	4.0	31

Given that the rivers and wetlands typically transcend national and district boundaries, there are relatively few statistics pertaining to individual systems. The water within these systems is used locally, as well as dammed and piped hundreds of kilometres away to mines, towns and irrigation systems. Consequently, there is a diverse array of livelihood activities found near to and/or supported by this ecoregion. Some are very localised, and at times poor (e.g. Basarwa in the Okavango Delta), whilst others, such as many mines and irrigation developments, boast major capital investments as employ hundreds of people. Subsistence fishing communities are often extremely vulnerable. It is not just the physical availability of water, but also the access by all communities, as well as the capacity to manage it and use. A composite index that includes social, ecological and management dimensions is the Water Poverty Index (www.ceh.ac.uk). All the countries in the study domain are in the high to severe categories as measured by this index, indicating severe limitations in the availability or access or management of water resources.

2.2 CASE STUDIES

Eight recently completed and written up case studies from across the region provided an important source of in-depth and local level information on the linkages between ecosystem change and poverty. They were selected on the basis of (i) being drawn from each of the three ecoregions, (ii) including at least two or more ecosystem services, and (iii) a focus on changes in ecosystems and poverty. Abstracted descriptions of each case study are provided in Appendix 2 and summarised in Table 9 below.

Table 9: Selected case studies from the southern African region

Case study no.	Locality	Ecosystem services	Drivers	Trends	Interventions and adaptations	Impacts of interventions
No. 1 Chivi (also Campbell *et al*. 2002, Frost *et al*. 2007) (Semi-arid savanna)	Romwe and Mutangi catchments, Chivi District. South-central Zimbabwe	Water, forage, woodlands products (range), crops, social and cultural services	Rainfall fluctuations and drought, land pressures, land transformation, over harvesting, high livestock numbers and grazing pressure, increasing poverty, top down policies, macro-economic policies, shortage of formal employment, lack of markets, changing institutional arrangements –	Increasing climate variability, increase in area of land under cropping, changes in woodland structure and function, more time spent collecting woodland products, large annual variations in ground water level, water point failure, increasingly stressed livelihoods for the	Integrated Natural Resource Management (INRM), institution building, micro-credit, catchment management, soil and water conservation, garden expansion, networks for sharing well water, sharing of land and grazing resources with neighbouring villages, soft and	Technical and institutional interventions can strengthen safety nets and improve the natural resource base but do not appear to reduce poverty significantly. In fact people have often already done what is possible for themselves. These areas "need integrated,

Case study no.	Locality	Ecosystem services	Drivers	Trends	Interventions and adaptations	Impacts of interventions
			e.g. reduced enforcement of environmental legislation such as cultivation on stream banks, reduction in adherence to traditional rules and challenges to the authority of traditional leaders, changes in social mores (e.g. petty theft), HIV/AIDS	poorest, greater vulnerability and poverty	flexible institutional arrangements (reduces transaction costs), matching abstraction to temporal fluctuations, expand water use rather than loose through evapotrans-piration	multi-tiered, and long-term interventions that expand economic opportunities and empower people to drive their own development" (Frost *et al.* 2007)
No. 2 Gorongosa (Semi-arid savanna)	Muaredzi and Nhanchururu, Gorongosa National Park, Mozambique	Forage, water, woodland products, land	Increases in human population, growing livestock numbers, commercial timber extraction, climate change, increasing wild fires, changing human values, increases in wild life numbers	Reduction in wilderness areas, land degradation and soil erosion, changes in ecosystem functioning, greater use of purchased food, greater demand for Park resources and more conflict, increased human-wildlife conflict	Parks-People Programme.	Not discussed.
No. 3 (Mt Coke) (Semi-arid Eastern Cape thicket)	Mt Coke, Eastern Cape, South Africa	Woodland products – building materials, fuelwood, wild foods, medicines, rangelands – fodder for grazing, natural steams – water for drinking, arable fields - crops	Historical land-use policies – betterment planning, Ciskei cooperatives programme; unrest and a coup with a subsequent decline in local rules and adherence to these; less trust & cooperation between farmers & access to traction	Decline in cropping (from 80% in 1988 to 10.3% today), reduced woodland health, bush encroachment of *Acacia karoo,* decreased cooperation between farmers, livelihood diversification	Changing species preferences, participatory forest management, greater use of food gardens, reticulated water and electricity since 2000	Not discussed in detail although fuelwood consumption has declined due to electricity and women have more time for gardening
No. 4 Kat River (Semi-arid East Cape thicket)	Cathcartvale, Kat River Valley, Eastern Cape, South Africa	Mountain water, cultural species, housing, fuelwood, forage, medicines, river water, crops, wild spinach, wild fruits	Change in land ownership historically, modernisation	Change in land use (less intensive farming), increase in woody vegetation cover, reduction in reverence for sacred sites, harvesting of riverine vegetation, loss of local ecological knowledge	N/A.	N/A
No. 5 PANRUSA study (1998-	3 border sites: 1) North West Province, RSA & Southern	Forage (range), water, veld products, soil fertility	Various land use policies especially those favouring	Greater sedentarisation, ecosystem degradation, loss	Provision of fodder, drought relief (with mixed consequences),	Not discussed.

Case study no.	Locality	Ecosystem services	Drivers	Trends	Interventions and adaptations	Impacts of interventions
2001) (Arid ecoregion)	District, Botswana, 2) Ghanzi District, Botswana and Omaheke District, Namibia, 3) Kgalagadi District Botswana & Northern Cape Province, RSA		commercial production (transition from colonialism to independence), privatisation of range, fencing, boreholes, high stocking levels	of palatable grasses, increases in annuals and bushes, water tables falling and becoming saline, wind erosion, livelihood diversification, diversification of livestock - more smaller stock, move to wildlife, nutrition depletion in soils, greater dependence on welfare grants, displacement of landless, marginalisation of hunter-gatherer groups and poorer households, growing underclass and greater pressure on non-excluded communal areas, sand dune reactivation	growing melons, use of *Rhigozum* flowers as a spring feed by small stock owners, bush clearing projects, moves away from cattle as predominant livestock type, tourism initiatives, dropping fences during drought, livestock movement, local resource use committees	
No. 6 Okavango (Wetland in arid ecoregion) (Madzwamuse & Fabricius 2002)	Xaxaba, Ngamiland District, Okavango Delta, Botswana (Case of the hunter-gather Basarwa people)	Water, reeds, fish, tourism, wildlife, social and cultural services	Floods, droughts, animal migrations, past laws and policies, e.g. 1968 Tribal Land Act (affected hunter gatherer societies), 1975 Tribal Grazing Land Policy, 1991 Agricultural Policy (resulted in displacement by new settlers), betterment schemes for the Basarwa, cordon fences to control foot and mouth disease restricted movement and trapped wildlife increasing conflict with humans, restricted harvesting in conservation areas, prevention in use of fire	Increasing tourism, diversification especially into tourism, increased sedentarisation, loss of social capital, loss of cultural capital, loss of indigenous knowledge, greater dependence on welfare	Previously - Nomadic lifestyle - mobility, flexible livelihood strategies, good social capital. Eroded by historical policies. Now – jobs in tourism – guides, *Mokoro* polers and trackers, trading in natural products – baskets, reeds, thatch, welfare grants, CBNRM initiative inclusive of Basarwa, resource committees - rules	Increased vulnerability, maginalisation, new way of life, conflict between modern and traditional institutions, dependence on government handouts, erosion of traditional coping mechanisms (which policies seldom support)
No. 7 Kalahari (Madzwamuse *et al*. 2007)	Kgalagadi District, southwestern Botswana	Forage, wild food, commercial veld products (oils, waxes), genetic	Rainfall, privatisation of commonage, bush encroachment around	Land degradation, livelihood diversification, reduced abundance of	N/A Suggestions made for more attention to the marketing of veld products	N/A

Case study no.	Locality	Ecosystem services	Drivers	Trends	Interventions and adaptations	Impacts of interventions
(Arid desert)		resources, firewood, construction materials, handicraft materials (skins, shells) , medicinals, recreation and tourism, social and cultural values, carbon sequestration, erosion control, habitat, reflecting and absorbing solar radiation, pollination services, ground water storage, soil fertility regeneration	boreholes, heavy subsidies for livestock production, climate change, overexploitation of natural products	some plants, heavy grazing, increased bush	and development of tourism opportunities. Need greater economic diversification and private sector investment.	
No. 8 Paulshoek (Arid desert)	Paulshoek, Namaqualand, Northern Cape Province, South Africa	Water, fuelwood, forage, wild plant foods, wild animal foods, building materials, food gardens, crops, cultural services – tourism, water regulation	Provision of reticulated water and electricity due to policy change, rainfall, increased rainfall variation, modernisation, western medicine	Return to traditional sheep breed, livelihood diversification, use of reticulated water for food gardens, reduction in cultivation, wide fluctuations in animal numbers	Drought relief, provision of basic services, land reform and access to new grazing for farmers with large herds, decreased pressure on commonage, food garden project, water tanks	Improved nutrition from food gardens, improved water supply and sanitation, reduced time spent collecting water and firewood – more time, small stock production supplementary rather than primary livelihood activity

3. METHODS AND DATA SOURCES

3.1 GENERAL APPROACH

A number of different methods were employed to locate and summarise the data and information for this situation analysis (Fig. 4), as well as raise awareness in the six countries:

- Preparation of a summary list of all ecosystem services and their categorisation as provisioning, supporting, regulating or cultural (Appendix 1). From this the importance of each ecosystem service in different ecoregions of southern Africa was ranked. Finally, at least one ecosystem service was selected per category for detailed examination. It should be noted that coastal ecosystem services are covered in a separate situation analysis.
- Desktop synthesis of existing information. This was the main approach. Key literature and key informants who could identify less accessible literature and grey reports were identified early on, and consulted. Additionally, for each section and ecosystem service a detailed literature search was performed on several search engines and databases, including Science Direct, Ebsco Host, Scopus and Google Scholar. Emphasis was

placed on literature from the last ten years, although not exclusively so. It was assumed that work prior to that was referenced within the later work. The search covered each ecosystem service within each country, as well as southern Africa as a whole.

- Within the literature we specifically sought data and information that provided *evidence* of the links between ecosystem services and the poor. We felt it was important to move beyond the anecdotal information, generalisations (and rhetoric) that are often common in this field.
- Drivers of change and their relative magnitude were derived from the project team's interpretation of existing information and case studies, at times verified by expert opinion.

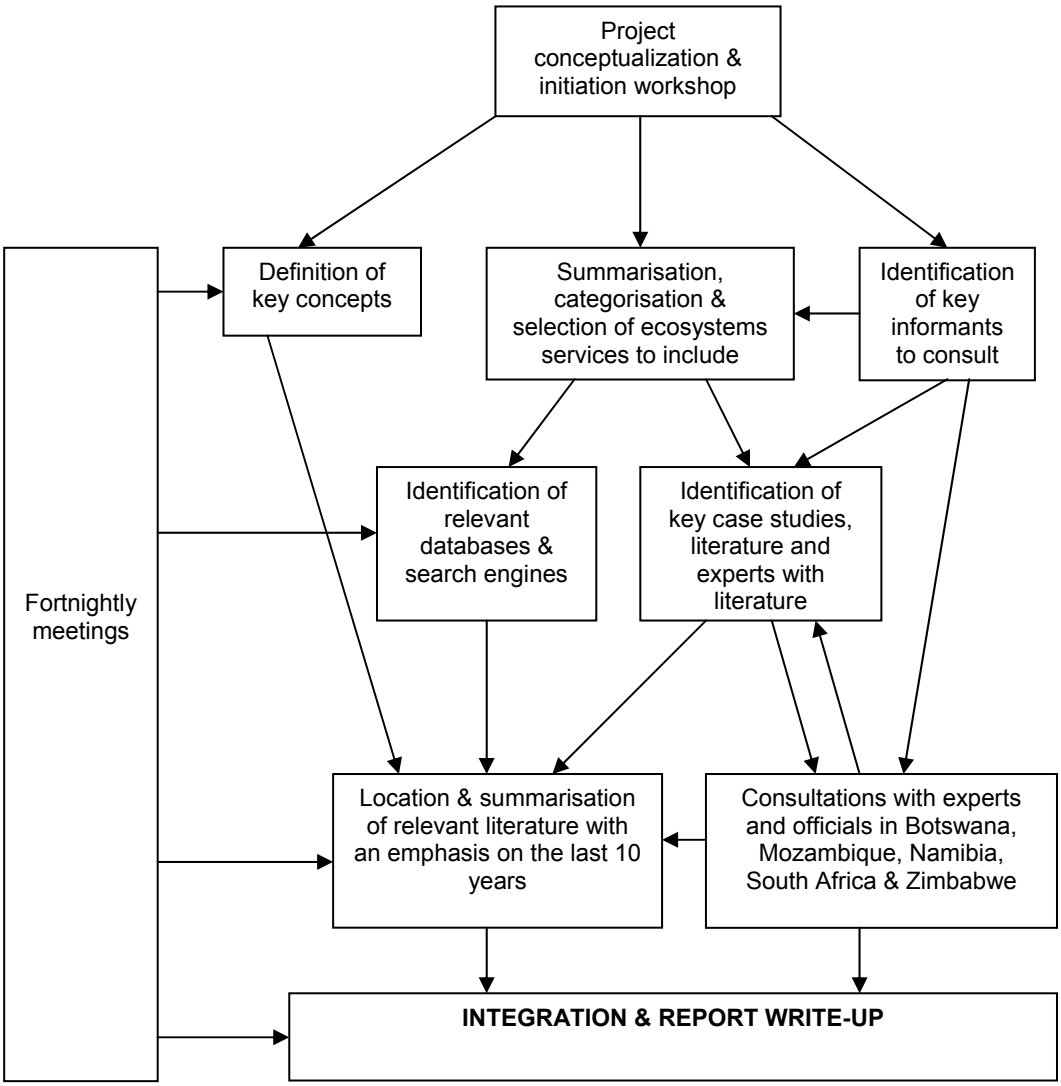

Figure 4: General steps in the CEPSA study

- Identification and summarisation of illustrative case studies (see Section 2.2). In-depth, location specific case studies that integrated several of the core aspects were identified (Appendix 2), and then summarised by the team or key informants for cross-reference throughout the project.
- Consultations with subject experts. Key experts in the six countries were identified early on and then approached either via e-mail, telephonically or direct meetings. In total 85 face-to-face meetings were held (Appendix 3). All will be sent a copy of this report.
- Awareness raising meetings with officials (Appendix 3). Meetings were held in five of the six countries (not Swaziland) with available officials to:
  - inform them about the project,

- canvass their opinion,
- obtain their understanding of the linkages between ecosystem services and poverty and the drivers of change,
- obtain comments regarding in-country capacity to manage ecosystems for poverty alleviation,
- determine if any projects were underway in their country linking ecosystems and poverty alleviation, and
- ascertain and open the links for future communication should CEPSA go into a second phase.

- Team workshops. These were held approximately every week to discuss and debate conceptual issues and integrate findings across sectors.

3.2 INTEGRATIVE FRAMEWORK AND THEMES

To facilitate integration of the different components, the design of the project and interpretation of the literature was guided by (i) a conceptual framework of the links between ecosystems and poverty (Fig. 5), (ii) a detailed report outline and 'expanded table of contents' provided by the scientific leader of the project, and (iii) a number of central and integrative themes. As presented in the Introduction (Section 1.2) these themes included:

- Factors, at multiple scales, in isolation and in synergy, that are driving changes in the capacity of ecosystems to deliver services.
- Evidence of thresholds having been crossed in the capacity of ecosystems to deliver specified services.
- The vulnerability of the poor to changes in the availability of essential services.
- Trade-offs in policy and management options that affect the supply of different ecosystem services relative to one another.
- The complexity of the relationship between humans and ecosystems, and that it is a dynamic relationship.

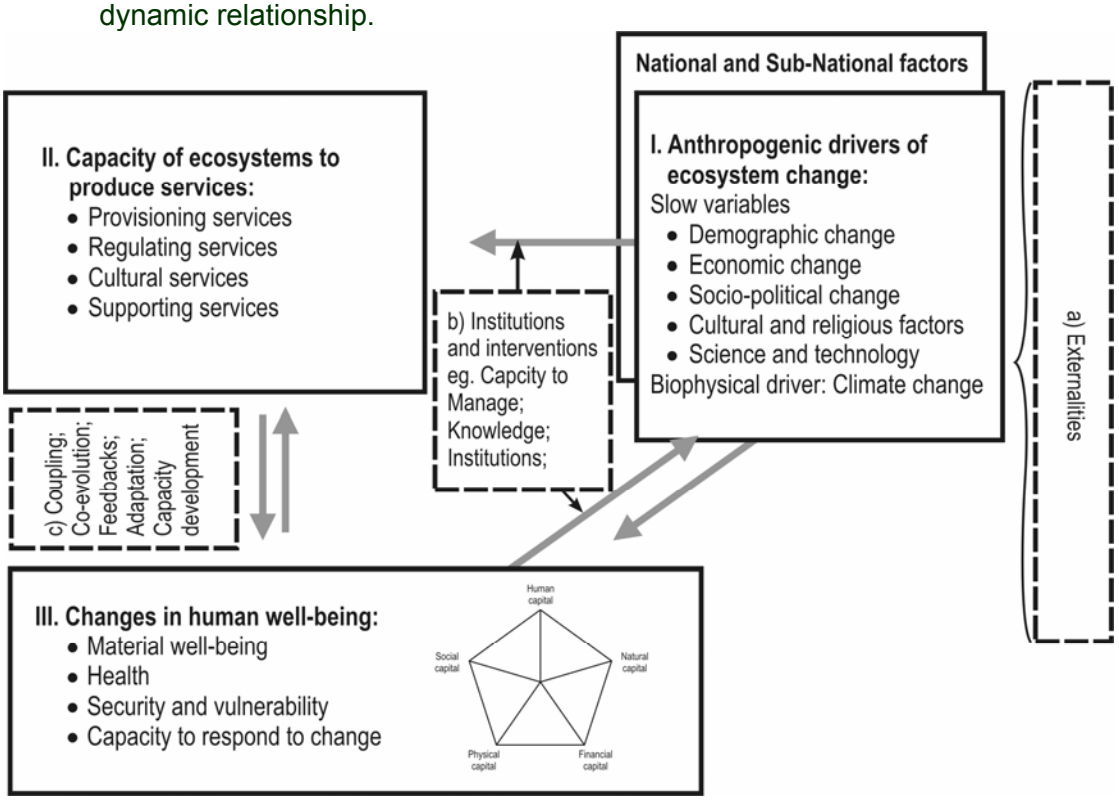

Figure 5: Overall conceptual framework

3.3 METHODOLOGICAL CHALLENGES

Throughout the process a number of challenges were apparent:

- The project required that at least one ecosystem service was selected per category, i.e. provisioning, supporting, regulating and cultural. However, most work to date in southern Africa has been on provisioning services, and consequently the wealth of information and literature on the others, especially as they relate to poverty and well-being, is relatively sparse.
- The short time frame of the project restricted much of the literature search to readily available literature. In-country consultations with experts were done in parallel, and consequently it was difficult to access and incorporate any literature pointed out by them during the later consultations. Due to the time constraints, the team member undertaking the consultations was not part of the team writing the main report and therefore it is likely that some valuable insights were lost.
- Of the existing information, relatively little has been captured or reported within a framework that links ecosystems and poverty. Most of the information separates these two domains, namely the biology and ecology of ecosystems on the one hand, and economics, poverty and social dynamics on the other. Consequently, much of the integration of the two spheres was done by the project team, and at times was intuitive rather than based on the hard evidence required.
- There was a large differential in the volume and availability of literature and information between the six countries covered, with perhaps Swaziland and South Africa at the two ends of the spectrum. Very little or recent information was available on Swaziland other than standard national indices. In contrast there was a relative wealth of published and grey information in South Africa, as well as projects on the ground where practitioners are linking ecosystem management and poverty alleviation. This is not a bias of the project team, who were situated in South Africa, as it was also confirmed during the in-country consultations. The other four countries fell between these two extremes. Zimbabwe had a lot of information, both published and grey; Namibia and Botswana less so and with more emphasis on grey literature; whereas Mozambique had mostly grey literature, but often inaccessible to the project team because of language.
- It was often difficult to differentiate between drivers, trends and interventions (all required as separate sections in this report). For example, often the driver of change in an ecosystem service was a specific policy or intervention (e.g. land reform, electrification – see Appendix 2, Case Studies). Many trends such as increasing variability in rainfall or increasing commercialisation of natural products can also be thought of as drivers. Often all three interact to produce a particular result. Thus, the conceptual framework is less clear-cut then it appears at first glance.

4. FINDINGS

4.1 OVERVIEW OF THE DEPENDENCE OF THE POOR ON ECOSYSTEM SERVICES

While all of humankind is dependent on ecosystem services, the poor are disproportionately so. This dependence is often most apparent in poor rural communities who rely on small-scale farming and livestock production, extensive pastoralism, fishing and forest-based activities for their livelihoods and who are directly affected by changes in the availability of common pool resources such as water, wild foods, medicinal plants, raw materials for building and household and farming implements, and firewood (Scholes & Biggs 2004, WRI 2005). Moreover, direct dependence on services from ecosystems is highest amongst people living in arid and semi-arid lands where alternative livelihood options are often limited and environments are particularly fragile and risky (MA 2005b).

Poor people rely on ecosystem services for subsistence needs, food security, as inputs into a wide range of livelihood activities and for cash income, although the degree of dependency is often differentiated across communities, households, individuals and regions (Box 2, 3, Fig. 6, Appendix 2 - Case Study 2). For some households, farming or livestock production may form a primary livelihood activity, whilst for others it may be a strategy for diversifying household income. For example, in the arid Namaqualand region of South Africa small stock farming has shifted from being a core economic activity to an insurance against unemployment, with pastoralism being seen as a way to build resilience through the diversification of household economic activities (Berzborn 2006). In the savannas of Zimbabwe, dryland arable agriculture is practised by most households, but on average contributes less than a quarter (22 %) of total household income, and only 10 % of all cash income (Campbell *et al.* 2002, Appendix 2 - Case Study 1). Its role in food security, however, is critical. Other important sources of ecosystem service based income included livestock production (21 % of total income), use and sale of savanna resources (15 %) and cultivation of gardens (8 %). In general, this pattern of livelihood diversification is repeated across the region, supporting the contention that people living in uncertain environments adopt multiple livelihood strategies to spread risk and reduce vulnerability (Campbell *et al.* 2002). However, while direct use of ecosystem services are often just one element of a complex livelihood base, an analysis of poverty-environmental linkages in participatory poverty assessments has shown that poor people see the environment as a "crucial 'card' in the balance of livelihood management" (Brocklesby & Hinshelwood 2001). Moreover, they perceive that threats, damage and change in ecosystem services has made them increasingly vulnerable and many livelihood tasks and activities have become more time consuming and risky (Brocklesby & Hinshelwood 2001).

Box 2: Ecosystem services that are important for the poor as identified in the in-country

Across all countries provisioning services such as water supply, fuelwood, wild fruits and vegetables, grazing land and constructions materials were the most often mentioned ecosystem services. Regulating services such as water regulation and flood control were the next most frequently mentioned. In terms of supporting service soil fertility was mentioned more often than biodiversity. Cultural services were almost never mentioned.

NAMIBIA – Water, wetlands, woodland products, wildlife. Regulating services thought not to be important.
SOUTH AFRICA – Woodland products, plantations, water.
BOTSWANA – Water, veld products, grazing, scenic landscapes for tourism, wildlife, fish, crops in some areas.
ZIMBABWE – Woodland products, forage (livestock), crops, wildlife.
MOZAMBIQUE – Crops (subsistence agriculture), biodiversity, water, flood regulation, woodland products.

In all the countries the poor do not rely solely on ecosystem services; other sources of livelihood/income from jobs, remittances, and welfare grants are critical with the possible exception of Mozambique where a large proportion of the population are subsistence farmers.

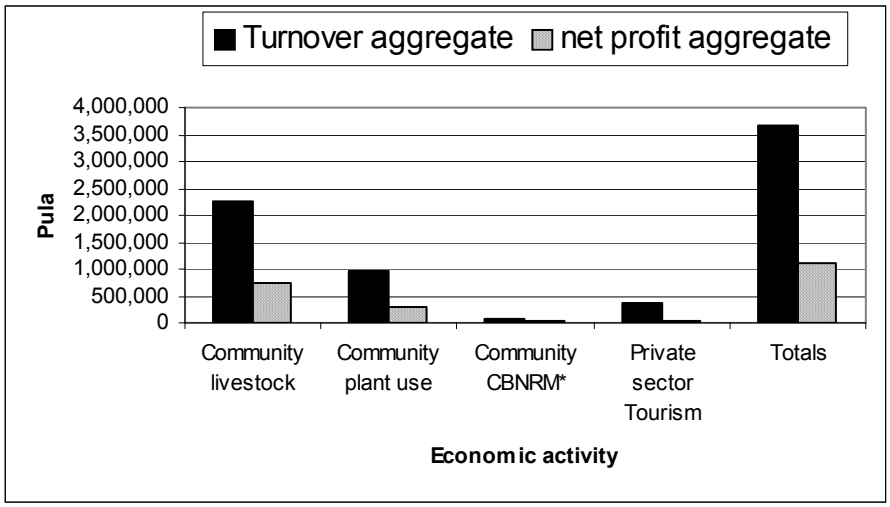

Figure 6: Private household direct use values from ecosystem services: Kgalagadi case study (Source: Appendix 2, Case Study 7, Madzwamuse *et al.* 2007) (**Note**: Exchange rate for one Pula = US$0.159 in 2007)

Box 3: Importance of different ecosystem services for the poor – examples from case studies: a) drylands of Botswana (Appendix 2 - Case study 7, Madzwamuse *et al*. 2007), b) savanna ecoregion South Africa (Appendix 2 - Case study 4), c) savanna ecoregion, Gorongosa, Mozambique

a) Kalahari, Botswana

Service	Livestock	Wildlife	Plants/veld products
Food	Beef, goats, poultry, milk, eggs	Game meat	Truffles, wild melon, bush raisin, mopane worms, honey, leafy vegetables, cucumbers
Fuel			Firewood
Fertiliser	Manure		
Medicine			Grapple plant, hoodia, herbal teas
Construction material			Thatching grass, poles
Utensils		Belts, skins and hides	Bowels, spoons, mortars, etc.
Handicraft materials	Skins, hides	Skins, skulls, hides, ostrich shell, feathers, horns	Palm, seeds, carving wood, clay
Oils/ lipids/ waxes			Marula, water melon seeds, bush candle
Recreation		Trophy hunting, photographic and cultural tourism	

b) Cathcartvale, Kat River, South Africa – Local people's rating of ecosystem services and reasons for their rating

Rank	Resource	Reason
1	Mountain water	Water is crucial to one's survival, and this water is healthy, unlike the river water.
2	Cultural species	Traditions are essential to the life of a Xhosa person and these species are needed when performing them.
3	Fuel wood	Used for many purposes, such as cooking, heating and traditions.
4	Livestock	Acts as a safety net; important for traditions; and supplies meat and milk.
5	Medicinal plants	Medicinal plants are used to treat many illnesses and play a role when performing traditions.
6	Building materials	Used for building homes, kraals and fences.
7	River water	Acts as a safety net for when the mountain water dries up. Also useful for irrigation; washing in and provides drinking water for livestock.
8	Agricultural crops	Used as food; they are fresh and good for health; and will provide a constant supply of food.
9	*Imifino* (wild spinach)	Are healthy (full of vitamins); act as an alternative to meat; and are important when in poverty.
10	Honey	Treats asthma; useful when hungry in the bush; and has many vitamins.
11	Wild fruits	They act as a food supplement; have lots of vitamins; and are important in times of poverty.

c) Gorongosa, Mozambique. Most important ecosystem services as ranked by the community were water, land for agriculture and housing, construction materials, fuelwood, general household and craft materials and various wild foods. Constraints to use were dominated by lack of tools, inputs and equipment, official regulations and poor soil fertility (see Appendix 2, Case Study 2 for a detailed table).

Box 4: How important are ecosystem services for the poor?

"Ecosystems are – or can be – the wealth of the poor. For many of the 1.1 million people living in severe poverty, nature is a daily lifeline – an asset for those with few material means. This is especially true for the rural poor, who comprise three-quarters of all poor households worldwide. Harvests from forests, fisheries and farm fields are a primary source of rural income, and a fall-back when other sources of income falter. But programmes to reduce poverty often fail to account for the important link between environment and the livelihoods of the poor". WRI (2005)

"Particularly important services on which poor people are dependent include the provision of food (both the components of biodiversity that are consumed and the wide range of biodiversity that is crucial for food production); medicines and health (through both the supply of natural medicines, and through the regulation of infectious and emerging diseases); timber, fibres and fuels from forests and other sources; the regulation of fresh water quality and quantity; protection from (and regulation of) natural hazards; and the cultural benefits of biodiversity. Supporting services on which these various benefits depend are also crucial, and in particular soil formation, pollination, nutrient cycling and the control of agricultural pests and diseases". UNEP-WCMC (2007)

When assessing the importance and value of an ecosystem service it is necessary to ask the question "how valuable to whom"? (Madzwamuse *et al.* 2007). The benefits provided by an ecosystem service can fall unequally across different groups and there may be trade-offs between groups. Forage production is an example where the better-off (livestock owners) tend to benefit more from the provisioning service than poorer community members (Appendix 2 - Case Studies 3 and 7). However, generally, it is the poorest and most vulnerable members of society who depend most on ecosystem services for their livelihoods and well-being. For example, Cavendish (2000) working in Zimbabwe found that 'environmental income' (including forage for livestock production) formed some 40 % of total income for the poorest households relative to 29 % for more well-off households. Women in particular are dependent on a wide range of wild harvested products, from fruits to craft materials, as a source of cash income, with a high proportion of female-headed and elderly households trading in these goods (Madzwamuse *et al.* 2007, Shackleton & Campbell 2007, Shackleton *et al.* 2008). Indeed, the

trade in natural products is often one of the few sources of cash income that rural people with limited education and skills can access. In Botswana, for example, basketry (from palm fronds) forms a crucial source of income for thousands of poor women (Cunningham & Terry 2006), while the trade in mopane worms in the same country was valued at UK£4.42 million in 1995 and employed as many as 10 000 local people (Styles 1995). Increasing commoditisation of biodiversity is a well reported general trend across the region (see references in Shackleton 2005) with repercussions for resource access, governance, management and sustainability.

Given the livelihood uncertainty in arid and semi-arid lands, the safety net function provided by ecosystems and biodiversity is critical and plays an important role in reducing vulnerability and smoothing income. Wild foods, with some specifically considered as famine foods (e.g. wild melons in the Kalahari), assist poor households to meet their nutritional requirements during lean times. The harvesting, processing and sale of natural products can provide income to purchase food in years of low or failed crop production. Increasingly, households affected by HIV/AIDS are turning to freely available natural resources for both subsistence and trade (Shackleton 2006). Of the countries considered in this analysis only South Africa, Botswana and Namibia have social welfare support systems to fall back on, with old-age pensions being a particularly important source of cash income for poor households.

Box 5: Links between the vulnerability of the poor and degradation in ecosystem integrity – the example of water

"Because of social and economic disadvantages the poor often live in fringe areas where access to potable supplies and adequate sanitation facilities is limited and where higher mortality, morbidity and disease rates prevail. Or they live in highly vulnerable areas (floodplains and degraded watersheds), where buffering capacity to natural and anthropogenic shocks and disasters is limited. Also poor downstream communities relying on flood recession agriculture, dry season water supplies, fodder, firewood or fishing are left out when major upstream water allocation or urban/industrial development decisions are made without adequate considerations of downstream uses". (Hirji and Ibrekk 2001 in SADC n.d.)

Many ecosystem services are substitutable (UNEP-WCMC 2007). For example, clean water can be obtained through mechanical filtration and manufactured materials can be used instead of timber for housing. Where local supplies of goods are depleted, stocks can be bought in from elsewhere. Where soil fertility has declined chemical fertilisers can be applied to ensure continued high production. However, the limited purchasing power of the poor means that they can seldom afford these alternatives. Consequently, they are often ill equipped to buffer against the effects of changes in ecosystem services. This, in turn, renders them more heavily dependent on the integrity and diversity of their local environment for the continued supply of services than is the case for other sectors of society. This dependence is further amplified amongst rural communities, especially those living in arid areas, whose remoteness is often an additional factor limiting access to substitutes.

Similarly, because of their limited resources, poor people bear much of the burden associated with the degradation of ecosystem services. They tend to be more susceptible to extreme natural events like floods. Often they do not have the resources to build appropriate shelters or they may occupy environmentally unsafe areas. Many do not have the savings and assets to recover from disaster. The poor are also more affected by diseases linked to deteriorating ecosystem services. For example, in Malawi the costs of malaria consume some 33% of household income amongst the poor compared to 4.2 % for the rich (UNEP/IISD 2004).

The MA (2005a) revealed that as human well-being diminishes there tends to be a concomitant increase in immediate dependence on ecosystem services. The resultant increased pressure often has a negative feedback on the capacity of the ecosystems to deliver these services. This can create a downward spiral of increasing poverty and ecosystem degradation. There is accumulating evidence that the AIDS pandemic may be driving such a situation in the region (Shackleton 2006, McGarry 2008).

Despite the seemingly obvious links between ecosystem services and poverty, the reliance of the poor on ecosystem services is rarely measured and is thus typically overlooked in national statistics, poverty assessments and land-use and natural resource management decisions. In

particular, the patterns of winners and losers associated with ecosystem change, and their impact on the chronically poor and women in particular, has been given little consideration. Such inattention can lead to inappropriate strategies that ignore the role of environment in poverty reduction, possibly leading to further marginalisation of the poorest sectors of society and increased pressure on ecosystems.

4.2 EXAMPLES OF IMPORTANT PROVISIONING SERVICES

4.2.1 Natural products (non-timber forest products (NTFPs) or veld products)

4.2.1.1 Importance of natural products for the poor and trends

Across the southern African region, poor rural and, to a lesser extent urban, communities make use of a wide array of products gathered from natural and modified ecosystems to meet their everyday livelihood needs (Table 10, Appendix 2 - Case Study 2 from Mozambique provides a comprehensive list of products). These provisioning services or goods are key in providing energy (Section 4.2.2), food and nutrition, medicines, and the raw materials for construction, crafts, tools and implements, and ritual and cultural purposes (Section 4.4.1). Considering food security alone, natural products are critical for many regularly utilised foods, for crisis or famine foods, for firewood to cook, for nutrients and vitamins, for forage, for genetic resources, for inputs into agricultural production such as poles for fencing, implement handles and ploughs, and for the raw material for manufacturing items as such as baskets and canoes for fishing (Bass *et al.* 2001).

Table 10: The importance of wild natural products in the livelihood options of the vulnerable Basarwa in Ngamiland District (Okavango Delta), Botswana (Source: Madzwamuse & Fabricius 2004, also see Appendix 2 - Case Study 6).

Livelihood strategy	Site	
	Xaxaba (n= 15)	Khwai (n=14)
Fishing	15 (100%)	9
Basket making	11	7
Arable farming	0	8
Mokoro safaris	4	0
Hunting	2	0
Formal employment	5	3
Remittance	7	5
Sale of reeds	15 (100%)	8
Sale of grass	8	9
Drought relief and food rations	0	3
Traditional building materials	9	4
Wild fruits and vegetables	13	4
Other CBNRM	4	0

A synthesis of 14 case studies from the communal woodlands of South Africa indicated that wild vegetables, fuelwood, wooden utensils, wild fruits and traditional brooms were used, on average, by 85 % or more of households. Other important products, harvested by approximately half of households, included wood for fencing or cattle enclosures, weaving materials, edible insects, traditional medicines and bushmeat (Shackleton & Shackleton 2004a). Across the savanna ecoregion household use of these products has been valued at between US$50-1 130 per household per annum, contributing between 15-29 % of total household income (Box 6). The value for the Kalahari arid region in 2007 was estimated at US$270 per annum. This use of

essentially 'free' natural products permits poor households significant cash savings that can be redirected to other needs (Shackleton & Shackleton 2004b). However, in general, the gathering of NTFPs is an undervalued activity because of limited data and information (Madzwamuse *et al*. 2007).

Box 6: Value of natural products to poor households

Valuation studies undertaken in a number of arid and semi-arid areas of southern African countries have demonstrated the significant economic value of wild resources for rural households, with the income share from these products reaching as much as one-third of total household income. In most cases, the largest proportion of this value can be attributed to fuelwood consumption, followed by wild foods and construction materials.

Region/Country	Value (US$ per household per year) #	Contribution to total household income (%)	Source
Botswana	335	20.1	Zitzmann (2000) in Chipeta & Kowera (2004)
* Botswana , Kgalagadi South,	270	-	Madzwamuse *et al*. (2007)
Zimbabwe	436	28.4	Cavendish (2000)
Zimbabwe	50-85	-	Campbell *et al*. (1996)
Zimbabwe	120	-	Clarke *et al*. (1996)
Zimbabwe	578	-	Campbell *et al*. (1997)
Zimbabwe	320	-	FAO (1999)
Zimbabwe, Chivi	99	15.0	Campbell *et al*. (2002)
South Africa, Kat River, E. Cape	241	-	Shackleton *et al.* (2002a)
South Africa, Fish River, E. Cape	160	-	Cocks & Wiersum (2003)
South Africa, Kwajobe, KwaZulu-Natal	469	-	Shackleton *et al.* (2002b)
South Africa, Bushbuckridge, Limpopo Prov.	572	19.4	Dovie (2004)
South Africa, Mogano, Limpopo Prov.	1 130	-	Shackleton *et al.* (2002b)
South Africa, Ha-Gondo, Limpopo Prov.	565	-	Shackleton *et al.* (2002b)
South Africa, Mametja, Limpopo Prov.	620	-	Twine *et al*. (2003a)
South Africa, Makua, Limpopo Prov.	388	28.2	Crookes (2003)
South Africa, Manganeng, Limpopo Prov.	180	22.0	Crookes (2003)
South Africa, Cwebe, E.Cape	694		Shackleton *et al*. (2007)

#Values are not directly comparable as different studies have varying criteria regarding what to include/exclude from the analysis, for example the Cavendish study includes livestock browse while the others do not. Local currencies have been converted to US$ at the exchange rate for the year that fieldwork was completed. *This is example is from the arid ecoregion while all the others are from the savanna ecoregion.

Numerous products, ranging from raw materials like thatch grass, to crafts, medicines, plant extracts such as oils, and insects like mopane worms are also traded in local, national and, increasingly, international markets, providing an important opportunity to generate cash income. This trade is especially important for the poorest and most marginalised sectors of society and those living in regions with few alternative economic options or poor agricultural potential such as in the southern Kgalagadi District of Botswana (see Appendix 2 - Case Study 7). There is evidence across southern Africa of a general trend of growing participation in the natural resource trade as households face increasing hardship (e.g. Campbell *et al.* 2002, Shackleton 2005). In some instances this includes products that were previously taboo to sell, e.g. marula beer (Shackleton 2004). In Chivi in Zimbabwe, cash from sales of woodland products provides on average 15 % of total income for 'very poor' households, but less than 1 % for wealthy households (Campbell *et al.* 2002). For poor women trading traditional brooms in the northeast of South Africa, income from sales contributed more than 75 % of cash income for one-third of households surveyed (Shackleton & Campbell 2007). In the Okavango delta, basketry for sale to tourists is a key livelihood option for poor Basarwa women (Table 10). In the Kalahari about one-quarter of households generate income from the sale of 'veld' products (Velempini 2006).

Regarding the export trade, the development of natural products for specialised cosmetic, pharmaceutical, food and nutraceutical markets is increasingly being seen as an opportunity to contribute to poverty alleviation while simultaneously ensuring conservation and maintenance of natural ecosystems (e.g. PhytoTrade Africa, Section 4.8.2). However, there needs to be much greater recognition and support of this sector (Madzwamuse *et al.* 2007). In Botswana during 2005 approximately US$77 000 was generated through the sale of veld products at national level, however this figures does not include the many products, such as thatch grass, sold in informal markets (Madzwamuse *et al.* 2007, Appendix 2 - Case Study 7).

Box 7: Importance of riparian areas and wetlands for wild foods and natural products in the study region

Fish is an important food source in many natural wetland areas and rivers in the study area, as well as in artificial lakes such as Lake Kariba where the introduced species kapenta supports a viable commercial and subsistence fishing industry. Two examples of wetlands where fish make a major contribution to the diet of local people are east Caprivi in Namibia and the Pongola foodplain in South Africa.

Riparian zones provide many natural resource products and foods in addition to fodder and fuel. Jacobsen et al. (1995) describe how people in the Hoanib catchment in western Namibia make widespread use of natural products including tree fruits for food, resins (some of which are eaten), medicinal plants, household utensils and dyes and tanning agents for leather. In many wetland areas thatch grass is an important product while grasses and reeds are used for baskets, mats and fishing traps.

Wild game is attracted to these areas due to availability of water and forage, thus providing both a food source and in conservation areas, a tourist attraction. Many of southern Africa's main tourist areas are linked to river or wetlands systems (Okavanga Delta, Etosha pans, Chobe Reserve, Mana Pools). Tourism provides a local source of income, but is also excludes people from tourism areas. The extent to which tourism alleviates poverty is not well researched

Seldom appreciated is the fact that a significant proportion of products are harvested for their social, spiritual and cultural significance and value. Work in the Eastern Cape of South Africa has shown that the amount of plant material harvested for cultural uses (2 016 kg per household p.a.) exceeds that for utilitarian uses (1 754 kg) (Cocks 2006). These products may be used as traditional gifts (e.g. mats and brooms), as cultural symbols (e.g. woodpiles amongst the *amaXhosa* in South Africa), in rituals (e.g. particular species of firewood, alcoholic brews, medicines), as charms and talisman against external agents like witches, as 'protectors' against events such as lightning strikes (e.g. grass brooms), and to build friendships and reciprocity. The latter is particularly important in assisting households cope with vulnerability. For example, the sharing of marula (*Sclerocarya birrea*) beer (a widespread savanna ecoregion product) plays a key role in building and maintaining vital social support systems, allowing people to draw on these networks in times of need (Shackleton & Shackleton 2005). Often the procedure of gathering and processing natural products results in important social benefits as groups of people cooperate in these activities (den Adel 2002). Hunting amongst the San communities of the Kalahari Desert for example is not just important for providing protein, but is integral to the social fabric and identity of this group of people (Campbell 1986). A significant part of the trade in natural products within urban areas relates to the cultural rather than utilitarian significance of these products (e.g. traditional brooms and mats and protective medicines). Many products are also frequently used to barter for other goods that are not available locally or as a source of exchange for labour. For example, female-headed or elderly households needing the help of a strong man to assist with, for instance, building repairs, often brew traditional beers (Shackleton & Shackleton 2005) or collect wild fruits as 'payment'. It is also not unusual for children to exchange wild fruits for other foods such as milk (Shackleton *et al.* 2000a, McGarry 2008). While complex to do, some scholars have attempted to place a monetary value on these consumptive cultural resources. In two sites in Zimbabwe, Campbell *et al.* (1997) reported that the cultural value of the environment accounted for 29 % and 16 % of the value of goods appropriated from the environment.

Frequently natural products may only be gathered, used and/or sold in times of emergency, hardship or misfortune as a form of 'natural insurance', at critical times of the year to bridge income gaps (i.e. during the so called lean period between agricultural harvests), and/or to meet specific needs such as school fees or the costs of a celebration. This safety net, buffering, and gap filling role of natural products serves the function of reducing household risk and vulnerability, often helping to prevent households, particularly the poorest from sinking lower into

poverty in difficult times, such as during droughts, disease, retrenchment, escalation in commodity prices, conflict, death of a breadwinner or cash flow crises (Takasaki *et al.* 2004). Examples include the harvesting and sale of firewood and crafts along roadsides; the construction of dwellings or shelters from poles and clay as opposed to cement bricks; and the more frequent use of wild vegetables.

As way of illustration, wild foods and medicinal plants as two of the most widely used and important natural products in terms of human well-being within the southern African region have been selected for more detailed discussion.

4.2.1.2 Wild foods

Chronic food security has been a major concern in southern Africa since the turn of the millennium (Maunder & Wiggins 2007). In South Africa, the most developed country in the region (Table 6), approximately 14.3 million people are considered to be vulnerable to food insecurity (DEAT 2006). In Mozambique, 33-56 % of children between 0-5 years old are suffering from chronic malnutrition, with the exception of Maputo province in which 24 % of children are malnourished (UNEP/IISD 2004). Multiple factors are believed to be driving this situation including a deepening of poverty, HIV/AIDS, drought, land degradation, increasing food prices and weak governance (DEAT 2006, Maunder & Wiggins 2007). In this context, wild foods, which have always formed a significant component of poor people's diets, are becoming an increasingly important option in the suite of coping strategies that households employ when faced with food shortages and nutritional deficiencies.

Box 8: Impacts of ecosystem change on natural products, wild foods and food security: An example from arid Namibia (Mizuno & Yamagata 2005)

The pastoral Topnaar people of the arid Gobabeb region of the Kuiseb River (average precipitation is 27 mm from rain and 31 mm from fog) rely on the wild melon - *Acanthicyos horridus* - as their most important food source during the hot summer months of December to March. This plant grows extensively in fields in the lower reaches of the river providing not only food but also cash income from the sales of the seeds for food and oil. However, the growth and production of this species has declined dramatically in recent years because of a lack of floodwater in the river due to the construction of a dam upstream. Floodwater is considered to be vital for the regeneration and survival of this important food species. In the same region, *Acacia erioloba* trees, which are vital as a source of famine food, firewood, forage for goats, shade and shelter and medicines, have been buried by encroaching sand dunes.

Local people's vulnerability has greatly increased as a result of these environmental changes and the authors argue that there is a need for a much better understanding of the dynamic relationships between environment and vegetation and the implications for people in Namibia, especially given the evidence of climate change.

Wild foods as a category represent a diverse complex of both plant and animal derived products, including fruits, green leafy vegetables, woody foliage, bulbs and tubers, cereals and grains, nuts and kernels, saps and gums which are eaten or use in wine making, mushrooms, invertebrates such as insects and snails, honey, birds eggs, bushmeat from small and large mammals, reptiles and birds, and fish from fresh water ecosystems. Hundreds of different species are involved. In general, the savanna ecoregion produces a greater diversity of wild food products (e.g. of approximately 1 365 woody species in this region 265 (19 %) produce edible fruits) than the drier deserts and dwarf shrublands ecoregion, although inhabitants of the latter are often more reliant on these resources because of the poor potential and high risks associated with arable agriculture in these harsh environments (Madzwamuse *et al.* 2007). In this ecoregion, the Cucurbitaceae (melons - also a significant genetic resource) are particularly important and may be cultivated (Maggs *et al.* 1998, Madzwamuse *et al.* 2007). Other important wild foods from Botswana's drylands include truffles (*Terfezia pseilli*), bush raisins (*Grewia flava* fruits), mopane worms (*Imbrasia belina*) and honey (Madzwamuse *et al.* 2007). Some wild foods, e.g. wild vegetables or bushmeat, may be relied upon as relatively regular inputs into the diet (wild vegetables were rated as the second most frequently used food item in the diet amongst the Vhavenda in northern South Africa – Nesamvuni *et al.* 2001), while others such as wild fruits and insects are often subject to opportunistic consumption in the form of seasonal snacks. In the more arid areas, so called famine foods may only be turned to in times of crisis and would not normally be consumed as part of the diet.

In general, the critical role of wild foods in household food security across the region tends to be under-reported and overlooked (Biggs *et al*. 2004). While lists of edible species and information on the nutritional properties of some of these exist, quantitative data on the use of wild foods and their contribution to the overall diet in terms of both food quantity and in meeting nutritional requirements are scarce. With regard to bushmeat, this may be partly because wildlife harvesting is illegal in most countries and therefore use goes undeclared and unrecorded. Where data do exist, the evidence supports the importance of these products in meeting household dietary needs (Table 11), particularly given that poor people's diets across the region are based on staple grains (millet, sorghum and maize) and are therefore high in carbohydrates and low in essential vitamins and animal derived proteins (van der Waal 2004). Analysis of the nutritional composition of numerous wild food species has shown these to be superior to many cultivated vegetables and fruits, while insects and bushmeat are important sources of protein.

Table 11: Examples demonstrating the importance of wild foods in the diets of poor households across the region.

Country	Evidence of importance of wild foods in the diet	Source
Botswana	"Without wild food the greater part of the Khoe and San population would starve". For the primarily foraging !Kung group, *Ricinodendron* (manketti) forms 60 % or more of their vegetable intake. Some 75 species of edible plants were recorded.	Campbell (1986)
	91% of households in a study in Botswana collected and consumed mopane worms (*Imbrasia belina*). The popularity of mopane worm as a food has resulted in an extensive trade across the region, with thousands of tonnes sold annually in South Africa, Namibia, Botswana and Zimbabwe.	Zitzmann (2000) Greyling & Potgieter (2004)
Namibia	The pastoral Topnaar people of the Kuiseb river rely on the wild melon, *Acanthicyos horridus*, as their most important food source from December to March.	Mizuno & Yamagata (2005)
	In Caprivi wild foods provide up to 50 % of household sustenance during the non-agricultural season.	Ashely & LaFanchi (1997)
South Africa	In the Eastern Cape of South Africa edible green leaves formed more than half the daily frequency of intake of vegetables and fruit during summer, with 50 % of households sampled mentioning that they also dried the leaves for winter consumption.	Kirsten (1977)
	An average of 96 % of households across 14 studies were found to eat wild vegetables and 88 % wild fruit. Average mass of wild vegetables and fruit consumed per household per year was 58.2±26.3 kg and 104.2 ± 15.6 kg respectively. (Quantities based on recall rather than direct measure).	Shackleton & Shackleton (2004)
	In northeast Limpopo Province (formally Venda), 96 % of households surveyed (711 in total) consumed grasshoppers. A daily per capital consumption of 19 grasshoppers or 14 g was estimated.	Van der Waal (2004)
Swaziland	Of 133 meals surveyed, 39 % contained wild vegetables including naturalised weeds.	Ogle & Grivetti (1985)

Mirroring the pattern for other ecosystem services, more vulnerable households tend to rely more on wild foods than better off households. Research in Zimbabwe has shown that that recourse to wild foods as a strategy for coping with food deficits is diminished when people have access to alternative sources of cash or food (Zinyama *et al.* 1990). In the Kat River valley in South Africa, the mean frequency of consumption of edible herbs and the amounts eaten per household were highest for poorer households (Shackleton & Shackleton 2006). Recent work in the dry savannas of northeast South Africa has illustrated how households affected by an adult mortality experience (most likely due to AIDS) use more wild foods to meet household dietary needs than unaffected households (Hunter *et al.* 2007). Ongoing work with AIDS orphans in the Eastern Cape of South Africa has shown that hunting of small mammals and birds provides one of the few sources of protein for these children (McGarry 2008) (Table 12). The strain that HIV/AIDS is placing on household resources and social networks may be increasing dependence on wild food sources as even better off kin and neighbours can no longer afford to help each other out.

Table 12: Frequency of wild animals in children's diets over a two-week period and the percent of children hunting each taxonomic group. Proxy indicators were used to determine the vulnerability of each child to the social, economic and health impacts of HIV/AIDS and to categorise them as either highly vulnerable or least vulnerable (McGarry 2008).

Taxa		Least vulnerable n=24	Highly vulnerable n=25	P value
Mammals	Frequency in diet	39	133	0.04
	% Using	33	60	0.06
Birds	Frequency in diet	89	195	0.02
	% Using	25	64	0.01
Reptiles	Frequency in diet	8	13	0.33
	% Using	4.2	12	0.03
Insects	Frequency in diet	3	13	0.05
	% Using	4.2	24	0.05

4.2.1.3 Traditional medicines

Wild plants form an important component of healthcare in the region, with more than 80 % of people across most countries in sub-Saharan Africa consulting traditional healers. Traditional medicines may be collected by users themselves, bought from traders or obtained through consultation with a traditional healer. Large markets for these products exist. In southern Africa, the trade in medicinal plants is dominated by between 400 000 and 500 000 traditional healers, and provides income for a similar number of poor, mainly female, urban and rural traders. The volume of plant material traded is estimated to be between 35 000 and 70 000 tonnes p.a., with a market value of US$75 to 150 million (Mander & le Breton 2006).

In contrast to some of the other provisioning services, the use of traditional medicines is not confined to rural and low-income groups but rather represents a basic requirement for the treatment of certain conditions irrespective of education and income levels (Marshall 1998, Cocks & Dold 2000). The local availability and affordability of medicinal plants, however, does make their use an obvious and important choice for poor people, with many using these products for self-medication. In Mozambique it is estimated that some 60 % of the rural population has access only to traditional medicines (UNEP/IISD 2004).

Like other natural products, the use of traditional medicines goes beyond just healthcare. Numerous medicinal plants are used to control events by supernatural means, while others have symbolic value. Cocks & Dold (2006) found that of the 60 most frequently traded species in the Eastern Cape, South Africa, 50 % were administered for purging and 48 % for ritual washing. Such actions are important for protection against sorcery and evil forces; communicating with the ancestors; and for spiritual well being. This suggests even with improved access to western medicine there will continue to be a large demand and market for traditional medicines.

Like wild foods plants, information on the scale of use and the importance and value of medicinal plants to user households, traders and other actors is sparse. In South Africa rural households utilise a mean amount of 3.9 kg per annum and urban households 2.9 kg. These quantities equate to approximately US$12.30 in monetary terms for urban households and US$8 for rural households (Cocks & Dold 2006).

A number of medicinal plants from the region have been commercialised for the international trade. One of the most important of these is devil's claw (*Harpagophytum* spp.), a Kalahari plant used to treat rheumatism and arthritis. It is estimated that some 9 000 of the most marginalised

rural people in the arid areas of Namibia, Botswana and South Africa rely on the harvesting and sale of this plant as their primary source of cash income (Wynberg 2004). In Kgalagadi South, Botswana devil's claw was rated as having the highest priority in the livelihoods of people in that region (Madzwamuse *et al*. 2007). However, the returns harvesters receive (US$10-50 p.a.) from a trade worth some US$100 million is minuscule with almost no value-adding taking place in the region. It is also argued that moves to cultivate this plant, which would help address concerns regarding the sustainability of wild extraction, may further threaten local benefits by favouring commercial farmers and agribusiness over and above marginalised small farmers and local livelihoods (Wynberg 2004). *Hoodia goordonii* another important internationally traded Kalahari plant is discussed in Section 4.5.1.

Many medicinal plant resources are under pressure, with research across the region revealing a growing shortage in the supply of popular species (Williams *et al*. 2000, Dold & Cocks 2002, Maundu *et al*. 2005). Escalation of harvesting for commercial production has led to concern regarding the sustainability of wild extraction and the concomitant effects on local livelihoods for a number of species including devil's claw (Wynberg 2004). High demands have led to the virtual extinction of species such as wild ginger (*Siphonochilus aethiopicus*) and pepper-bark tree (*Warburgia salutaris*) outside of protected areas (Maundu *et al*. 2005). A TRAFFIC study in east and southern Africa has identified approximately 100 species of conservation concern in one or more of the countries covered (Mulliken 2003).

4.2.1.4 Drivers of change in the availability of natural products

There are multiple interrelated and interacting direct and indirect factors or drivers of change that affect the supply of natural products (Table 13). Many of these operate at a local level while others manifest at a regional scale with local impacts. A number are in common with those for other ecosystem services described in this report.

Land transformation is probably the major factor influencing the availability of the broad range of wild natural products, particularly within the savanna ecoregion where some 20-80 % is transformed. In Romwe catchment in Chivi, Zimbabwe, woodland cover had declined from 36 % to 22 % between 1984 and 1999 due to clearing for expanded cultivation, reflecting the demand for land by a growing population (Campbell *et al.* 2002, Appendix 2 - Case Study 1). Most of the remaining woodland is confined to rocky ridges and hills requiring a considerable increase in scarce labour time to collect products. Conversion to agricultural land, however, does not necessarily result in the loss of all species. Important fruit tree species are retained in fields and homesteads and even actively planted. **Competing demands among multiple-use species** can have negative impacts on some uses. For example, local fuelwood shortages have led to the felling of fruit producing species for firewood in some areas (Shackleton *et al.* 2000). Such competition amongst different uses for particular species is likely to be exacerbated by increasing land transformation and greater pressure on remaining patches of natural vegetation. **Selective use of favoured species** as well as heavy grazing, which impacts on regeneration, can result in ecosystem degradation (Campbell *et al.* 2002).

Box 9: Impacts of declining availability of natural products on the poor

- Greater allocation of scarce labour time spent searching for and harvesting products.
- Use of less favoured or effective alternatives.
- Need to purchase previously free supplies – with impacts on cash flow.
- Erosion of income earning opportunities built on the sale of natural products, which are most important for the poorest people and women.
- Loss of products with social and cultural value.
- Reduced food security and nutritional diversity.
- Loss of vital safety nets as fallbacks during periods of hardship and vulnerability (e.g. droughts).
- Social disruption and conflict because of greater competition for resources.
- Greater marginalisation of the poor and reduced resilience to stress and shocks.

While **unsustainable harvesting** is a direct driver affecting the availability of natural products, it is influenced by a number of indirect drivers. **Rising unemployment, poverty and HIV/AIDS** (see below), for example, are increasing dependence on natural resources for both home consumption and sale leading to higher, and potentially unsustainable, harvesting rates. Greater

reliance on the cash economy and the concomitant commercialisation for new and growing markets has resulted in increased pressure on selected resources, as is the case, for example, for hardwood species used in the woodcarving industry (Shackleton 2005) and a number of medicinal plant species (see above). **Urbanisation and population growth** are further factors driving the burgeoning trade in natural products, in particular medicinal plants. The opportunity offered by **expanding tourism markets** (see Section 4.4.2) can also lead to overutilisation of particular species, unless efforts are made to manage the resource base. There are clearly trade-offs between the growth in the markets for natural products and the impacts on poverty alleviation and the long-term, sustainable management of the resource base upon which the trade is dependent. Also especially remote communities often cannot access large or multiple due to distance or poor transport infrastructure.

Table 13: Key drivers of change in natural products as a provisioning ecosystem service for the poor in arid and semi-arid regions of southern Africa (Key for magnitude: 1 = Low and 5 = High)

Drivers of change in supply of natural products for use by the poor	**Ecoregion**					
	Arid		**Savanna**		**Rivers & wetlands**	
	Direction of change	Magnitude	Direction of change	Magnitude	Direction of change	Magnitude
REGIONAL SCALE						
Land transformation	▼	1	▼	2	▼	3
Climate change	▼	1	▼	1	▼	1
Poverty	▼	1	▼	2	▼	2
Insecure tenure rights	▼	1	▼	1	▼	1
Net direction and magnitude of change	▼	1	▼	2	▼	3
LOCAL SCALE						
Land transformation	▼	1	▼	3	▼	4
Construction of large dams and water abstraction	▼	1	▼	1	▼	4
Heavy grazing	▼	1	▼	1	▼	1
Over-harvesting	▼	2	▼	3	▼	2
Commercialisation of products	▼	1	▼	2	▼	2
Weak governance or regulation	▼	1	▼	3	▼	2
CBNRM initiatives	▲	1	▲	1	▲	1
Erosion of traditional knowledge	▼	1	▼	1	▼	1
Net direction and magnitude of change	▼	1	▼	3	▼	3

Ineffective and weak local institutions in many areas have led to poor, or non-existent, harvesting controls and the exploitation of local resources by more powerful outsider groups (see Box 11, in-country consultations). In the past, the sustainable use of medicinal plants, for example, was facilitated by several inadvertent controls and some intentional management practices such as taboos and seasonal and social restrictions on gathering that were issued by traditional leaders and enforced by local headmen and community police. However with **cultural, policy and institutional change** (e.g. devolution of resource management responsibility to democratically elected institutions), and the pressures mentioned above, these controls are no longer effective in many areas (Maundu *et al.* 2005, also see Section 4.4.1 on cultural services). **Insecure and unclear tenure and use rights** across the communal areas of the region further undermines effective local governance of resources and can result in

unexpected loss of access to resources through 'privatisation' (often by the elite – e.g. rangelands in Botswana) or reversion to state control. In parts of Botswana and Nambia areas of communal rangeland are being fenced to secure exclusive access to key resources for livestock production. This is impacting particularly on politically marginalised groups, such as the San and Damara people, as they are cut off from essential resources necessary for their livelihoods and are unable to adapt to the changes that are taking place (PANRUSA Brief 4 2001).

HIV/AIDS is an important regional driver of change in natural resource use that has received limited attention to date (see Section 4.6.1.3). HIV/AIDS is increasing reliance on a number of natural products as other livelihood assets including financial, social and human capital are eroded. Evidence shows that agricultural labour and cash shortages amongst HIV/AIDS affected households has led to the reversion and increased consumption of wild plant foods and protein sources such as bushmeat and insects (UNAIDS 1999, Kengni *et al.* 2004, Hunter *et al*. 2007, McGarry 2008). A strong link has been reported between the increase in the AIDS pandemic and the use of traditional medicines (Maundu *et al.* 2005; Barany *et al.* 2005, Mander & le Breton 2006). Households are turning to more accessible and cheaper herbal remedies to ease the suffering of household members from AIDS related opportunistic infections. Within the South African context, 54 % of traditional healers interviewed in one study indicated an increase in the number of patients they had attended to over the last five years; 81 % expected a further increase in the next five years and cited the HIV/AIDS pandemic as the main reason for this (Dold & Cocks 2002). Recognising the importance of traditional medicines, the World Health Organization (WHO) has advocated the inclusion of traditional healers in national AIDS programs since 1991 in many southern and eastern Africa countries (Barany *et al.* 2005). Greater vulnerability and the loss of income in HIV/AIDS affected households may also lead to the increased use of a range of other natural products as households can no longer afford to purchase alternatives (Shackleton 2006). The increased harvesting of natural products created by the AIDS pandemic is likely to exacerbate pressure on existing stocks. This in turn may undermine one of the few coping strategies available to affected households. The complex linkages and feedbacks between HIV/AIDS and natural capital in terms of increased dependence on natural products; loss of indigenous knowledge and the strain on local institutions caused by the death of leaders and active members of society; changing markets and the potential for overexploitation needs more investigation.

Climate change is a looming threat to all ecosystem services, although presently there has been little research of its impacts at a local level in the region. The effects of climate change will be most felt amongst the poor and those in arid and semi-arid lands, both because of their dependence on natural resources and their limited capacity to adapt (WRI 2005). Changing rainfall and temperature patterns are predicted to increase water scarcity and have severe impacts on rainfed agricultural production. Both the area of land suitable for cropping and crop yields are expected to decrease (a recent FAO report predicted a decrease of 11 % in rainfed agriculture in developing nations – FAO 2005). In the arid regions of Namibia and Botswana even a slight increase in temperature or change in precipitation could produce a striking change in vegetation exacerbating the already human induced trends such as those taking place in the arid rangelands (Section 4.2.4) (Mizuno & Yamagata 2005). This change in turn becomes a positive feedback loop, and the effects continue to increase. Climate change is therefore expected to substantially increase reliance of locally adapted natural products in particular wild foods, wildlife and a range of hardy products that demonstrate good market potential (such as some of the desert medicinal plants).

4.2.1.5 Trade-offs in the provision of natural products for the poor

The everyday functioning and well-being of poor households is linked to a greater or lesser extent to some use of natural products or biodiversity. But, with food security as one of the most pressing issues in the region there is growing pressure to convert natural ecosystems to arable agriculture. Yet, the balance between the conversion of natural habitats for crop production and the need to maintain sufficient natural environment to support that agricultural endeavour and

broader livelihoods is extremely complex and subject to change in response to variations in the local and external context. Table 14 outlines some of the comparative advantages of wild foods relative to crop plants. It is thus not unsurprising that the poor make greater use of wild plant foods than to wealthier households (e.g. Shackleton & Shackleton 2006). Nontheless, external crop varieties remain a significant component of national and household food security strategies. Any considerations of trade-offs need to take into account multiple factors such as the marginal conditions for crop production in many arid and semi-arid areas, the potential effects of climate change, poverty and the potential winners and losers in the process, land tenure issues, labour requirements and what this means in the context of HIV/AIDS, market opportunities including for natural products and ecosystem services, and alternative land uses such as wildlife and tourism, to name but a few. In many instances the information to make informed decisions and choices is lacking. Where trade-offs are inevitable, farming approaches that promote biodiversity such as agroforestry could help maintain a supply of important natural products.

Table 14: Comparative advantages of wild plant foods and crops (adapted from Arntzen *et al.* 2007)

Wild plant foods	Crops
Adapted to local climatic and soil conditions, and thus are *relatively* drought and disease resistant. Safety-net to fall back on during adverse climatic times	Some stable crops stressed by heat and low variable rainfall, frequent crop failure
Based on multiple species and wide genetic base	Based on am extremely limited genetic base
Very limited or no inputs	High input costs, and many are provided via external markets (e.g. seeds, fertiliser, pesticides)
Gathering, little cultivation although potential for this. Accessible to all	Grown in designated areas. Need access to land
Part of a diverse, multi-use landscape providing numerous other ecosystem services	Part of more simplified system that can result in the loss of other ecosystem services
Highly nutritious	Less nutritious per unit weight
Part of local cultures	Introduced, alien to local cultures
Lower labour requirement	High labour requirement
Poor markets	More developed markets
Hardly recognised in policy and land use planning; little research and data	Mainstream development and land use; extensive research and support

While trade-offs between different ecosystem services occur, for any particular service there are also often trade-offs between the use of the service for immediate poverty relief and the need to ensure its long-term maintenance (Appendix 2 - Case Study 1). For example, trade-offs exist between natural product commercialisation and the vital income this is able to bring to some of the poorest members of society and the long-term sustainability of the resource base for the particular product. In some instances increased commercialisation also threatens subsistence use or displaces the local trade and the generally marginalised people involved in it. Often commercial gatherers, whether for the local, national or international trade, undertake this activity because they are in dire need of cash income and can ill afford to be concerned with resource management and more specifically curtailed use (Maundu *et al.* 2005). However, in other instances economic value may provide the incentive for sustainable management of the resource base (one of the premises of community-based natural resource management). The issues of sustainability and equity are areas that remain a challenge in use of natural products as an income generating and poverty alleviation option.

Often there are also trade-offs between environmental goals and sustainability and livelihoods – e.g. fencing of rangelands can sometimes help to improve the condition of the range resource but may exclude some of the poorest and most marginalised people from accessing the natural products they require for their livelihood needs, and consequently also increase pressure on remaining communal resources (PANRUSA Brief 4 2001, Appendix 2 - Case Study 5).

4.2.1.6 Interventions to secure provision of natural products for the poor

Generally, interventions to secure the sustainable supply of natural products have been product and location specific. Thus, the success, or failure, of such interventions, are dependent upon the context in which the intervention occurred and the nature and commitment of local actors. Key interventions that can have been shown to work in at least one locality include:

- Strengthened (legally recognised) local tenure and access rights.
- Strengthening of local institutions for natural resource management and more integrative approaches through, for example, CBNRM and INRM.
- Land use and district and local planning that take into consideration the broad range of natural resources/products that are key for local livelihoods including the links to culture (also see Section 4.8.4.3).
- Incorporation of local knowledge and practices into resource management (also see Section 4.8.4.6).
- Ex-situ cultivation – e.g. of medicinal plants (although as mentioned above precautions need to be taken to ensure that this does not fall into the hands of the more well-off and landholders at the expense of the poor).
- Multiple land use approaches, such as agroforestry, eco-agriculture.
- Increased access to the sustainable use of products in areas from which communities were traditionally excluded (e.g. protected areas).
- Support for and formalisation of the trade in natural products that includes systems for sustainable natural resource management and that ensures realistic pricing for raw material and finished products (Madzwamuse *et al.* 2007).
- Recognition of the importance of natural products for women and their increased participation in the management of these resources.
- Development of alternative land use strategies such as ecotourism that encourage the maintenance of natural ecosystems (see Section 4.4.2).
- Support for more efficient agricultural production, soil fertility maintenance, water conservation, etc. that can help reduce the constant conversion of new land to agriculture (Case Study No. 1, Frost *et al*. 2007).

4.2.2. Fuelwood as a provisioning service

4.2.2.1 Importance of fuelwood for the poor and trends

Over 80 % of rural and urban inhabitants in southern Africa as a whole make use of fuelwood as a primary or secondary energy source (IEA 2002). In Mozambique, and to a lesser extent in Zimbabwe, the harvested fuelwood resource is first transformed into charcoal before being used or sold. Amounts of fuelwood or charcoal used per household depends upon the local context in terms of local fuelwood availability, price and availability of alternative energy sources, household income, cultural preferences and taboos, but ranges from less than 1.5 tons per year to over 8 tons per year. The dynamic nature of many of these attributes means that modelling fuelwood demand and scarcity is problematic. At both sub-continental (e.g. Biggs *et al*. 2004) and local (e.g. Shackleton 1994, Banks *et al*. 1996) scales various modelling approaches have identified widespread areas with acute shortages of fuelwood juxtaposed with areas of seemingly adequate or plentiful supplies. Even in electrified villages and urban areas, use of fuelwood remains prevalent a decade or more after electrification (Campbell *et al*. 2003, Madubansi & Shackleton 2006).

At a macro-scale the links between poverty and use of fuelwood are clear, with a strong relationship between increasing GDP and access to electricity (Fig. 7). Access to adequate energy supplies and security of supplies underpins many aspects of development and the MDGs. Fuelwood is a poor country's fuel.

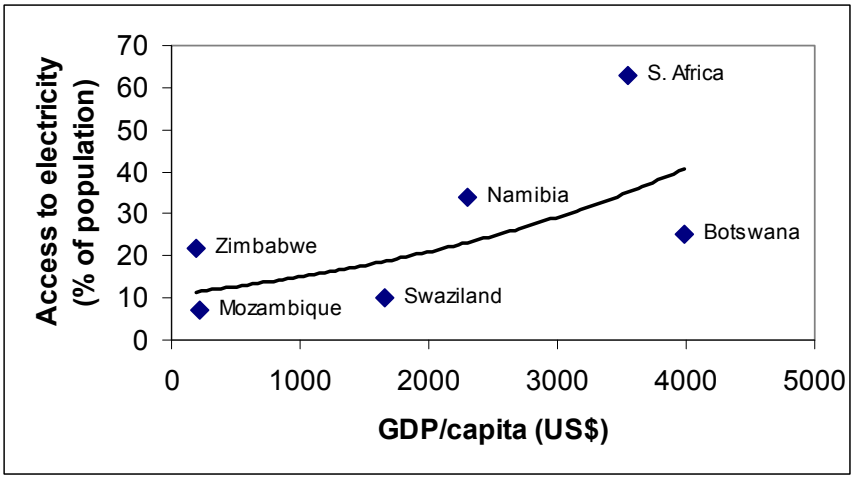

Figure 7: Increasing access to electricity with GDP for the six arid and semi-arid countries in southern Africa (Source data: ISES 1999)

At the local-scale the importance of fuelwood for the poor is readily apparent when contrasting fuelwood use patterns between different wealth groups (Table 15). Similar information from urban residents of Maputo (Mozambique) demonstrates that households with the lowest cash income use fuelwood the most frequently (Fig. 8). These two cases, and others, show that fuelwood is a poor person's fuel, and consequently, changes in availability and access can have significant impacts on the livelihoods of the poor (Box 10).

Table 15: Fuelwood use patterns and values across different household wealth categories in the Kat River valley (South Africa). (Source: Shackleton & Shackleton 2006)

	Poor	Intermediate	Wealthy
Fuelwood use (kg/person/day)	3.3 ± 0.8	2.4 ± 0.4	1.6 ± 0.3
Gross annual direct-use value per person (Rand)	318	231	154
% of household buying fuelwood	28	37	48
% of household selling fuelwood	20	3	0

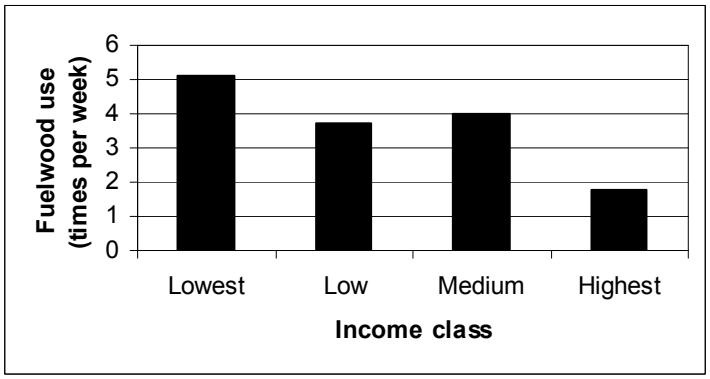

Figure 8: Frequency of use of fuelwood per income class in Maputo city (source data: Brouwer & Falcão 2004)

Box 10: Impacts of changing fuelwood supply on the poor

Because fuelwood is a poor person's fuel insufficient access to adequate fuelwood supplies has been shown to disadvantage the poor in a number of ways thereby exacerbating poverty:

- Increased walking distance to find supplies which results in increasing opportunity costs, especially for women, (e.g. Brouwer *et al*. 1997, Madubansi & Shackleton 2007), and risk of attack whilst collecting in the wilds (Shackleton *et al*. 2007a).
- Increasing use of poor quality species, meaning more fuelwood has to be collected to generate sufficient energy (Solomon 2000, Madubansi & Shackleton 2007).
- Use of species that may be traditionally protected or culturally taboo (Madubansi & Shackleton 2007).
- Increasing use of substitute energies such as dung, dwarf shrubs and crop residues (e.g. Shackleton & Gambiza in press).
- Reduced cooking time for meals, or fewer cooked meals per day, undermining nutritional status, and consequently jeopardising health (e.g. Brouwer *et al*. 1997).
- Purchase of what has been usually been regarded as a free resource, thereby reducing already limited cash resources. The corollary of this is that harvesting and marketing of fuelwood is an important livelihood option for the poor, with most sellers of fuelwood being poor households rather than more well-off ones (Table 14; Shackleton *et al*. 2006).
- Swapping to commercial fuels, impacting scarce cash resources.
- Progressive reduction of vegetative cover in the landscape, potentially contributing to environmental decline, depending on overall management and governance of the harvested areas.

There are marked differences across the countries and ecoregions with respect to fuelwood supply and demand, and hence role as a safety net for the poor. In the deserts and dwarf shrublands, relatively little fuelwood is produced. Consequently, local communities and individual households (i) consume less fuelwood, (ii) rely more heavily on what would be deemed as poorer quality biomass resources such as twigs, dung and dwarf shrubs, and (iii) collect and transport wood from key resource areas such as wooded riparian fringes (Solomon 2000). Such strategies will probably suffice for the short-term because human population densities are relatively low. However, if they were to increase, then the communities in the arid regions will be vulnerable to increasing energy insecurity (Biggs *et al*. 2004) and the attendant affects on poverty and well-being. The overall trend in the capacity of the arid ecoregion ecosystems to provide the existing low supplies of fuelwood is probably stable, with localised areas where it may be declining.

The higher rainfall of the savanna ecoregion results in higher densities and biomass of trees. Where human population densities and land transformation are low, there are usually adequate stocks of trees such that local communities can harvest deadwood with no impact on the productive capacity. But where human populations increase, along with land transformation for agriculture, then the productive capacity of the tree component declines, and households may resort to cutting live wood (e.g. Appendix 2 - Case Studies 1 and 3). If this progressively worsens then energy insecurity deepens, and is only ameliorated by one of more of the coping responses described above (Box 10), exacerbating poverty. The savanna ecoregion as a whole provides an excess of fuelwood, which is frequently exploited by local entrepreneurs to supply urban markets with fuelwood. However, there are many localised areas and communities where demand exceeds supply, which contributes to declining woodland exacerbating loss of other services, such the provision of wild fruits, carbon sequestration, erosion control, and ecotourism potential. Women bear the brunt as they typically are responsible for fuelwood collection and the cooking of meals. Conversely, there are areas where tree abundance is increasing via the process known as bush-encroachment (Appendix 2 - Case Studies 4 and 7). This includes alien and indigenous tree and shrub species. Reasons for encroachment of indigenous species are widely debated, including climate change, poor rangeland management, or stochastic interactions of a number of factors including drought and soil nutrient status (Ward 2005). These areas of local enrichment of woody resources are useful supplies of fuelwood, and local communities can become dependent on alien or indigenous encroaching species. However, this frequently comes with trade-offs such as loss of land for grazing, loss of biodiversity and if in riparian areas, reduced water availability (Shackleton *et al*. 2007a).

4.2.2.2 Drivers of change in the supply of fuelwood

The high temporal and spatial variability in the supply and demand for fuelwood undermine and estimates of rates and drivers of change (Table 16). Nonetheless, at the broad scale, **land transformation** is probably the most significant driver of a declining supply of fuelwood which could benefit the poor (e.g. Appendix 2 - Case Study 2). This includes transformation to other land uses, not only agricultural fields, but also residential areas, mines and transport infrastructure, and protected areas.

Table 16: Key drivers of change in fuelwood as a provisioning ecosystem service for the poor in arid and semi-arid regions of southern Africa (Key for magnitude: 1 = Low and 5 = High)

Drivers of change in supply of fuelwood for use by the poor	**Ecoregion**					
	Arid		**Savanna**		**Rivers & wetlands**	
	Direction of change	Magnitude	Direction of change	Magnitude	Direction of change	Magnitude
REGIONAL SCALE						
Land transformation	▼	1	▼	3	▼	4
Climate change	=		▲	2	=	
Poverty	▼	1	▼	2	▼	2
Poor or erratic electricity supplies	▼	1	▼	2	▼	1
Net direction and magnitude of change	**=**		**▼**	**2**	**▼**	**3**
LOCAL SCALE						
Land transformation	▼	1	▼	3	▼	4
Over-harvesting	▼	2	▼	3	▼	2
Too-frequent fires			▼	1		
Weak governance or regulation	▼	1	▼	3	▼	2
Land alienation	▼	1	▼	1	▼	1
Land redistribution	▲	1	▲	1	▲	1
Urban markets	=		▼	2	▼	1
Bush encroachment	▲	2	▲	1	▲	1
Net direction and magnitude of change	**▼**	**1**	**variable**	**2**	**▼**	**1**

Box 11: Collapse of governance and institutions impacts on fuelwood supplies

In the Bushbuckridge lowveld in South Africa Twine (2002) described a free for all over sudden access to fuelwood stocks on a private farm that resulted in the intervention of police. The farm was neglected and run-down. A rumour started that it was open for harvesting. Within two days dozens of pick-up trucks and over 200 harvesters were cutting and collecting, walking home with head-loads of fuelwood, or driving off to local markets and then returning for more. Some had come from many kilometres away. Warnings from the police were ignored, and eventually the harvesters were tear-gassed, simply because they were desperate for fuelwood

In a survey of 10 villages in three provinces, Twine *et al*. (2003b) reported that all experienced considerable problems with competition for harvesting of fuelwood by outsiders – either from neighbouring villages or entrepreneurs supplying urban markets. A range of reasons were provided for the problem: 22 % of respondents said poverty, unemployment and inadequate supplies in their own villages forced outsiders to disrespect local regulations and needs, whereas 54 % referred to inadequate regulations, no policing, and disrespect for local authorities.

At the local scale, drivers and net changes are dynamic, with some areas severely depleted and others experiencing increases due to bush-encroachment. However, the drivers with the most widespread and severe impact are negative, namely land transformation and **over-harvesting**. Often the latter is a result of the former, because the transformation results in less tree and fuelwood stocks per capita, resulting in higher intensities of use of the remaining stocks, and

rates of both are influenced by the **strength of local governance structures**. The drivers of change are relatively similar between the different ecoregions, but the magnitude differs. Most have greater magnitude in the savanna ecoregion because it experiences higher human pressures, both from locals as well as large urban markets (Box 11).

Generally, most of the drivers of change are relatively slow variables with cumulative effects built up over time. However, changes such as land alienation or the reverse, i.e. land redistribution, can be rapid with immediate impacts on the availability of fuelwood and the capacity of local ecosystems to support the poor. For example, alienation through establishment of protected areas, mining concessions or golf courses can cut off local people relatively suddenly from areas in which they have harvested for decades or centuries as described by Shackleton e*t al*. (2006) near Alicedale in South Africa. They are typically powerless to do anything about it. In comparison, land redistribution can return communities alienated in the past to areas of higher tree densities than they currently experience, such as has happened in Zimbabwe over the last few years, or several land claims in South Africa and Namibia. Bush-encroachment is also usually a slow process, but is noteworthy for three reasons, namely (i) it is has positive benefits on fuelwood supply, (ii) that these come with trade-offs for other ecosystem services, and (iii) it probably involves the crossing of thresholds, such that bush-encroached areas do not return if the local driver is relaxed.

4.2.2.3 Trade-offs in the provision of fuelwood services

Trees provide a variety of ecosystem services other than just fuelwood. Consequently, promoting or maintaining treed areas for fuelwood will benefit the rural and urban poor in other ways too. For example, the supply of fruits for consumption and sale, carbon sequestration, cultural beliefs associated with specific species, habitat for wildlife, ecotourism, and so on. Fuelwood itself could be, and has been, supplied via woodlots and plantations, but then some of these other ecosystem services would be absent or reduced. Moreover, woodlot programmes for fuelwood are expensive to establish and are plagued by governance and management issues, such that only relatively small areas have been planted in southern Africa (Box 12), and these have generally not lived up to their potential in any of the countries (Ham & Theron 2001). Currently, government and international institutions are rather moving towards supporting existing practises of tree retention and planting for numerous benefits in homesteads and fields, as opposed to planting woodlots (e.g. Kojwang & Chakanga 2002, Sekgopo 2002). Typically this involves a mix of exotics and indigenous species, with marked preferences for species with large or commercial fruits, cultural importance, wind-breaks or substantial shade. Fuelwood attributes are rarely a significant criterion (e.g. Chivaura-Mususa *et al*. 2000, Paumgarten et al. 2005).

Box 12: Approximate area of woodlots per country

Country	Area of wood-lots (approx.)	Source
Botswana	< 2 000 ha	Sekgopo (2002)
Namibia	± 1 000 ha	Kojwang (2000)
South Africa	± 62 000 ha	Ham & Theron (2001)
Swaziland	< 20 000 ha	Gov of Swaziland (2001)

4.2.2.4 Key interventions that can ensure continued provision of fuelwood

Numerous policy interventions have been touted to ensure energy security for the poor through use of fuelwood, with several authors stressing that integrated solutions are required through pursuit of several options simultaneously, rather than single sectoral approaches (Mahari & Howorth 2001, Shackleton *et al*. 2007c). In instances where local fuelwood stocks have been restored, local livelihoods have benefited through a reversal of one or more of the adverse effects on the poor listed in Box 13. Typical restoration approaches have been via (i) tree distribution and woodlot planting programmes, (ii) clearing of invasive species (alien or indigenous) and subsequent use of the wood, or (iii) facilitation of access to fuelwood stocks in protected areas (Box 13).

Box 13: Ensuring fuelwood supplies to benefit the poor

(1) Harvesting of fuelwood from protected areas
Many protected areas throughout the region permit some harvesting of fuelwood, either by hand or from bush-clearing operations. In the arid and harsh Richtersveld National Park on the border between Namibia and South Africa, local pastoralists are allowed to harvest deadwood in the park. They do so mainly from the riparian fringes of the Gariep River, as woody biomass in the rest of the park is very low. They take the fuelwood along with them when travelling to the relatively treeless arid interiors of the park (McDermott 2006). In a more structured programme, Davies (1994) describes a community-orientated programme of bush-clearing in private reserves of the central lowveld, employing approximately 100 local people and supplying the wood to local markets.

(2) Supplying trees in high population areas
Most of the countries in the region have had programmes at one time or another to supply trees to rural communities. One of the largest was the Plant for Life initiative in South Africa during the late 1980s and early 1990s (Williams *et al*. 1996). Over one hundred thousand trees were planted or distributed and 96 nurseries and 50 woodlots established. Areas with limited or declining natural wood stocks were targeted. The long term benefits were never monitored.

(3) Charcoal markets in Mozambique
Many rural dwellers increase use fuelwood or charcoal when hardship strikes. Some also turn to selling fuelwood along the roadsides, or transporting it to local urban markets. For some, this consequently evolves into a full-time activity, providing a regular cash flow and easing household vulnerability. For example some charcoal sellers supplying urban markets in Mozambique earn up to US$ 4.00 per day, well above local poverty lines.

(4) Clearing of invasive trees
South Africa has one of the largest, and most labour intensive, alien clearing programmes in the world. It targets riparian areas, and hence is called the Working for Water programme (WfW). It provides over 20 000 jobs annually (Binns *et al*. 2001), but equally importantly the cleared wood is available to poor rural communities either for free, or a small fee. Approximately 40 000 ha are cleared annually, which would conservatively yield 600 000 – 800 000 tons of wood. In some area small businesses have been establish to add value through charcoal making, or chopping and bagging for niche urban markets.

(5) Agroforestry & retention of trees
Maintaining trees in fields and homesteads, as is commonly practiced by local households, provides much needed fuelwood, and ameliorates the growing conditions for crops.

4.2.3 Fresh water as a provisioning service

4.2.3.1 Importance of a safe water supply for the poor and trends

Rivers and wetlands comprise two interconnected ecosystems. For the purpose of this report a river is defined as a linear ecosystem characterised by channelised flow that may be perennial, seasonal or ephemeral. A wetland is an area that normally lies adjacent to a river and that are permanently, seasonally or infrequently saturated. Wetland areas are therefore well-watered land surfaces that can support a large biomass of vegetation, associated fauna and human activities. Wetland areas often include pools and ephemeral or seasonal distributary channels that themselves provide important habitat.

Because water is essential for life, the ecosystems associated with rivers and wetlands acquire special significance in dryland areas, being green corridors in an otherwise arid landscape. These ecosystems supply a range of services that are of value to people which Masundire & Mackay (2002) and Turpie & van Zyl (2002) list as follows:

- Water supply for household use, agriculture, industry and power generation.
- Dilution, transport and purification of biodegradable wastes.
- Harvesting of wild plants and wild animals including fish.
- Transport routes.
- Aesthetics, leisure and tourism.
- Cultural customs and spiritual values.
- Flood attenuation.
- Moderation of microclimate.
- Maintaining terrestrial ecosystems through groundwater recharge.

With specific reference to poverty, Hirji & Molapo (2002) show the importance of water (Table 17).

Table 17: Linkages between water, environment and poverty. (Source: Hirji & Molapo 2002)

Dimensions of poverty	Examples of water and environmental linkages
Income and consumption	Access to water for productive use. Access to natural resources, sustainable growth
Inequality and equity	Secure tenure and access to natural resources, water rights and entitlements
Sustainable livelihoods	Sustainable land and water practices
Health	Water quality, safe drinking water and sanitation. Protection against water borne disease
Security and vulnerability	Improved disaster preparedness and response, water harvesting and conservation
Inclusion and empowerment	Participation, devolution of ownership. Right and responsibilities to water users, community groups, basin organizations, local governments

Fresh water is the most obvious provisioning service provided by rivers and wetlands. Water is essential for domestic purposes (drinking, cooking and personal hygiene) and for watering crops and livestock. Water is thus important for maintaining health and for supporting agriculturally based livelihoods. Box 14 outlines how HIV/AIDS increases the need for safe water and how poor water supply can substantially increase the vulnerability of affected households and the discomfort of AIDS sufferers. In urban areas water is also used by industry and for power generation.

Box 14: HIV/AIDS and household water use in Ngamiland, Botswana (Source: Ngwenya & Kgathi 2006)

The majority of households (73 %) in Ngamiland have access to piped water from community standpipes. However, water supply can be erratic, leaving households without piped water for several days. Reasons for the failure of supply include, amongst others, breakdown of the pump, as well as "high absenteeism from work by the water officials due to HIV/AIDS related illnesses and attendance at funerals". The two most common coping strategies to deal with interrupted waters supplies are to (i) use less water and (ii) collect water from nearby dams or streams. The unreliability of supply compromises local livelihoods – 66 % of households complained of the inconvenience.

This unreliability has other impacts, especially in view of the high incidence of HIV/AIDS in the region (± 35 % of pregnant females presenting at clinics are HIV+; overall prevalence in the adult population is ± 15 %). Mean daily consumption rates of water are 30 l person. However, in households with AIDS sufferers, the amount of water required increases by 67 – 165 %. Consequently, households with AIDS sufferers experience severe and potentially life-threatening difficulties when the water supply is interrupted. Firstly, the use of water from dams or rivers potentially makes the AIDS patient more vulnerable to opportunistic infections derived from water-borne micro-organisms. Secondly, the inability to bath the patient increases their discomfort. Thirdly, the inability to wash soiled clothes presents unhygienic conditions in the household. Lastly, family care givers face social sanction and exclusion for not looking after patients properly when they fail to bath them regularly or wash their clothes. The majority (96 %) of care givers stated that the unreliability of water supply increased the burden of caring for AIDS sufferers.

In urban and more developed communities treated water for household use is normally delivered via a reticulated system either to the house or to a nearby standpipe. Water for irrigated agriculture is delivered to fields via a sophisticated infrastructure that may include pumps, canals and off-channel storage dams. Whether water is for household use or irrigation, the reliability of supply is enhanced by the construction of storage dams, sometimes linked to interbasin transfer schemes and other engineered structures.

The poor are most likely to belong to those communities that do not have developed household supplies and are excluded on economic grounds from being able to afford the necessary infrastructure for a formal irrigation scheme. They therefore depend more directly on the natural water sources for domestic water supply and flood irrigation, as do dispersed rural settlements. The quality and quantity of water in the river/wetland or aquifer is therefore of great importance for the well-being of poor communities, especially rural ones because bulk water supply systems are more limited (Table 18). For example, 76 % of rural dwellers in Mozambique rely on unimproved water supplies, with the attendant health risks due to pollution and water-borne diseases. A common intervention is

the tapping of groundwater supplies along with community stand pipes scattered throughout the village.

Table 18: Access to improved water supply (note that this does not imply in-dwelling taps).

% of population with accessed to improved water supplies (2002)	Botswana	Mozambique	Namibia	South Africa	Swaziland	Zimbabwe
Urban	100	76	98	98	87	100
Rural	90	24	72	73	42	74

The quality of river water is impacted by pollution from upstream users, with faecal waste being the most serious for human health. An important service provided by the river ecosystem is to cleanse the water of organic and faecal materials. Wetlands further enhance this purification process. Thus, good river health engenders good human health. Not only does this improve the quality of water for those who depend directly on the river, but it also reduces the cost of treatment of a reticulated supply.

For those who depend on river water for domestic use, the seasonal flow of water is an important consideration. In semi-arid or arid areas a perennial river whose source is the humid upland areas is clearly a crucial resource. Upstream developments that reduce the dry season flow have a negative impact on downstream users (e.g. Box 8). In areas fed by seasonal or ephemeral rivers, an important dry season source of water is the riverbed itself. Wells dug into the riverbed or adjacent wetlands are used to extract water. Recharge of riverbed aquifers and wetlands often depend on flood flows. Upstream developments that reduce the magnitude and frequency of floods impact negatively on these recharge processes and therefore on dry season water supplies.

Throughout most of the region rainfall is inadequate and unreliable for widespread agriculture. Consequently, large-scale agricultural production is confined to moister regions, or is supported via irrigation water. This may be for crop farming or to provide fodder for livestock. Table 19 indicates the irrigation potential and the extent to which this has been taken up in the study area. Despite the fact that agriculture is the main user of water in all these countries, only South Africa comes near to developing its full irrigation potential. Also telling is the high prevalence of undernourished people in all countries but South Africa. The FAO strongly promote irrigation as the way forward to reduce malnourishment.

Table 19: Water use for irrigation. (Source: FAO 2007).

	Botswana	Mozambique	Namibia	South Africa	Swaziland	Zimbabwe
Total renewable water resource in 2005 (m^3/person/yr)	6 796	11 137	8 718	1 103	4 149	1 542
Irrigation potential ($x10^3$ ha)	13	3 072	47	1 500	93	366
% of potential area equipped for irrigation	11.1	3.8	16.0	99.9	53.4	47.5
Unequipped irrigation based on floods and cultivated wetlands and valley bottoms ($x10^3$ ha)	6.5	0	2	0	0	20
Ratio of natural to equipped	4.71		0.33			0.16
Prevalence of undernourished people (% of total population)	32	44	24	3	22	47

Box 15: West coast rivers of Namibia: A source of life. (Source: Jacobsen *et al*. 1995).

The west coast rivers of Namibia represent an example of the complex interplay between upstream landuse, flooding and the dynamics of lowland floodplains as they affect the ability of these ecosystems to provide services to local communities. These rivers comprise a suite of 12 ephemeral rivers, two of which end in the sand dunes of the Namib Desert, the rest finding their way to the Atlantic Ocean. The climate of the arid is arid, with high evapotranspiration. The inland areas, which act as the main source area for runoff have a higher rainfall, exceeding 500 mm per year on average, while annual rainfall in the lowland coastal area is extremely low and sometimes zero. Floods are the source of water and nutrients that maintain the ecosystems associated with these rivers. Riparian forests line these rivers well into the deserts; locally wetlands also exist.

The catchments of these rivers can be divided into three zones. The upper catchments support commercial rangeland. The middle zones consist of communal farmlands and the lower reaches parks and tourist areas. While the commercial farms depend on grazing from the sparsely vegetated rangelands and a water supply from dams built for livestock watering and supplying urban centres, the communal areas and wildlife rely largely on the river corridors for ecosystem services and water. These riparian ecosystems provide fodder for animals, wild foods, wood for building materials, fuelwood woodcrafts for sale, and arrows for hunting, as well as poisons. Wildlife, including a range of birds, is an important source of protein. The attractiveness of the tourist areas depend on the riparian corridors that provide food and shelter for wildlife.

The ecosystems of these ephemeral rivers are threatened by upstream developments that impact on the intensity of flooding. Dams reduce both the size and frequency of flooding. Climate change may also result in decreased flooding. The size of a flood determines how far down the river the floodwaters will reach. Floods recharge the groundwater in the riverbeds (from where it can be abstracted through shallow wells) and into the adjacent floodplains. They also transport fine sediments and organic materials down the river system, thus determining nutrient supplies for plants. Seeds are also washed downstream, allowing redistribution. Floods create new channels and new habitats, uproot mature trees and make space for recruitment of juveniles. Sufficient recharge of alluvial aquifers is necessary to allow effective recruitment as the young trees must develop deep roots before they are able to withstand long drought periods.

These west coast rivers of Namibia are an extreme example of the importance of floods in dryland areas. Similar processes operate in all floodplain systems, where diversity of habitat and associated biodiversity are dependent on maintaining dynamic geomorphic systems. Storing water in dams and regulating rivers so as to increase dry season flow at the expense of floods will inevitably result in negative impacts on the biodiversity and ecosystem health of floodplain systems.

Resource poor farmers may not be able to afford access to irrigation infrastructure, or may have been excluded from irrigation schemes for political reasons. These farmers often have to rely on the natural flow of the river for irrigation, depending on seasonal flooding. Floods not only bring water, but they also supply nutrient rich sediments, reducing the needs for inorganic fertiliser. In some countries and districts flood irrigation and cultivation of wetlands is more prevalent than equipped irrigation (Table 19), for example, Botswana. Cultivation of wetlands is widespread in Zimbabwe. Headwater wetlands known as dambos are important areas of smallholder cultivation in the upper Zambezi basin.

Flood recession irrigation depends on seasonal inundation of the flood plains adjacent to the river. Flow regulation by upstream dams often inhibits regular flooding and, while it expedites formal irrigation, it has a negative impact on those farmers who rely on floods for irrigation of crops and pasture. Formal irrigation schemes also tend to be fixed in location, giving rise to tensions between crop farmers who are part of schemes and pastoralists who rely on dry season grazing on flooded areas.

Since the 1970s an increasing number of large and small dams have reduced the frequency of moderate sized floods that are key drivers of ecosystem processes. A number of cases are cited indicating a reduction in the total wetland area (Linyata-Chobe and Zambezi Delta). This has had a negative effect on the provision of services by wetland ecosystems to the poor. It has also encouraged encroachment of settlement on to floodplains where people become vulnerable to the most extreme events that are not significantly impacted by dams (cf the 2000 floods). The rate of increase in large dams is beginning to decline due to the lack of suitable sites and the recent focus of water managers on water conservation measures rather than relying on increasing supply. Water abstraction for agriculture continues to be the major user of water in all southern African countries and is likely to continue to be so in the future. There is an urgent need for African countries to increase food self sufficiency as world food prices escalate. The trade-offs between increased food security at a national level through to the instigation of commercial irrigation schemes versus the potential loss of ecosystem goods and services that support livelihoods at the local level due will continue to be an important point of discussion. The increased demand for potable domestic water and water requirements for economic development will add to current water scarcity. This will lead to increased periods of low or no

flow in dryland rivers as is already the case for the Save and Limpopo rivers. Poor communities relying on river flow for domestic water supply and food production will suffer. The impact of climate change is difficult to predict but is likely to exacerbate the above trends. Masundire & MacKay (2002) see pollution as the most critical factor affecting the sustainability of water resources in the region. They point to a serious downward trend in water quality that impact all water users in the area, but especially the poor who do not have access to treated water supplies.

4.2.3.2 Drivers of change in the supply of water

Drivers can be considered or both water quality and quantity, with many impacting both. Construction of large dams, land transformation and invasive species are major drivers of change (Table 20).

Table 20: Key drivers of change in fresh water as a provisioning ecosystem service for the poor in arid and semi-arid regions of southern Africa (Key for magnitude: 1 = Low and 5 = High)

Drivers of change in supply of fresh water for use by the poor	**Ecoregion**					
	Arid		**Savanna**		**Rivers & wetlands**	
	Direction of change	Magnitude	Direction of change	Magnitude	Direction of change	Magnitude
REGIONAL SCALE						
Land transformation	▼	1	▼	2	▼	3
Climate change	▼	1	▼	1	▼	1
Poverty	▼	1	▼	2	▼	2
Net direction and magnitude of change	▼	**1**	▼	**2**	▼	**3**
LOCAL SCALE						
Land transformation	▼	1	▼	3	▼	4
Construction of large dams	▲	2	▲	2	▼	4
Maintenance of 'normal' flood regimes and flows	▲	3	▲	2	▲	4
Over abstraction of water	▼	2	▼	2	▼	2
Heavy grazing	▼	1	▼	1	▼	1
Alien invasive weeds/ plants	▼	1	▼	1	▼	3
Urban pollution	▼	1	▼	2	▼	1
Agriculture run-off of fertilisers and pesticides			▼	1	▼	2
Net direction and magnitude of change	▼	**1**	▼	**2**	▼	**3**

Water quantity: River and wetland ecosystems depend first and foremost on the quantity and timing of water that is received by the system. In semi-arid and arid areas **floods** are seen to be especially important due to their role in recharging water levels in the wetland and riparian zones and in ground water supply (Appendix 2 - Case Study 1, Box 16). Floods also redistribute sediments and organic materials, spread seeds and through disturbance create new spaces for recruitment. Floods are the main geomorphological drivers that create the river and wetland morphology, thus determining the quality and distribution of habitat for both plants and animals. The importance of low flows cannot be discounted, as it is the low flow that provides the 'normal' habitat for aquatic organisms.

Factors that affect the quantity and timing of water include the **hydrological balance of the upstream catchment** as affected by climate change, especially in relation to the frequency of droughts and floods, or by landuse, upstream dams, and water abstraction for agricultural or urban use.

Box 16: Eastern Caprivi wetlands in Namibia (information from Chenge (2000) unless otherwise indicated)

The Eastern Caprivi wetlands of Namibia consisted in 1999 of 4 000 km^2 of open water, reduced from an estimated area of 11 2000 km^2 in 1985. These include the Chobe wetlands of the Linyati Swamp and Lake Liambezi on the border with Botswana, fed by the Kwando River, rising to the north in Angola. In 1999 these floodplains supported a population of 83 000 people, 134 708 cattle and 18 470 goats. Livestock were believed to be at three times the stocking capacity, leading to serious problems of overgrazing. In 1996 the total area cleared for cultivation in Eastern Caprivi was 1 719 km^2 of which almost half was in the floodplain and riverine areas. Numerous schemes have been proposed to increase the irrigated area in the Eastern Caprivi. Scholes & Biggs (2004) state that the value of the Eastern Caprivi wetlands is estimated at US$840 000 p.a. for crop and livestock production. Chenge (2000) gave an estimate of the average annual fish catch as being 1 500 tonnes, valued at US$1.8 million p.a. The East and West Caprivi Game Reserves are also dependent on these wetlands, bringing in additional income from tourism.

These wetlands have experienced drying out due to reduced flows in the Kwando River since the 1990s. This is probably as much to do with natural climatic variability as with human impacts. They also suffer from heavy resource use by the local population who depend on the wetlands for fish, reeds and grasses among other things. These pressures have lead to habitat and species loss. Fish catches in the Caprivi area are said to be declining due to droughts leading to a reduction in flood plain area, especially shallow breeding areas. Poor sanitation in these densely settled areas has led to water quality problems due to nutrient enrichment. Shallow wells use for drinking water have been contaminated.

Dams impact on both flood frequency and volume leading to a reduction in recharge of riparian and wetland aquifers. Water regulation by Kariba and Cahora Bassa dams has reduced wetlands in Zambezi delta from 18 000 to 15 000 ha, has impacted negatively on wetland productivity and shrimp catches and has increased salt water intrusion inland (Chenge 2000). Smaller dams for urban water supply or farming activities can also seriously impact flow if their number is great enough. The riparian ecosystems of the ephemeral rivers of western Nambia are threatened by reduced flooding resulting from numerous farm dams in their upper catchments.

Box 17: Zambezi delta (Mozambique) (information from Chenge (2000) unless otherwise indicated)

The Zambezi Delta in Mozambique covers an area of 15 000 km^2. It begins 120 km from the sea at Mopeia and is tidal for the last 80 km. Elevated areas are formed by levees along the main Zambezi and minor tributaries and old channels, plus relict beaches. The Mozambique coastal plain consists of extensive grasslands, freshwater swamps, dunes and mangroves.

The delta supports a thriving shrimp fishery and crop farming, with an estimated annual net income of per household of US$77 per ha (Chenge 2000). The wetlands of the Zambezi Delta have been significantly impacted by the combined effect of the upstream dams, Cahora Bassa and Kariba. Water regulation has reduced the wetland area from 18 000 ha to the current 15 000 ha. This has impacted negatively on wetland productivity and shrimp catches and has resulted in increased salt-water intrusion due to lower flows and reduced flooding. The environmental impact of dams and flow regulation on the lower Zambezi and its delta had not been fully assessed at the time of writing (Chenge 2002).

The town of Tete lies upstream from the delta. It has been identified as one of the urban growth points that is impacting on the water quality of the Zambezi through increased raw sewage outflows. Other threats to the delta wetland ecosystems include development of sugar irrigation schemes and harvesting of mangroves.

Water abstraction has most impact on low flows. The Save river in Mozambique is severely impacted by water abstraction in Zimbabwe (FAO), being dry for long periods of time.

Climate change will inevitably affect river and wetland ecosystems through changes to catchment hydrology, but the direction and degree of change will be locality specific and is difficult to predict. Indications are that an already variable climate is likely to become even more variable, with increased swings between drought and flood. The most effective interventions will be those that allow adaptation to variability through increased flexibility.

Water quality: The main threats to water quality come from **agriculture, urban development** or **dense rural settlement, mining** and **pest control programmes** (mosquitoes and tsetse fly) for human health. Agricultural use of fertilisers and pesticides (DDT) (Zimbabwe and South

Africa) can have serious direct impacts on wetland and riverine biota. This applies both to irrigated agriculture on the floodplains and to dryland agriculture in the catchment area.

Human settlements on or close to floodplains are often associated with **poor sanitation** leading to increased nutrient inputs into the water. The quality of drinking water in shallow boreholes can be negatively affected as in the eastern Caprivi (Box 16). Urban development results in pollution, especially by raw sewage, increasing nutrient levels in streams. The town of Tete is impacting the Zambezi delta through increased raw sewage (Box 17). The risk to health from outbreaks such as cholera and typhoid is greatly increased under these circumstances. Meyer (2007) points to the problems associated with uncontrolled growth of community settlement and land invasion and illustrates this with an example from the Bloemfontein and Mangaung areas of South Africa where the number of house plots more than doubled over eight years between 1990 and 1998. Associated with this growth are informal housing and shacks, a skeletal road system, a limited number of communal water supply points and basic sanitation, mostly in poor condition. Indications are that polluted water has led to poor health, exacerbating poverty. Poverty has led to a low rate of payment for services, leading to poor maintenance of services. Meyer (2007) stresses the need to move away from the attitude that the government must solve the problem, towards greater user responsibility.

Transformation of wetland areas for 'productive' landuse is a major threat to wetland ecosystems. The most common landuse change is to irrigated cropping. Firstly, there is the direct switch from natural ecosystems to agricultural systems with a loss of biodiversity. Secondly, large swathes of cultivated land cause fragmentation of ecosystems. Thirdly, there is an indirect effect on ecosystem function through the flow regulation that often accompanies irrigation schemes. Formal irrigation is not compatible with seasonal flooding. Changes in land use can also impact on the way that the traditional human use of floodplains is integrated into the wider landscape. Pastoralists may use the floodplain grasslands for dry season grazing, or may even reserve some areas for use in droughts. In the wet season livestock is taken to graze in upland areas. If grazing lands are lost to cultivation, the remaining grassland areas are likely to become degraded. This can also lead to conflict between grazers and cultivators.

Aquatic weed infestations are a major problem in many of the dams in southern Africa. Kariba weed (*Salvinia molesta*) originated in South America and became a major problem in Lake Kariba after the Zambezi River was dammed in the 1960s. It is also present in East Caprivi and is widespread in inland dams in Zimbabwe where it causes problems for irrigation, domestic and livestock water supply, fisheries and the environment in general (Chikwenhere & Keswani 1997) Water hyacinth (*Eichhornia crassipes*) is another invader from South America which in the 1990s took over from Kariba weed as the main aquatic weed infestation in Lake Kariba (Chenge 2000). It is also found to the south in rivers such as the Vaal of South Africa. Chenge (2000) attributes the spread of aquatic weeds to nutrient enrichment from fertiliser and raw sewage. Dense mats of water hyacinth have multiple negative effects for local livelihoods (Matthews & Brandt 2004), including (i) inhibition of boat traffic, thereby disrupting trade, fishing and recreational activities; (ii) clogging of irrigation canals and pumps, and hydro-electric power schemes; (iii) impeding water flow and trapping particles in suspension and thus increase siltation; (iv) adversely affecting the quality of drinking water; and (v) posing health risks by creating conditions suitable for mosquitoes and bilharzia-carrying snails.

In South Africa **invasive woody species** have been identified as a threat to water resources through increased consumptive use of water relative to natural vegetation. Among the main species listed are *Acacia mearnsii* (black wattle) *Acacia longifolia* (long-leaved wattle) and *Eucalyptus longifolia* (blue gum), all Australian imports. In the drier areas of the Karoo *Tamarisk*, *Prosopis* and *Nicotina* species have invaded dry river beds. Versveld *et al*. (1998) estimate that invasive alien species deplete the national mean annual runoff by 7%. In the Northern Cape it is as high as 16.7 %. To counteract this water loss the Department of Water Affairs and Forestry launched the Working for Water Programme in the late 1990s as an initiative to clear invasive vegetation using poverty relief funds (see Section 4.8.4.1).

4.2.3.3 Trade-offs in the provision of water for the poor

It has been illustrated above how resource poor farmers in dryland areas often rely on the services provided by river floods. This service can be impacted negatively by upstream dams and interbasin transfer schemes that are built to serve the needs of formal irrigation schemes. There is a significant trade-off between water developments to support commercial agriculture and mines and use of a wide range of ecosystem services by the poor.

Organisations such as the FAO promote irrigation as the most efficient means of increasing food production in the poor rural areas. If irrigation is used to produce commercial crops, and often non-food crops, it will impact negatively on poor people outside the commercial systems and their traditional coping mechanisms are likely to be compromised.

Box 18: Poverty, water, cropping and irrigation in Mozambique

Mozambique is the poorest of the six countries in the region. It ranked 170 out of 173 countries on the HDI 2002 of UNDP, with 70 % of its population below the poverty line (Table 6). The population is predominantly rural (63 %), with only 52 % considered to be economically active, of which 80 % work in agriculture

Mozambique gained its independence in 1975, but a prolonged civil war that ended in 1992 devastated much of the country's infrastructure. Today, it is largely a country of smallholder farmers who rely on rainfed cropping and livestock farming. Seventy-eight percent (or 62 million ha) of the country is covered by natural vegetation and only 4.4% of the 36 million ha suitable for agriculture are actually cultivated. The semi-arid and arid areas of Mozambique lie to the south of the Save River. These areas receive a rainfall of between 400 and 600 mm p.a. Rainfed agriculture is a precarious activity, with successful cropping in only 3-5 years out of 10. Despite this only 1.3 % of the three million ha that are potentially irrigable were under irrigation in 2002. Likewise, only 0.3 % of the country's renewable water resources are developed. Of this, 87 % goes to agriculture and 11% to domestic use.

Constraints on irrigation development stem from historical, geopolitical and environmental factors. After independence many commercial farmers of settler origin left, to be replaced by new farmers who lacked technical know-how regarding irrigation. The civil war destroyed much of the irrigation infrastructure including some 500 or so small farm dams. There has been a gradual reduction in public funds allocated to irrigation and agricultural inputs and technical assistance are at a low level. The floods of 2000 and 2001 submerged many schemes leaving large deposits of silt in drainage channels and canals. During years of drought the country becomes especially susceptible to abstractions by upstream users from internationally shared water resources. The dry southern area relies on rivers whose sources are in South Africa, Swaziland and Zimbabwe where they are heavily utilised for irrigation, for example the Limpopo, Mkomati and Save. Mozambique relies heavily on water from upstream countries, 53.4 % of its renewable water resource coming from sources external to the country. Water quality is also affected by agriculture and mining activities in South Africa.

Although there are an estimated 148 000 ha of potential irrigation lands in the Limpopo floodplains of Mozambique, only 40 000 ha are currently irrigated. Constraints to irrigation development exist in the form of the highly variable flow, the high silt load that rapidly depletes the storage capacity of any dams built to regulate the flow, and over-utilisation of water in upstream areas. Groundwater is relatively abundant and provides an important source of drinking water for human and livestock use. It is also utilised locally for irrigation

Given the generally impoverished and underdeveloped nature of Mozambique, a high dependence on environmental services is evident. In the drier areas of the south the main vegetation type is thicket, that provides fuelwood and forage for livestock. Small- holder farming activities are found close to rivers where crops are less prone to drought, but are at risk to flooding. In Gaza province in the lower Limpopo, eight of the 11 districts are at severe risk to drought and five to flooding (ARC 2003). The four driest districts are self sufficient in food crops for less than half the year. Reported coping strategies included a reduced diet and search for part-time work, sale of firewood, charcoal and traditional beverages, intensifying fishing and hunting and sale of livestock. Diversification of farming systems, using land next to the river and upslope areas as a combined assurance against drought and flood, was an additional strategy. Remittances from South Africa were an important source of income.

4.2.4 Fodder and forage

4.2.4.1 Importance of forage and fodder for the poor and trends

Rangeland is the most important source of forage in all countries in the region (Burgess 2001, Gambiza & Nyama 2001, Palmer & Ainslie 2001, Sweet & Burke 2001), supporting over 70 million cattle, sheep and goats (Table 21), not to mention millions of wildlife. These animals are held in both subsistence and commercial farming operations, which play a significant role in national economies and local livelihoods. Furthermore, millions of people depend on rangelands

for an array of other ecosystem services that are crucial for their livelihoods, such as water (section 4.2.3) and natural products (section 4.2.1).

Table 21: Number of livestock in 2005 and change over last ten years in selected countries. (Source: FAOSTAT 2006).

Country	Cattle		Goats		Sheep	
	Millions	% change	Millions	% change	Millions	% change
Botswana	3.1	+ 35 %	2.0	0	0.3	0
Namibia	3.1	+ 55 %	2.0	0	0.6	+ 23 %
South Africa	13.8	0	6.4	- 4 %	25.3	- 12 %
Zimbabwe	5.4	0	3.0	+ 11 %	2.7	0

The concept of veld type is used to describe the potential forage production of rangeland (Rattray 1957, Acocks 1988, Tainton 1999). Briefly, it refers to the number of livestock units (1 LU = 500 kg liveweight) a given vegetation type can support (i.e. grazing capacity), as a function of both the quantity and quality of fodder produced. A major challenge in the provision of forage from rangeland is the change in forage quality and quantity in space and time (Table 22).

Throughout the region the production of fodder is highly seasonal because of the markedly seasonal distribution of rainfall which is the major determinant of primary production (Rutherford 1980, Dye & Spear 1982, O'Connor *et al*. 2001, Esler *et al*. 2006; Figs 9 and 10). For example, O'Connor *et al*. (2001) found that for rangeland in good condition 0.277 g Dry Matter m^{-2} was produced mm^{-1} of precipitation. The strength of the relationship between precipitation and phytomass production varies with soil type and nutrient status. Dye and Spear (1982) found a tighter fit between precipitation and phytomass production on clayey soils that were more fertile and had a higher water holding capacity than sandy soils.

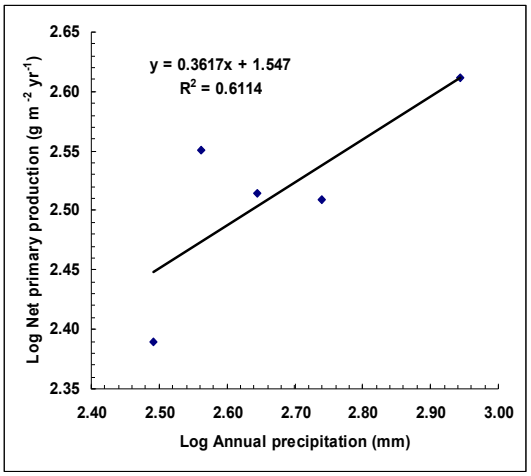

Figure 9: The relationship between net primary production and annual precipitation on Kalahari sands. (Adapted from Woodward & Lomas (2004))

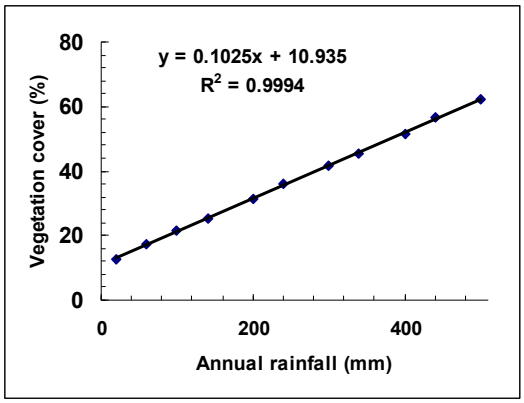

Figure 10: The relationship between vegetation cover (%) and annual rainfall on Karoo. (Adapted from Esler *et al.* (2006))

Box 19: Importance of riparian forage in arid and semi-arid areas

Riparian grasslands are a key resource to pastoralists, providing dry season grazing. Woody species may also provide valuable fodder. In the ephemeral rivers of western Namibia the pods of the ana tree (*Acacia albida*) are used as fodder by both domestic stock and wildlife (Jacobsen *et al.* 1995). Farmers collect pods and store them for the dry season.

Consequently, production of herbaceous forage is usually inadequate during the dry season, and livestock depend upon key resource areas such as agricultural residues in fields, wetlands, and browse (Box 19). The protein content of dry season browse and fodder is frequently below the 6 % crude protein content required to maintain body mass (Table 22). Consequently, in most areas livestock loose condition and body mass and experience increased mortality, especially towards the end of the dry season. Cultivating forage plants is a strategy that is commonly used to address the challenges of fluctuating forage quality and quantity on rangeland.

Table 22: Changes in forage quality and quantity on rangeland in Zimbabwe (adapted from Elliot & Folkertsen (1961))

Month	Dry matter (kg ha^{-1})	Crude protein (g kg^{-1})	Crude fibre (g kg^{-1})	Total digestible nutrients (g kg^{-1})
November	540	87	307	-
December	1081	70	316	612
January	1556	52	356	523
February	2441	43	369	529
March	2922	36	381	473
April	2920	31	388	438
May	2868	28	406	293

Cultivated forages and crop residues are important forage for domestic livestock production. Cultivation of forages is largely practiced in areas receiving more than 500 mm annual rainfall. Within the savanna ecoregion cereal crop residues are important during the dry season in most smallholder and communal farming areas in southern Africa, either collected and stored, or the animals allowed to graze the harvested fields (e.g. Bennett & Lent 2007). In the desert and dwarf shrubland ecoregion, the presence of agricultural residues is limited, and the most widespread coping strategy in the dry season is to range livestock into rotational or reserved grazing areas (Hoffman & Rhode 2007, O'Farrell *et al*. 2007).

Cultivated forages consist of herbaceous, succulent and woody species. Leguminous species are commonly grown because of their high nutritive value and also because some species fix nitrogen thereby improving soil fertility. Some cultivated species are an important drought feed reserve (e.g. *Atriplex* species, *Opuntia* species, *Leucaeana leucocephela*), fruit (*Opuntia*

species) and fuelwood (*Leucaena leucocephala*). Examples of cultivated forages in South Africa are shown in Table 23.

Table 23: Examples of commonly cultivated drought forages in South Africa (adapted from Palmer & Ainslie (2001))

Scientific name	Common name	Uses
Agave Americana	American aloe	Drought fodder in arid and semi-arid regions
Anthephora pubescens	Wool grass	Spring and summer grazing
Atriplex mueleri	Australian saltbush	Drought fodder
Atriplex nummalaria	Old man saltbush	Drought fodder
Cenchrus ciliaris	Blue buffalo grass	Spring, summer and autumn grazing
Opuntia species	Spineless cactus	Live fencing and drought fodder
Opuntia ficus-indica	Prickly pear	Live fencing, drought fodder and fruit
Vigna unguiculata	Cowpea	Multi-purpose legume (fodder, human consumption and soil fertility improvement)

Rainfall in arid and semi-arid areas is low and erratic resulting in unpredictable fluctuations in forage production on rangeland (Fig. 10). Although cultivation of forage improves availability it results in trade-offs with food crop production. Cultivation of forage requires land and inputs (e.g. seeds, tillage equipment, inoculants). Many poor communal farmers cannot afford to set aside land to cultivate forage, and consequently cultivation is most common amongst commercial farmers. Subsistence farmers unable to grow their own forage in times of shortage usually herd livestock to key grazing areas (Box 20), but in severe droughts may they may opt to sell some or all of their livestock, undermining their asset base. If is not uncommon for wealthier farmers to buy stock form poorer households during time of drought when prices are reduced.

4.2.4.2 Trends in forage production on rangeland

Box 20: Responses to declining fodder production

In situations of reduced or declining fodder land-users usually experience productivity of livestock, either in body mass or rate of reproduction. This frequently have negative impacts on livelihoods, such as reduced cash incomes, savings, or draught power. A number of coping strategies are possible, but usually at a cost or reduced level of well-being:

- Move livestock to new or reserve grazing areas
- Concentrate them on key resources areas of high productivity such as fields, fringes of wetlands, seep lines, etc.)
- Purchase supplementary feed
- Cut fodder elsewhere and carry/transport it home to feed to livestock
- Reduce herd size
- Change herd composition to smaller and hardier species

It has long been argued that poor grazing management has resulted in rangeland degradation in southern Africa (e.g. Nyathi & Gambiza 1994, Campbell *et al*. 2000, Hoffman & Ashwell 2000), (also see Appendix 2 - Case Studies 1, 5, 7 and 8) although contested by advocates of disequilibrium thinking (e.g. Behnke & Scoones 1993). For supporters of the notion of carrying capacity based on system equilibrium, there is much evidence of a declining trend in forage production in both the savanna and deserts and dwarf shrubland ecoregions. Key changes are seen as widespread replacement of perennial grasses with annual ones and less palatable forbs (e.g. Parsons *et al*. 1997), encroachment of woody species over millions of hectares (Ward 2005), piospheres of denuded land around artificial water points (e.g. Thrash 1998) and widespread erosion as a result of reduced vegetation cover (Hoffman & Todd 2000). The fact that there has not been large-scale collapse is due to use of key resources areas and supplementary forage purchased off-farm. For adherents to disequilibrial thinking, such trends are less evident because state and function of the systems is highly variable in response to rainfall and population mortalities. Systems not at equilibrium can be understood in terms of how drivers such as environmental stochasticity, drought, disease and their interactions influence plant-herbivore dynamics (Illius & O'Connor 1999, Gilson & Hoffman 2007).

Whatever the long-term trends and drivers of such trends, thresholds are frequently apparent in a number of rangeland systems. Those most commonly encountered are extensive replacement of perennials by annuals and bush-encroachment. These usually occur quite slowly, but once advanced cannot be reversed by simply reducing or removing livestock, because the changes affect other system dynamics, such as ground cover, reduced fire frequency, changes in moisture infiltration rates and rates.

4.2.4.3 Drivers of change in the availability of fodder

The primary driver of change in forage production in the semi-arid lands is this **seasonal and inter-annual changes in rainfall**, which in many areas dwarfs the impacts of human mediated drivers (Table 24). This is most apparent during drought years, which are frequent, and may be prolonged. Successive droughts in close succession can have significant and long lasting impacts. For example, Burgess (2001) reported that a million cattle died in Botswana during the mid 1980s following a sequence of droughts. The slow recovery in animal populations after drought can relieve pressure on rangeland leading to recovery in rangeland condition (Danckwerts & Stuart-Hill 1988). Thus, government policies that promote restocking after droughts may lead to continued deterioration of rangeland condition and to a reduction in the capacity of rangelands to deliver ecosystem services.

Table 24: Key drivers of change in fodder as a provisioning ecosystem service for the poor in arid and semi-arid regions of southern Africa (Key for magnitude: 1 = Low and 5 = High)

Drivers of change in supply of fodder for use by the poor	**Ecoregion**					
	Arid		**Savanna**		**Rivers & wetlands**	
	Direction of change	Magnitude	Direction of change	Magnitude	Direction of change	Magnitude
REGIONAL SCALE						
Land transformation	▼	1	▼	3	▼	2
Rainfall	Variable		variable		variable	
Climate change & severe droughts	▼	5	▼	4	▼	2
Net direction and magnitude of change	▼	**3**	▼	**3**	▼	**2**
LOCAL SCALE						
Land transformation	▼	2	▼	2	▼	2
Over-grazing	▼	3	▼	1	▼	3
Weak governance or regulation	▼	2	▼	2	▼	2
Land alienation	▼	2	▼	2	▼	2
Land redistribution	▲	3	▲	4	▲	3
Episodic disease outbreaks	▲	4	▲	4	▲	4
Bush-encroachment	▼	4	▼	4	▼	4
Stock theft	▼	1	▼	1	▼	1
Injudicious fires			▼	2	▼	1
Net direction and magnitude of change	▼	**3**	▼	**2**	▼	**2**

Besides drought, **bush-encroachment** (Table 24) suppresses herbaceous forage production (Trollope *et al*. 1989, Roques *et al*. 2001). Woody plants compete with herbaceous plants for moisture and nutrients. Furthermore, woody plants also shade herbaceous plants leading to

reduced biomass production. Roques *et al*. (2001) found that bush-encroachment in an African savanna resulted from interactions between grazing and fire frequency and also between drought frequency and high shrub cover. Bush-encroachment affects millions of hectares in Botswana, Namibia and South Africa (e.g. Appendix 2 - Case Studies 3, 5 and 7), reducing forage production and hence benefits from livestock by up to half (Mugasi *et al*. 2000). Grazing affects **fire frequency** through its effects on the grass fuel load that determines the frequency and intensity of fire and thus fire damage to woody plants (Gambiza *et al*. 2005).

Episodic disease outbreaks (e.g. foot and mouth, cattle lung sickness, and avian flu) have resulted in massive culling of cattle and ostriches in southern Africa (Burgess 2001, Palmer & Ainslie 2001, Gambiza & Nyama 2001). The enforced slaughter of domestic livestock has three important implications for rangeland condition and people's livelihoods. First, a decrease in stocking rate can lead to a recovery in rangeland condition because of reduced post-drought impacts of livestock on vegetation (Danckwerts & Stuart-Hill 1988). Second, poor people cannot afford to restock when diseases have been eliminated. Furthermore, it is usually the wealthy and well-connected people who benefit from government livestock restocking programmes. Third, poor people who usually work as herdsmen for the stock owners often lose an important source of income when cattle are culled (Burgess 2001).

Government policies are an important driver of livestock dynamics which in turn influence rangeland condition. The effects of **historical policies** such as the betterment programme in South Africa (Hoffman & Ashwell 2001, Palmer & Ainslie 2001) and the Botswana's Tribal Grazing Land Policy (Burgess 2001, PANRUSA 2001a) are still influencing rangeland condition today. The sinking of **boreholes** has (i) limited the movement of livestock; (ii) limited wildlife movement and migration, and (iii) placed year round pressure on vegetation. The net effect of these boreholes has been the localized degradation of rangeland around boreholes (PANRUSA 2001b). **Increasing sedendarisation, fencing and infrastructure** has meant that the old practice of high mobility of herds, moving them in search of better grazing, has diminished dramatically. There are no truly nomadic header groups left in southern Africa, in contrast to East Africa, and even localised mobility between winter and summer grazing grounds is rare (Baker & Hoffman 2006).

At a very local level, several commentators have attributed declining herd sizes of cattle on a household basis due to increasing **stock theft** and **decreasing land for grazing** (e.g. Shackleton *et al*. 2005, Hebinck & Lent 2007).

4.2.4.4 Trade-offs in the provision of fodder

In communal areas, ownership of livestock is concentred in the hands of wealthier households; not exclusively so, but it is a common phenomenon. Consequently, they differentially accrue the benefits of fodder availability, but do not carry all the costs when rangelands pass thresholds, and other ecosystem services are affected. For example, the burning of rangelands to rejuvenate grass for fodder denies other households the chance to collect thatching grass which is destroyed by the fires, or the siltation of local streams by soil eroded as a consequence of heavy grazing. These wealthier elites can frequently dictate how the broader rangelands are used or accessed, frequently limiting opportunities for poorer households.

At broader scale, there are well documented tensions between pastoralists and arable production. Sedentary cropping activities privatise the commons, and may restrict movements of livestock. Within increasing sedentarisation (e.g. Case Studies 1 and 5), subsistence pastoralists resist confinement of grazing areas. In the commercial sector, production of forage competes with other land uses, especially for food production or biodiversity.

4.2.4.5 Interventions that can ensure continued provision of fodder

Governments in southern Africa have promoted several methods to engender sustainable use of rangelands (Palmer & Ainslie 2001, Burgess 2001, Gambiza & Nyama 2001, Sweet & Burke 2001). These include:

- promoting grazing management schemes often linked to destocking directives (with many failures);
- growing of drought fodder reserves;
- growing of multi-purpose crops (e.g., cow peas, pigeon pea, lablab);
- drilling of boreholes;
- promoting livestock improvement schemes (e.g. disease control and provision of animal health centres); and
- facilitation of seasonal mobility

Most of these interventions have failed as highlighted earlier in the report. A major reason for failure has been a lack of involvement of the resource users in designing the interventions.

Box 21: Indigenous vegetation project in Botswana (Source: http://www.ivp-rcu.org/index.htm and in-country consultations, Appendix 3)

The Indigenous Vegetation Project (IVP –see below), which has been described as "CBNRM for livestock", has the goals to improve rural livelihoods and conserve biodiversity through the rehabilitation of indigenous vegetation and degraded dryland systems. It aims to secure better livelihoods through improved livestock production and marketing, and provision of alternative livelihoods. The IVP is being implemented in three areas in Botswana, two in Kenya and two in Mali, and has developed a database for monitoring systems. It is linked to the DryLand Knowledge Resource and Practice Network. The project found there were clear opportunities to improve peoples' well being through livestock and livestock product marketing in each site in each of the three countries. In Mali, Kenya, and Botswana, one opportunity related to hides and skins marketing, involving both research to identify market opportunities and interventions to improve production and management techniques. In Mali and Botswana, research to understand the nature of household decision making was indicated; and in Kenya, Mali, and Botswana, research linking ecological dynamics to economic decision making and allowing for improved policy decisions was proposed.

(The IVP is a five-year project, ending in 2007, supported by GEF and implemented through the ministry of Agriculture. It is a pilot project aimed at developing models for community-driven rehabilitation of degraded rangelands, for replication throughout the arid and semi-arid zones of Africa).

4.3 EXAMPLES OF IMPORTANT REGULATING SERVICES

4.3.1 Soil fertility

4.3.1.1 Importance of soil fertility for the poor and trends

Within southern Africa over 90 % of rural inhabitants till the soil to grow some or all of their food requirements, and if sufficient land, or in years of good harvest, any surplus is sold to generate income. Such producers are typically termed subsistence, smallholder or small-scale, farmers, and agriculture is a significant component (22 – 70 %) of their livelihood portfolio (Dovie 2001, Shackleton *et al*. 2001, Campbell *et al*. 2002). It is within the rural areas that formal poverty measures are most extreme. Nonetheless, urban agriculture is also a common practice in the region (e.g. Rogerson 1993, Drakakis-Smith *et al*. 1995, Slater 2001), upon soil fertility services.

Box 22: Poverty alleviation through urban agriculture?

The potential for urban agriculture in southern Africa and the continent has been debated for decades. Whilst it has never reached the promise of feeding whole cities, there is little doubt that it provides an important role in food security and poverty alleviation for many households from ecosystem services produced in urban areas. The majority of peri-urban dwellers engage in some sort of food production activities, for home consumption and perhaps the sale of surplus production. This home production allows scarce cash resources to be invested in other activities, such as school fees (Webb 1998, Shackleton & Shackleton 2004b). Reuther & Dewar (2005) demonstrated that well run gardens in Cape Town had the potential to provide an income level equivalent to monthly social security grants. A recent survey in the Durban metropolitan area showed modal income from the sale of garden produce was R30 per month over and above the produce consumed at home (Shackleton *et al*. 2007c). The top few were earning over R3 000 per month. Many urban householders also collect wild fruits and spinaches from vacant lots, parks and disturbed lands within the city limits. Within southern Africa urban agriculture is usually the domain of women (Slater 2001, Shackleton *et al*. 2007c), who are typically amongst the poorest. Thus, whilst formal incomes and even productivity might be low, they are very important for poor households who have limited alternative options, as well as significant opportunities for social networking and empowerment (Slater 2001).

The production of crops, whether subsistence or commercial, depends upon a vast array of institutional, economic, social and environmental factors, of which an adequate supply of nutrients for plant growth is simply one. Thirteen nutrients are essential for normal plant growth. Micronutrients are required in small amounts, and typically (but not always) there are sufficient stocks of these within the soil. Macronutrients are required in relatively large amounts, and consequently frequently become limiting, especially under continuous cropping systems with low soil fertility management. This especially applies to nitrogen, phosphorus and potassium. But the first basis for all the nutrient requirements for crop production is the inherent soil fertility of the site, which is an essential supporting ecosystem service. Soil fertility underpins not only arable agriculture, but also grazing systems and primary productivity generally, such that heavy continuous grazing can lead to soil fertility declines as described in Namibia (Zeidler *et al*. 2002).

The level of the inherent soil fertility is variable. At the broad scale it is a function of the underlying geology and the prevailing rainfall regime. At the regional level, the soils of much of southern African are situated on ancient weathered granites and are regarded as relatively infertile and with low organic matter. They are typically particularly low in nitrogen and often also phosphorus (Scholes 1993). But where situated on younger igneous intrusions, soil fertility is markedly better. At finer scales it is influenced by topography, natural erosion and deposition processes, disturbance and on-farm practices, such that on a single farm there are patches of low fertility juxtaposed with patches of better fertility. Consequently, local knowledge is vital in optimising crop production, both with respect to what crops are grown on specific soils, at what times of the year, as well as soil fertility management techniques.

Box 23: Soil nutrition depletion rates in small-scale farming systems (Folmer *et al*. 1998)

Models of nutrition depletion rates in Mozambique under small-scale farming estimate average losses to be approximately 33 kg N ha^{-1} yr^{-1}, 25 kg K ha^{-1} yr^{-1} and 6 kg P ha^{-1} yr^{-1}.

The availability of soil nutrients to plants is dependent upon adequate soil moisture (and soil pH), and throughout much of the region productivity is more a function of rainfall as well as labour and other capital available to farmers, than of soil fertility. However, long-term cropping of a site without active maintenance of soil fertility (for whatever reason) results in declining crop yields as soil nutrients are extracted at a rate faster than they are replenished (see Appendix 2 - Case Study 5). The time scale and speed at which this occurs depends upon the rate of cropping relative to the inherent nutrient stocks (Vanlauwe & Giller 2006), and ranges from decades to millennia for specific nutrients. Nutrient balance studies of small-holding cropping systems across Africa typically show that there are insufficient nutrient inputs from fertiliser or manure (e.g. Scoones 2001, Dougill *et al*. 2002). There are many exceptions, and short-term nutrient balance studies can be misleading (Scoones 2001), but overall such studies usually indicate a negative balance for nitrogen and also frequently insufficient phosphorus, which therefore may potentially reduce crop yields over time (Chibudu *et al*. 2001, Dougill *et al*. 2002).

At a macro-scale the links between poverty and the degree of subsistence agriculture is evident, with a strong relationship between increasing GDP and a decreasing proportion of the GDP

contributed by agriculture as well as the proportion of the population that is rural (Fig. 11). Thus, poorer nations in the region tend to rely upon agriculture, and are consequently more sensitive to polices and practices that impact on soil fertility. At the local level, agriculture is a significant contributor to the livelihoods of the rural poor, and consequently poverty levels are strongly dependent on macro and local factors that affect crop production, including soil fertility. But much work throughout the region has stressed that unravelling and understanding the role of agriculture in local livelihoods and the investments or extractions that households make in small-scale agriculture is complex because it is so spatially and temporally dynamic (e.g. Scoones 1997, Dahlberg 2000; Campbell *et al*. 2002, Twyman *et al*. 2004, Verlinden *et al*. 2006). Consequently, there are few generalisations that can be made, and therefore there is no single technical or policy solution (Scoones 1997).

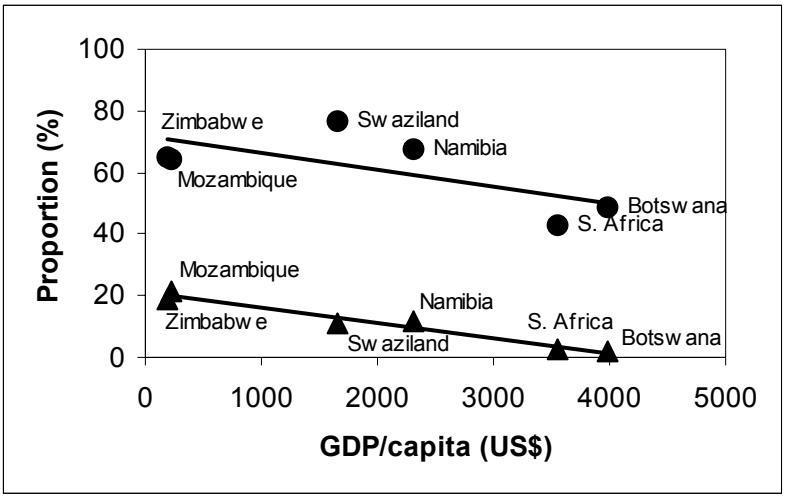

Figure 11: Contribution of agriculture to GDP as a function of GDP (● % of population that is rural; ▲ % of GDP contributed by agriculture)

At the local-scale the importance of agricultural productivity for meeting subsistence and cash needs is readily apparent when contrasting wealth classes (Table 25). Poorer families have a greater proportion of their livelihoods derived from cropping, but have fewer resources to provide inputs. This is demonstrated in the frequently reported higher soil nutrient levels in home-gardens and fields relative to distant fields, because the ones closest to the home receive most of the organic manure from the kraals (Chibudu *et al*. 2001). For example, Zingore *et al*. (2007) reported that soil carbon levels in home fields were generally double that of outfields on different soils in Zimbabwe. The difference in nitrogen was between 33 % and 900 % higher. Consequently, the poor are most vulnerable to spatial and temporal changes in soil fertility.

Table 25: Contribution (%) of arable cropping to total household income. (Source: Campbell *et al*. 2002)

Location	Income type	Wealth quartile			
		Lowest 25 %	25 – 50 %	50 – 75 %	Highest 25 %
Out fields	Sales	1.2	4.9	3.0	6.5
	Subsistence	24.2	20.4	12.8	16.3
Home-gardens	Sales	4.6	3.8	4.4	4.1
	Subsistence	4.3	2.4	3.5	4.0
Total		34.5	31.5	23.7	30.9

There are major differences across the three ecoregions. In the arid deserts and shrublands there is relatively little arable cropping (other than small home-gardens; or along the edges of rivers, deltas, dams and wetlands) because of the low rainfall. Where irrigation water is supplied, it is usually for capital-intensive commercial systems, which might provide employment opportunities for the poor and which are not constrained by price or access to fertilisers or knowledge. Although limited cropping, long-term heavy grazing can reduce soil nutrient levels significantly (Zeidler *et al*.2002). In the semi-arid savannas, the prevalence of cropping increases with increasing rainfall. Within both these areas, the presence of large water bodies, rivers and wetlands provides opportunities for intensive cropping. The seasonal or periodic flooding of rivers and deltas helps maintain soil fertility (Section 4.2.3.1).

Box 24: Impacts of declining soil fertility on poor farmers

In situations where poor farmers do experience declining soil fertility, it can potentially deepen poverty levels through a number of mechanisms including:

- Declining crop yields resulting in increased food insecurity, under- and malnutrition which have further ramifications such as:
  - Reduced health and hence increased susceptibility to disease
  - Reduced dietary diversity
  - Reduced productivity of household labour, further eroding agricultural productivity (especially relevant in communities with high HIV/AIDS prevalence rates)
  - Straining of social networks due to reliance on others for food handouts
  - Possible disintegration of the family resulting in migrancy.
- Reduced crop surplus for sale, either in amount or frequency, thereby eliminating a source of much-needed cash resources.
- Diversion of scarce cash resources from other needs (e.g. education, health) to purchase food and/or fertilisers.
- Clearance of natural lands for new fields (Dahlberg 2000, Chibudu *et al*. 2001). This requires significant labour, and new fields may also be situated far from the homestead. This clearance has direct and indirect impacts on the supply of other ecosystems services such as biodiversity, water provision, carbon sequestration and supply of useful natural resources, meaning that trade-offs need to be considered by the farmers.
- Reduced plant cover associated with low crop yields increases the possibility of soil and wind erosion, providing further negative feedbacks on soil fertility (Folmer *et al*. 1998).
- Reduced land values, limiting the returns if the farmers had to sell, hire out or share crop all or some of his/her fields.

4.3.1.2 Drivers of change in soil fertility and trade-offs

Depletion of soil fertility is usually a slow process, whereas the reverse (i.e. building up soil fertility) can be rapid. The existence of thresholds of environmental change have not been identified, although a reduction in soil organic matter is associated with rapid declines in other nutrients, water holding capacity and soil structure, which is harder to restore (Chivenge *et al*. 2007). At a broad scale the primary driver of soil fertility loss is **long-term nutrient extraction (mainly via cropping, but also through erosion or heavy grazing)** with **limited fertility management** practices. Farmers make use of a variety of nutrient inputs, but application is spatially and temporally variable in response to available resources (Table 26).

Table 26: Types of nutrient inputs by farmers (%) during 1995/96 at two sites in Zimbabwe. (Source: Chibudu *et al*. 2001)

Type	Mangwende (Zimbabwe)		Chivi (Zimbabwe)	
	Homefield	Outfield	Homefield	Outfield
Fertilizer	96	66	20	16
Manure	44	14	36	38
Ash	24	4	42	12
Compost	66	20	30	22
Termitaria soil	0	2	40	24
Leaf litter	10	4	6	4

Thresholds in fertility levels have not been shown as it is typically a slow variable. But thresholds may exist in household assets which hinder or foster investments in agriculture and soil fertility measures. If **labour or cash resources decline beyond a critical level**, it is hard for households to supply sufficient fertiliser, manure or labour (Chibudu *et al*. 2001, Twyman *et al*. 2004, Hebinck & Monde 2007), which feeds back into declining yields, and a potential downward spiral develops, in which households may become entrenched for long periods of time. Many poor households simply cannot afford the cost of inorganic fertilisers (Dougill *et al*. 2002) and so they are restricted to use of manure. However, manure may be in limited supply for poorer households since most farmers who are poor are also the ones without livestock. Thus, they are dependent upon social capital to access manure from kin and neighbours, as well as upon adequate labour to transport the manure or other types of inputs (such a termiteria soil, leaf litter, ash, Table 26). Consequently, soil nutrient depletion rates are expected to be faster for poorer farmers than wealthier ones, but nonetheless may be sufficient for decades of low-level cropping with the few inputs they are able to make, and thus it is rarely a case of imminent crises (Fairhead & Scoones 2005). Consequently, rates of fertility decline are marked for some farms and some regions. But within the same region, other farmers are able to allocate resources to soil management and rates of decline are slower or limited.

The drivers of change are relatively similar between the different ecoregions, but the magnitude differs (Table 27). Most have greater magnitude in the savanna ecoregion because it experiences higher cropping frequencies.

Table 27: Key drivers of change in soil fertility as a regulating ecosystem service for the poor in arid and semi-arid regions of southern Africa (Key for magnitude: 1 = Low and 5 = High)

Drivers of change in soil fertility	**Ecoregion**					
	Arid		**Savanna**		**Rivers & wetlands**	
	Direction of change	Magnitude	Direction of change	Magnitude	Direction of change	Magnitude
REGIONAL SCALE						
Poverty	=		▼	2	=	
Decreasing land availability per household	=		▼	2	▼	1
Decreasing organic manure supplies per hh with decreasing herd sizes	=		▼	2	=	
Net direction and magnitude of change	**=**		▼	**2**	**=**	**1**
LOCAL SCALE						
Insufficient hh labour	=		▼	2	=	
Cost of external inputs	=		▼	2	▼	1
Deagrianization	▼	1	▼	1	▼	1
Weak governance of agricultural conservation laws	▼	1	▼	2	▼	1
Poor soil conservation practices	▼	1	▼	2	▼	1
Net direction and magnitude of change	▼	**1**	▼	**2**	▼	**1**

4.3.1.3 Interventions that can help ensure continued soil fertility

It is necessary to appreciate that any interventions come at a cost, either in terms of cash or labour (Vanlauwe & Giller 2006). If these are limiting then the adoption of any specific

intervention by a particular subsistence household will be limited or delayed until labour or cash constraints are reduced, even though the farmers recognize the benefits. They have to make frequent trade-offs as to the best returns on their resources.

Box 25: Market liberalisation and appropriate fertiliser supply

"The problem of unbalanced fertilisation is exacerbated by the limited range of fertiliser blends that are available in many African countries. The liberalization of fertiliser markets has led to the abandonment of regulations designed to prevent deficiencies of some nutrients. For example, in Zimbabwe all fertilisers for application before or at planting were required by law to contain 4 % sulphur, but the recent liberalization of the market has led to a wide range of products being available that do not contain S. Given the wide distribution of sandy soils in Zimbabwe, which have inherently small stocks of S, this is likely to lead to widespread S deficiencies in the future" (Vanlauwe & Giller 2006).

There are a number of commonly advocated interventions, under various banners (integrated soil fertility management, organic farming, agroforestry, low- or no-tillage farming, etc.), but the essence of most of them is to maximise nutrient inputs into the soil during and after the cropping cycle. The success of these systems is variable depending upon the actual amounts of nutrients that are incorporated into the soil, and the availability of labour and land to either grow the organic materials, or transport it to each field, or cash purchase them. The most common intervention is application of inorganic fertilisers, but requires that (i) the farmer knows the best type for his/her farm and specific fields, (ii) the required type is available, and (iii) the price is affordable for subsistence farmers. A combination of both organic and inorganic is now widely advocated (Vanlauwe & Giller 2006).

Other interventions include:

- Building local knowledge of soil fertility and location of fields in areas of high fertility
  Most farmers are extremely knowledgeable of the local conditions, including moisture and fertility status, of each of their fields, and even sections of fields (e.g. Chibudu *et al*.2001, Verlinden *et al*. 2006). They consequently plant high demand crops in the most fertile areas, and may preferentially fertilize these areas with manure or fertiliser. Sharing and institutionalisation of local knowledge both with farmer groups, as well as with external advice agencies is important.
- Situating fields on or close to termite mounds
  Termite mounds are higher in nutrients than surrounding areas. Consequently, farmers deliberately place intensive production gardens or fields adjacent to termite mounds, or bring in soil from termite mounds to top-dress their fields (Verlinden *et al*. 2006).
- Improving capacity and implementation of anti-erosion practices
  Soil erosion is a primary source of nutrient loss from farmers' fields. Modelled losses in Mozambique indicate that up to 55 % of macro-nutrient depletion can be attributed to erosion in areas with high erosion rates (Folmer *et al*. 1998). Successful interventions such as contouring, vegetation belts, and maintenance of vegetation can reduce erosion rates dramatically, and hence also the associated nutrient losses, and have been widely advocated by central governments throughout the region fro decades (Scoones 1997).
- Shifting cultivation in areas where human populations are relatively low
  This is limited in many areas because of relatively high human population densities in the semi-arid savanna regions. It is evident in many areas of Mozambique (although restricted due to mine fields laid during the civil war (Folmer *et al*. 1998)) and to lesser extent in Zimbabwe and Botswana. New fields are cleared from wild lands. The cleared vegetation is burnt on the cleared field. The field is cropped for several years. As soil fertility declines, and consequently crop yields decline, the field is abandoned and a new one cleared. The abandoned site returns to savanna vegetation, until it is cleared again in several decades (e.g. Dahlberg 2000).
- Agroforestry
  This approach involves the incorporation of trees into the cropping system. Typically, subsistence farmers already leave important indigenous fruit tree species in their fields (Chivaura-Mususa *et al*. 2000), but this might be at lower densities or cover than recommended by agroforestry system. Additionally, tree species commonly advocated by agroforesters have characteristics important for maximising benefits for cropping, such

as being nitrogen fixers, high productivity, rapid regrowth after pruning/chopping, etc. The trees also ameliorate extremes in soil moisture and temperature.

- Crop rotation and fallows
  Rotation of compatible crops in different seasons on the same piece of land is widely practiced and can have benefits for soil fertility. Such rotation can take various forms, including alternating nutrient-demanding crops with less demanding ones; introducing legume crops every few years; after several rotations, leaving the land fallow for a year or two, and so on. Interventions relate to promotion of useful species (such as the best legumes for the area), and sharing of knowledge relating to the best sequence of crops for specific regions and species soils.
- Additions of local organic nutrient sources
  As indicated in Table 26, farmers in the region make use of a range of nutrient inputs, many of which can be sourced locally, or grown specifically as a green manure or mulch. However, adoption of such practices varies from year to year depending on available labour, as well as place-to-place. Interventions to address the constraints, such as pooling of organic sources between farmers and then an "in-turn" sharing of the pooled sources; farmer groups to help share labour, viable share cropping arrangements, etc.

4.3.2 Water regulation and flood control

The importance of water as a provisioning service has been highlighted in Section 4.2.3. But there is also the important regulating service provided by wetlands and riparian habitats. Floods are essential for maintaining ecosystem processes in the wetlands of arid and semi-arid areas of southern Africa, but these wetlands in turn play a role in regulating flows. As floods spread out over wetland areas, the downstream threat of flooding is reduced. Recharge of wetland aquifers provides a store of water that is released after the river returns to normal flow levels, and continues into the dry season. The flow of the Zambezi River is regulated by the many wetlands in its upper reaches in Zambia which attenuate floods and sustain dry season flows. Dams have similar effects on floods, but will only augment dry season flows if they are operated to do so. It must be borne in mind that wetlands and dams are only effective in attenuating smaller floods. The most extreme events, such as those in Mozambique in 2000, will quickly fill up the available storage capacity with little effect on the size of the flood. One outcome of the differential effect of dams on different sized floods is that by reducing the frequency of moderate floods, people are encouraged to settle closer to the river. They are not protected from the infrequent large events which can have devastating consequences on the increased numbers of people settled on flood plains. Urban areas can be especially vulnerable as undeveloped flood prone areas are often taken over by informal settlements, whose inhabitants have little security against hazards such as floods.

The drivers, etc. of food regulation and control are similar to those provided in Section 4.2.3.2 where water as a provisioning service is discussed.

4.4. EXAMPLES OF IMPORTANT CULTURAL SERVICES

4.4.1 Social, cultural and spiritual

4.4.1.1 Importance of social, cultural and spiritual services and trends

The less tangible benefits of ecosystem services and their importance for people are seldom acknowledged (Madzwamuse *et al.* 2007). The SAfMA (2003) revealed that spiritual, aesthetic and recreational services were highly valued by different sectors of society and at a variety of scales, contributing to their emotional, religious and psychological well-being (Biggs *et al*. 2004). The cultural significance and uses of a wide variety of harvested species and natural products has already been discussed in Section 4.2.1.3. In this section we focus on *non-consumptive*, or *non-material*, cultural, social and spiritual services.

The cultural values and belief systems of local people, their use of biodiversity and space within the landscape, and their adaptations to the local environment are integrally linked and have co-evolved over centuries through learning, innovation and experimentation (Berkes & Folke 1998). Many traditional norms, taboos and practices assist either directly or inadvertently in the management of ecosystems and specific species (Madzwamuse *et al.* 2007). Sacred sites, e.g. forests that harbour spirits, sites for ritual ceremonies and offerings, burial sites where the ancestors reside, imposing trees and natural features such as pools, springs, mountains and caves, can assist in the protection of habitats and biodiversity, provide refugia for particular species, deliver regulating services and contribute to landscape diversity (see Box 27). Such sacred places play a prominent part in the religions of many rural communities in the region representing 'hidden forces' upon which people draw for their survival (Murombedzi 2003). At present there is little evidence that these services are more important for the poor than other members of local communities. With respect to scale, most work examines cultural affinities of species, spaces and processes at the level of individual people, households and communities. There are no assessments at national or regional scales.

Box 26: Spiritual significance of rivers

Rivers have a strong spiritual significance for many people in Africa (see Appendix 2 – Case Study 4). For many people the river is a living entity that should be revered. This is captured by a statement by Martin Shikuku, MP for Butere in Kenya, when he challenged the building of dams on the Tana River with the words " Do not block the stream, because if you block the stream, so that no more water is going downstream, there will be snakes and other creatures coming upstream to find out why there is no water downstream; they will bite the person who has dammed the stream. (Republic of Kenya 1074: 680).

In the village of Tidbury in the Kat River valley in the Eastern Cape of South Africa, three cultural sites or 'spaces' were identified: burial grounds, sacred pools and cattle kraals (enclosures) (Fox 2001, Appendix 2 – Case Stud 4) (also see Box 27 for another example). These areas are seen as "where our culture is based" and crucial for maintaining relationships with the ancestors whose spirits occupy these sites. Burial grounds have restricted access and can only be visited at predefined times (e.g. during funerals) or with community permission. Resource extraction is generally disallowed (Mandondo 1997). This protects the vegetation in these areas. Scared pools are important sites for worshipping and apologising to the ancestors and for ensuring

Box 27: Sacred sites and cultural spaces identified amongst the Shona in Nyamaropa Communal Area, Nyanga, Zimbabwe (along the eastern border with Mozambique) (Source: Mandondo 1997)

Burial places for the ruling elite – these are viewed as extremely sacred as when the ruling elites die they join the founding spirits in these burial grounds, who are see as the real custodians of the land. These grounds are expansive, associated with key features in the landscape such as hills, and often have wider significance.
Burial places for commoners – these are usually much smaller and only of local significance. They stand out as islands of dense vegetation with more mature trees in the more deforested areas of the landscape. Men, women the young and old may be buried in different ecological locations, assisting in preserving a range of habitats. Infants for example are considered weak, but having 'hot' spirits, and need to be buried in moist 'cool' areas.
Spaces for spirits, their hosts and messengers – non-ancestral spirits have human hosts, spirit mediums, but also animal hosts and messengers, e.g. lions, pythons and bateleur eagles (which are given special names when they host a spirit). These spirits have dwelling spaces which are sacred but also routes through the environment that they follow which are also considered sacred but less so. Some spirits may use certain flora or floral assemblages as their hosts – e.g. *Afzelia quanzensis* hosts the rain spirits while the fig, *Ficus capensis*, is believed to host the hunter spirits.
Spaces for propitiating the spirits – besides having spaces for their sustenance within the environment, spirits also need to propitiated (thanked, asked for blessings, asked for help). Some of these rituals are undertaken in specially designated places in the environment. Sites of eminence include sites for rain ceremonies, but most are small and localised and may be a specific tree within the village. Most are under secular and religious taboos.
Ritual daughter's pools – among the ruling elite the power to communicate with the ancestors usually lies with the ritual daughters of the clan. These single women are believed to obtain their supernatural power through bathing in sacred pools.
Springs created by the ancestors - some sources of potable water are believed to have been created by the ancestors with this power. These are often on higher ground. While not always considered sacred there are a range of sanitary and preservationist norms that protect them. Trees around these springs are often protected through the belief that cutting them will cause the water to disappear.
Spaces under ethical controls – although not necessarily sacred, some spaces in the local environment such as sources of rivers and riparian zones, are under ethical controls. Local norms exist against the cutting of trees believed to be of hydrological importance.

These spaces are associated with a variety of emotions including fear, respect and reverence, which protect them.

individual and community health (Box 27). The health of the river is perceived to be linked to the 'quality' of the benefits obtained via the ancestors; if the river is in good condition "your physical health would be better and the unity in the village would be stronger" (Fox 2001). Sacred pools are often associated with particular myths, beliefs, superstitions and taboos that protect these sites from pollution (washing), harvesting, fishing, and water collection (Bernard & Kumalo 2004). Access to these pools is also often restricted to certain times of the day or even days of the week. If the taboos and restrictions are not adhered to, it is believed that punishment (in the form of misfortunes) from the ancestors will ensue (Mandondo 1997, Fox 2001). Often this is backed up with political sanctions by the traditional authorities. The python and mermaid are key symbols found repeatedly in the oral histories of different groups throughout southern Africa. They are viewed, along with the ancestral spirits, as guardians of the land and sacred sites and act as potent constraints to the misuse of resources or the violation of taboos (Byers *et al.* 2001, Bernard & Kumalo 2004). In Bawa in northeast Mozambique, the lion spirit is particularly influential as the community is extremely reliant on hunting for their protein. Great respect is still accorded to the spirit forces that exist within the natural environment providing evidence that a complex spiritual ecology still exists within segments of the diverse communities that make up southern Africa (Mandondo 1997, Bernard & Kumalo 2004).

Sacred forests or groves are a relatively common feature of the landscape in the savanna ecoregion (Mandondo 1997, Byers *et al.* 2001, Virtanen 2002). The most well known in South Africa is the Thate-Vondo forest in the former Venda. Local people were alienated from this forest in 1947 with it remaining under state control ever since. In Zimbabwe, traditional spiritual and religious values have been critical in influencing behaviour towards the unique dry forests in the Muzarabani area of northern Zimbabwe, where more than 30 sacred sites were identified (Byers *et al*. 2001). These sacred forests, also burial places, show less evidence of forest loss than non-sacred forests and continue to be acknowledged by most community members (Table 28).

Table 28: Results from an opinion survey regarding sacred sites in the Muzarabani area of the Zambezi Valley, Zimbabwe (N=59). (Source: Byers 2001)

Question	% Yes	% No	% Other
Are there sacred places nearby?	57.6	16.9	25.4 (don't know)
Is it good to respect sacred places?	85.7	3.6	10.7 (doesn't matter)
Are there rules about sacred sites?	73.5	5.9	20.6 (don't know)
Do people respect sacred places?	35.9	2.6	61.5 (some do, some don't)

Areas of natural vegetation and forests are also important as initiation sites, where boys undergoing circumcision and entry into manhood spend time in specially constructed exclusion shelters. In some cases these may be small patches of natural vegetation, often in municipal commonages, on the outskirts of urban areas. Male initiation is fundamental in the culture of many southern African ethnic groups and people talk about "going to the bush".

Shared traditional and ecological knowledge and cultural rituals and practices, often at a community or neighbourhood level, are critical in building social cohesion contributing to a 'sense of community or belonging'. The example of marula beer gatherings has already been mentioned in Section 4.2.1.1. Such social capital and shared identity can be an important asset or safety net for the poor, providing a mechanism for ensuring on-going acceptance and support of more vulnerable members of the community or those facing crisis.

Ecosystems and their services also influence the types of social relations that are established amongst different groups of people (MA 2005a). The fishing societies of the Okavango delta will, for example, differ in their social relations from the hunter-gatherer communities of the Kalahari or the pastoralists of Namibia. The close ties between social organisation, local institutions and the environment amongst subsistence societies has been emphasised by many scholars

(Murombedzi 2003). Spirit mediums, who are able invoke the presence of various spirits representing natural elements such as land, wildlife and sacred areas and channel the wisdom inherent in these spirits into practical guidance, are a powerful institution in many rural communities across the region and have an important influence over the community's decision-making processes (Byers *et al.* 2001, Bernard & Kumalo 2004, Johnson 2004). Harvest sharing rules in hunter-gatherer societies of the arid ecoregion not only ensure food security and promote egalitarianism, but are also believed to enhance resource conservation in these harsh, uncertain and dynamic environments (Chakraboty 2007, Madzwamuse *et al.* 2007). Many informal collective institutions and networks that build social bonds and trust are associated with wild resource harvesting, processing, range management, water management, etc. These contribute to building the social capital of poor and vulnerable communities (Pretty & Ward 2001).

While many wild plant and animal species are harvested for cultural artefacts, practices and rituals as well as everyday needs (see Section 4.2.1.1) (Cocks 2006), some are revered for their presence in the environment as totems and symbols. Particular animal species may be messengers for the ancestors such as bees and the wagtail in the Eastern Cape, others may be prophetic and bring bad luck if injured, some may personify spirit beings, while others may be representative of individual clans or groups and therefore of symbolic importance (Fox 2001). The Baswara (San) of the Okavango delta respect certain species of animals as god's (*N!adima*) creatures and their hunting is strictly controlled (Madzwamuse & Fabricius 2004). Sometimes a total prohibition on harvesting of certain totem species may be imposed. For the Tonga in the Zambezi Valley of Zimbabwe, eating the meat of one's clan animals is considered sacrilegious (Sibanda 2004). Certain trees are also sacred and protected from felling and harvesting such as those at sacred pools, and those housing good spirits. Those housing evil spirits tend to be avoided or shunned for fear of haunting (Mandondo 1997). But, just as some species are revered and retained on the basis of religious, emotional and ethical grounds some may also be eliminated, certainly within the space close to the homestead (Mandondo 1997).

For many communities the environment as a whole has significant intrinsic value (Fox 2001) and nature is seen as inseparable from society, culture and religion (Byers *et al.* 2001, Murombedzi 2003, Sibanda 2004, Table 29). In the Eastern Cape of South Africa three factors contribute to this: (i) the sense of continuity to place demonstrated by local people that allows the development of effective values and appreciation for the environment, (ii) the close linkages between the ancestors and the environment, and (iii) the relationship that exists between individual and community health and the condition of the environment. The importance of the latter two is illustrated in the quotes in Table 29. People also recognise the regulating services delivered by cultural species, such as the importance of riparian species in maintaining the stability of riverbanks. The MA (2005a) argues that many societies place high heritage value on the maintenance of either historically important landscapes ("cultural landscapes") or culturally significant species.

Table 29: Quotes indicating the importance of the environment for culture and well-being amongst the *AmaXhosa* in the Kat River valley, South Africa. (Source: Fox 2001)

"When we worship we believe that the environment helps us to worship the ancestors."
"In our culture, our traditions, our beliefs – the environment and ancestors are one thing."
"I think that all the trees are important because we go to the bush to worship the ancestors. We believe the ancestors are in the trees."
"The reason why we are healthy and able to do things is because of the environment."
"When the environment is healthy my body and spirit is also happy".
"What is very important from the environment for me is to be healthy and I also worship the ancestors."

Trends in cultural services are difficult to measure. Clearly the loss of natural ecosystems and biodiversity (see Section 4.5.1) will result in declining access to and availability of important cultural species and habitats. The Millennium Ecosystem Assessment found that globally there has been a decline in the numbers of sacred groves and other such protected areas (MA 2005a). In some instances, a weakening of local cultural institutions and controls has resulted in the harvesting of resources from these systems undermining their ecological integrity and compromising their 'sacredness'.

The importance of cultural services themselves may also be diminishing as people are faced with more urgent and immediate 'survival' needs and pressures on natural resources correspondingly increase. Many commentators make reference to the loss of traditional or indigenous knowledge, which in turn can reduce people's recognition or appreciation of cultural benefits of ecosystems (Bernard & Kumalo 2004, Sibanda 2004). In some cases, restrictive colonial policies resulted in the alienation of communities from their forests and the sacred rituals performed in these forests undermining important social institutions and leading to the younger generation loosing their spiritual connection with nature (von Maltiz & Shackleton 2004). Others have argued (e.g. Matowanyika 1991) that while colonialism attempted to replace African institutions with western ones, the latter did not fade away but continued to function because of fundamental differences in the perceptions and uses of the environment between the colonisers and the colonised (Murombedzi 2003). The exception is territorial cults (responsible for regulating the production and distribution of food and the protection of natural resources), which have all but disappeared (Murombedzi 2003).

Box 28: Impacts of the erosion of cultural services

- Reduced social cohesion, which can reduce social capital and its importance as a safety net.
- Less respect for the environment and sense of place, which can accelerate intergenerational migration and dislocation.
- The above two can make individuals and communities vulnerable to displacement activities with significant negative impacts such as substance abuse, crime, etc.
- Local groups are less able to control resources and maintain a united front against exploitation by outsiders.
- Fewer or reduced refugia for cultural and other important species resulting in negative feedbacks on species abundance – ultimately certain thresholds may be passed and local extinction follows.
- Loss of scared sites can result in diminishing regulating services such as clean water, pollination services, etc. to the detriment of the poor.

4.4.1.2 Drivers of change in the provision of cultural services

Scarcity of resources for meeting everyday needs, **demand for land** for agricultural production and the **need for cash income** is placing pressure on habitats and species with cultural value (Byers *et al.* 2001). **Increasing poverty and hardship** means that more emphasis is being placed on consumption and the provision of tradable goods (some of which may have cultural value – Section 4.2.1.1). For example, it was previously taboo to sell marula beer because of its social and cultural importance. However, traditional authorities now recognise that the sales of this beer can bring much needed income to poor, mainly female headed, households that have few alternative means of earning money (Shackleton 2004). This suggests that in some situations non-material values or services may be seen as a luxury that cannot be indulged when people's very survival may depend on consumptive use and commoditisation of the same resources. In other instances, people feel that the loss of important cultural species and uses would be disastrous. When asked what would happen when ritual species such as wild olive, sneezewood and cape willow disappeared from the environment in Tidbury village in Kat River, South Africa the respondent replied - " this would mean the nation would be killed, particularly Tidbury village: it would destroy our culture."

Erosion of traditional values amongst youth and increasing **uptake of western and more utilitarian values** may result in the declining significance of cultural practices and uses of natural resources, and ultimately trade-offs with other services (Sibanda 2004). However, this varies across the ecoregions and countries (Table 30). Research in two areas of the Eastern Cape (Dold & Cocks 1999, 2000, Fox 2001) indicates that there is no significant difference between age, gender and socio-economic groups when valuing cultural sites and species. On

the other hand, evidence from the Zambezi Valley shows that while most Tonga people younger than 50 years old had gained some traditional knowledge from their elders, they did not know how to practically apply it (Sibanda 2004). As one interviewee said: "*Our dignity is long lost, our language is fast disappearing, even concepts of resource management which were part of Tonga culture are not understood today"*. **Religious change** and adoption of Christianity, depending on the church, can influence ancestral worship and relationship to cultural resources. **Immigration** of people with different ethnic affiliations can also dilute and undermine local cultural values and institutions (Byers *et al.* 2001). In the Zambezi Valley in Zimbabwe, Christians (50 %), young people (38 %) and immigrants (13 %) were seen as the main groups not respecting sacred sites, although on further analysis these results were somewhat ambiguous (Byers *et al.* 2001). Cocks (2006) argues that cultural values often persist despite rapid social, economic and political change, and provides evidence from South Africa that demonstrates how both urban and rural communities continue to attach strong cultural value to wild resources. Yet, during in-country consultations cultural services were rarely mentioned.

Table 30: Key drivers of change in cultural and spiritual value as a cultural ecosystem service for the poor in arid and semi-arid regions of southern Africa (Key for magnitude: 1 = Low and 5 = High)

Drivers of change in social and cultural values	**Ecoregion**					
	Arid		**Savanna**		**Rivers & wetlands**	
	Direction of change	Magnitude	Direction of change	Magnitude	Direction of change	Magnitude
REGIONAL SCALE						
Land transformation	▼	1	▼	1	▼	2
Globalisation	▼	1	▼	1	▼	1
Construction of large dams					▼	2
Net direction and magnitude of change	▼	**1**	▼	**1**	▼	**2**
LOCAL SCALE						
Land transformation	▼	1	▼	1	▼	2
Over-harvesting	▼	1	▼	2	▼	2
Urbanisation	▼	1	▼	1	▼	1
Commodification of resources and spiritual sites	▼	1	▼	1	▼	1
Weakening of traditional and spiritual leadership	▼	1	▼	1	▼	1
Erosion of traditional values	▼	1	▼	1	▼	1
Construction of large dams	▼	1	▼	1	▼	3
CBNRM initiatives	▲	1	▲	1	▲	1
Net direction and magnitude of change	▼	**1**	▼	**1**	▼	**2**

Dilution of the influence and power of customary institutions such as chiefs, headmen and spirit mediums is impacting negatively on cultural values and respect for sacred sites. Byers *et al.* (2001) suggest that "the system of spirit mediums is under stress, and is experiencing difficulty adapting to the rapid demographic and economic changes in Zimbabwe". Democratically elected village committees are said to have no knowledge of the location and boundaries of sacred sites or how to enforce customary laws, and therefore encroachment into

these sites is becoming a problem. In Mozambique, political manipulation of sacredness and disputes over legitimacy has resulted in the weakening of respect for customary norms with regard to these sites (Virtanen 2002). The erosion of traditional values, driven by all the factors mentioned above, will also undermine the important local institutions associated with these, creating feedbacks on natural resource management and ecosystem integrity.

Policies for rural development and natural resource management rarely give cognisance to the importance of local knowledge, spiritual ecology and cultural services (Mandondo 1997, Bernard & Kumalo 2004). This means that little priority is afforded to these services in development and resource management initiatives. This could contribute to undermining the importance of this element of rural life and environment. If local people had greater opportunity to have a say in policy making it is possible that cultural values would feature more prominently.

In terms of thresholds of change there is no direct information because there are relatively few studies in the region that have examined cultural services of ecosystems, and none that have done so within an analytical framework of thresholds. Moreover, since cultural services are anthropogenic, communities can readily shift thresholds of change. Nonetheless, it is likely such thresholds to exist, and would be a function the abundance and relative accessibility of the service. If either become too low, then appreciation of the service may wane with time.

4.4.1.3 Trade-offs in the provision of cultural services

Cultural services are probably one of the most susceptible categories of ecosystem services to trade-offs as they are often seldom appreciated beyond the local level nor valued in monetary terms (which is extremely difficult to do) and therefore are frequently overlooked in policy, land use planning, conservation and development agendas. In Muzarabani in the Zambezi Valley, future threats to sacred forests include irrigation and resettlement schemes that ignore the importance of these forests (Byers *et al.* 2001). Furthermore, at a local level, cultural services are not always the most important in terms of putting food on the table. This means that more immediate and pressing demands, such as for agricultural land, may take precedence over cultural values. This can sometimes result in conflict between different groups in communities and between the elderly and the younger generation.

4.4.1.4 Interventions that can help ensure continued provision of cultural services

Key interventions that can contribute to ensuring the continued provision of spiritual and cultural services include:

- Respect for local knowledge and integration into decentralised and participatory natural resource management systems (Virtanen 2002, Johnson 2004).
- Customisation of natural resource management policies to local contexts.
- Empowerment of endogenous institutions (usually religious and political authorities) where these still carry legitimacy including the provision of legal authority to enforce their norms (Virtanen 2002). “Sacredness is a powerful means for conservation only when it is linked to a broadly respected belief system, with adequate normative controls and means for their enforcement” (Virtanen 2002). In the Tchumo Tchato CBNRM project in Bawa, north-west Mozambique, effort was made to purposefully engage with spirit mediums and include them as key project participants (Johnson 2004). The CAMPFIRE programme in Zimbabwe, on the other hand, has been criticised for failing to incorporate local knowledge and the spiritual dimension of natural resource management (Sibanda 2004).
- Stimulation of learning and interaction within the community so the younger generation learn about traditional and cultural values.
- Recognition of traditionally conserved areas in national biodiversity strategies and action plans, as is the case in Mozambique (Virtanen 2002).

One of the primary barriers to incorporating local controls into natural resource management approaches is that their complexity can impair their abstraction into articulate and practicable policy formulations (Virtanen 2002). Actions elicited by different controls are also not mutually

exclusive and are sometimes ambiguous, and consequently their inclusion in more generic policy may invalidate their effectiveness. Furthermore, there is a multiplicity of levels of human organisation at which different controls relate and the basis for some of the controls are shrouded in secrecy.

4.4.2 Recreation and tourism

4.4.2.1 Importance of tourism services for the poor and trends

Box 29: Size of the tourism industry in South Africa

State and private sector reserves in South Africa employ at least 60 000 people, supporting up to half a million dependents (Shackleton *et al*. 2007b), and foreign visitors spent approximately R48.8 billion in 2002 (Harvey 2003). Private ecotourism lodges in the Mpumalanga lowveld generate 15 times higher returns than cattle farms in the area and employ 25 times more people (Milton *et al.* 2003).

Recreational and tourism activity have increased globally in scope and scale in recent decades, in direct response to increased affluence in the western world and easier global connectivity (Williams 1998). The World Travel and Tourism Organisation has estimated a tripling in the number of international travellers to 1.6 billion by the year 2020. Within this context tourism has come to be seen by many developing countries as an ideal development approach worth fostering (Reid 2003), since it (i) attracts external capital, (ii) generates new sources of activity, (iii) may provide development stimulus in rural and often neglected areas, and (iv) is directly linked to ecosystem integrity (Box 29). Given that the natural attractions and biodiversity of sub-Saharan Africa feature prominently on the international tourism agenda, there is considerable scope to link tourism development to sustainable environmental management and poverty alleviation, through the revenue which tourism activity can inject into what are often the economically poorer parts of developing countries (Wahab & Pigram 1997, Mowforth & Munt 1998). Indeed, within southern Africa tourism is one of the most rapidly growing sectors, and already comprises more than 10 % of GDP on both Namibia and Botswana (Table 31). In Botswana tourism provides 4.5 % of all employment in the country and is the second biggest contributor to the GDP (Mbaiwa 2005).

Table 31: Contribution of tourism to national GDP in 2003/04 (note all values are rough estimates). (Source: www.tourism2006.com)

Country	Contribution (%)	Number of visitors
Botswana	10.3	975 000
Mozambique	1.0	900 000
Namibia	11.0	695 000
South Africa	7.4	6 700 000
Swaziland	6.6	220 000
Zimbabwe	3.3	1 850 000

Box 30: Concept of CBET

"From a conservation perspective, community tourism rests on the assumption that, "by generating direct local benefits from wildlife, adventure and cultural experiences and scenic landscapes tourism helps create incentives for the conservation of local habitats and sites by local communities" (Ashley 1998).

As part of the global expansion in tourism activity, its nature and focus has evolved and the search for 'alternate' forms of tourism has become a prominent dimension. In direct consequence, there has been a noteworthy expansion in various nature-related activities, referred to as: 'nature-based tourism', 'ecotourism' and 'adventure tourism'. Given that in much of Africa such activities are often undertaken in areas which are the homes of significant numbers of people, the potential for both conflict and compromise is a very real scenario, particularly in cases where various environmental assets have both tourism

appeal and traditional values (Box 31). Within this context, and as a direct consequence of the perceived capacity and responsibility of tourism to help fund or cross-fund poverty alleviation and conservation, approaches such as 'pro-poor tourism' and 'sustainable tourism' have become popular (Ashley & Roe 1998, 2002). Within this context it is important to reflect on the linkages between ecosystem services and tourism, with specific reference to potential poverty related impacts, and links with the concept of CBNRM and associated community-based ecotourism (CBET) initiatives. In this section the term CBET is used as a catch-all term to refer generically to recreational and tourism activities which are based in communities and grounded on concepts such as poverty alleviation, ecosystem management and sustainability.

Box 31: Value of ecotourism in the Okavango Delta (Source: Mmopelwa & Blignaut 2006).

A valuation study of the Okavango Delta to estimate (i) the direct consumptive use value, (ii) the non-consumptive use value (ecotourism), and (iii) the existence value of the Delta revealed the following:

- direct consumptive use value was between US$653 372 and US$979 990 or US$1.33/ha and US$1.99/ha.
- non-consumptive use value was between US$11.2 million and US$16.8 million or US$28.81/ha and US$34.21/ha - **considerably more than the direct use value of the resources in the Delta**.
- the mean 'willingness to pay' towards the conservation of the Delta (existence value) was US$214.08/tourist.

In southern Africa these alternate tourism activities occur across all ecoregions and ecosystems from mountain to desert, to wetland to bushveld zones and focus on tourist activities ranging from adventure sports (climbing, skiing, etc.), to game viewing, nature hikes, hunting, cultural tourism and aesthetic/scenic appreciation. It is includes state, communal and private tenure lands. Frequently such activities take place within the living environments of rural communities often suffering from poverty and limited access to resources, which impacts directly on their livelihoods. Consequently, maintenance of the tourism attractions of ecosystems can potentially benefit the poor, whereas poor management of such attractions can undermine the value of the tourism service and consequently reduce the potential poverty alleviation benefits. As a response, countries such as Zimbabwe, Namibia and South Africa have tried innovative interventions which to seek to preserve biodiversity, ensure sustainability, respond to poverty, and to empower communities through efficient management of recreational and tourist activity (see below). Arguments in favour of CBET stress, from a development perspectives that tourism activities are one of the few logical alternatives for the poorer and remote areas of countries where agriculture is unlikely to yield significantly improved yields.

In many cases however, the tourism opportunities provided by ecosystems can be put under pressure by over-use and degradation of the resource, including by the tourism enterprise itself. In addition, communities may only gain selective use of a resource and cultural practise can become commoditised (Ashley & Roe 2002). Alternatively, prime tourism sites may be expropriated by the state or private concessions, limiting the control, access and cultural use by local communities. For example, creation of private and state game reserves has involved translocating people, or denying them access to previously held resources and areas. The trade-off might be jobs and a market outlet for traditional products and culture. While there are numerous cases of sustainable tourism projects which prioritise the needs of the poor and focus on environmental and economic sustainability, this is not across the board (Ashley 1998). As a result, the key asset – the ecosystem – can become compromised and degraded over time and the rights of poor communities might be marginalized. Simultaneously however, there is also evidence from southern Africa that biodiversity can be enhanced and livelihood assets and income can be improved through these initiatives (USAID, n.d.). These differing experiences reflect the complex reality that exists on the ground, as much as they reflect different institutional and community-private sector dynamics.

4.4.2.2 Drivers of change in tourism activities and services

Overall the tourism sector is growing internationally which is mirrored in southern Africa. Tourism is now within the top three sectors contributing to GDP in Namibia, Botswana and South Africa,

and is rapidly growing in Mozambique. The political uncertainties in Zimbabwe and to a lesser extent in Swaziland have stagnated or reversed tourism growth.

The recreation and tourism sector in the sub-region is directly impacted by trends which are often externally sourced. Key drivers of change in this regard include (Table 32):

- increasing affluence on the part of the global middle class seeking alternative tourism activities;
- the rise of 'alternative tourism' and the search for 'authentic' experiences – both cultural and environmental;
- the vast areas of reserves and sparsely inhabited lands in southern Africa;
- the response of tourism operators to perceived new market opportunities, and marketing of the significant ecotourism potential of the region;
- enhanced global environmental consciousness and the need to pursue sustainable development;
- stability in governance structures over the last decades or two (except Zimbabwe);
- the general vulnerability of the global tourism industry to market shifts and terrorism threats; and
- regional cooperation in biodiversity management and tourism via Transfrontier Parks.

Within countries key drivers include:

- government support for new economic opportunities and the parallel consciousness of the need for the sustainable management of resources, the recognition of community rights and new avenues to address poverty relief;
- political processes and economic meltdown which can deter tourism activity, such as in Zimbabwe;
- local institutional and resource access dynamics which variously empower or constrict community access to resources; and
- competition for access to scarce resources.

Table 32: Key drivers of change in tourism value as a cultural ecosystem service for the poor in arid and semi-arid regions of southern Africa (Key for magnitude: 1 = Low and 5 = High)

Drivers of change in tourism	**Ecoregion**					
	Arid		**Savanna**		**Rivers & wetlands**	
	Direction of change	Magnitude	Direction of change	Magnitude	Direction of change	Magnitude
REGIONAL SCALE						
Land transformation	▼	1	▼	1	▼	1
Globalisation & inter-ational travel	▲	1	▲	2	▲	1
Political strife and social unrest			▼	2	▼	1
Net direction and magnitude of change	**=**		**▲**	**1**	**▲**	**1**
LOCAL SCALE						
Pro-poor tourism initiatives	▲	1	▲	2	▲	1
Privatisation of national tourism features	▼	1	▼	1	▼	1
Poor maintenance of infrastructure	▼	1	▼	1	▼	1
Crime	▼	1	▼	1	▼	1
Net direction and magnitude of change	**▲**	**1**	**▲**	**1**	**▲**	**1**

No thresholds were identified in terms of the ecosystem services that provide the ecotourism experience, but there are thresholds within the socio-economic context in which they are experienced or developed. Thus, there are clear conditions under which tourists are attracted to and are willing to pay for ecotourism experiences and where these decline, tourists seek alternative destinations. This can severely reverse local economic development enterprises based on tourism receipts, potentially leading to deeper poverty. At national or international levels, such adverse environments and thresholds include political uncertainty and civil strife as currently observed in Zimbabwe, or escalating oil prices. At more national and local levels, factors which negatively impact on tourism are crime, disease outbreaks, and poor accessibility through, for example, the neglect of roads and other infrastructure.

4.4.2.3 Trade-offs in the delivery of benefits from tourism services for the poor

As noted in many countries, the impact of tourism can vary from extremely positive to very negative, requiring sensitive management, planning and support of communities, particularly in terms of the latter's dealings with external market forces and the inherent vulnerability of the environmental assets. A review of CBET projects (Kiss 2004) suggests that the impact on communities varies, with there being, at one level, numerous instances of communities where incomes and local attitudes to conservation have improved (Box 32). However, there is also evidence that income improvements are often very modest and that often only minimal changes occur in land management practises (Box 33). There is a real concern that "tourism is also far from an ideal entry-level business for rural communities with little previous experience" (Kiss 2004).

In an ideal case CBET enables communities to derive income, it provides incentives for them to engage in conservation action and to protect biodiversity, and it draws people away from negative environmental practises (Kiss 2004).

Box 32: Evidence of positive impacts of ecotourism on poverty

Evidence from various community-based tourism projects in southern Africa indicates that they can have a not insignificant impact on poverty. For example:

- As part of livelihood diversification, in the Xaxaba area of Botswana up to half of the households relied on remittances from family members engaged in the tourism industry. Community income derived from CBNRM in that area was used to build a tuck shop and to buy a truck and a boat (Madzwamuse & Fabricius 2004).
- In Namibia cash income for households with a member participating in a community-based tourism project can be raised by N$ 2-3,000 p.a. above the minimum household cash need of approximately N$1 800 p.a. (Ashley 2000).

The most apparent advantages of CBET include:

- employment – either direct or indirect, full-time or seasonal and most often as a supplementary source of income;
- expansion of social services in areas – either as a result of direct community-benefits derived from a project such as CAMPFIRE or the general upgrade of services and infrastructure to meet tourism needs;
- exposure to the external economy;
- preservation of traditional livelihoods and biodiversity;
- new sources of supplementary income; and
- reduction in poaching and increased wildlife numbers.

In parallel a range of disadvantages can be noted:

- restricted access to areas with resources;
- clash of value-systems;
- commoditisation of culture/loss of traditional values;
- communities divided by differential access to new jobs and income;
- importation of skills and marginalisation of local people;
- success attracts in outsiders diluting local benefits;

- legal and land tenure barriers over access to resources are a common barrier (Ashley 1998, Ashley & Roe 2002, Logan & Moseley 2002, Sheyvens 2004, Hill *et al*. 2006).

Box 33: Evidence of negative impacts of ecotourism on poverty

Research undertaken in the Okavango Delta, primarily in Botswana, indicates that the impact of tourism on poverty is limited, and the poor have in fact been further marginalized – because salaries paid are often below the poverty datum line, weak linkages are developed with the local economy, control is exercised by foreigners who repatriate most of their earnings, and there is only limited scope for local participation. This in turn is forcing people to be increasingly reliant on natural resources for their livelihoods, increasing pressure on environmental resources, with associated negative impacts (Mbaiwa 2005, Kgathi *et al.* 2006).

4.4.2.4 Interventions to promote delivery of tourism benefits to the poor

One of the most well-known and well established CBNRM/CBET initiatives is that of Zimbabwe's CAMPFIRE programme. Established in the 1980s it has been hailed as a successful example of an initiative which fosters sustainable environmental management and generates income for communities (Logan & Mosley 2002, Scheyvens 2002). Success is evident in terms of improvements in biodiversity, reduced poaching, and measurable material gains made individually and collectively in communities (USAID, n.d.). But recently this has been undermined by (i) increasing control exercised by District Councils, (ii) reduced community access to resources, (iii) damage caused by wildlife, and (iv) a declining number of international hunters and the falling value of the Zimbabwe Dollar (Logan & Moseley 2002, Simpson 2007).

In Nambia, since 1994, the government has actively pursued CBNRM and CBET through devolution of significant levels of decision-making and control to local communities, particularly though the community-based management of conservation areas (Ashley 1998). In addition a range of management models in communal areas have been attempted, ranging from the establishment of private lodges to local enterprise driven development. Evidence indicates that the highest revenues for communities tend to accrue in cases where joint venture models are pursued and greater distribution of welfare occurs. Socially positive benefits such as skills development, strengthening of local institutions, the revitalization of traditional values and improved confidence in dealing with outsiders have been noted. Environmentally, while wildlife numbers have increased and desertification has apparently been partially halted (USAID, n.d.), it is argued that the benefits of wildlife to local communities must exceed the costs associated with their presence, which is complicated in the context of common property resources. In order to be effective (Murphree 1994, in Ashley 1998) notes that effective local institutions must be in place and local incomes must be distributed equitably. Significantly, unlike the Zimbabwean case, control rests with the community and not the more distant District Councils (Scheyvens 2002).

In Botswana, part-time employment in the seasonal tourism industry, joint venture leases and craft manufacture are important supplementary livelihood options generated through tourism initiatives, particularly within the context of reduced land access and hunting controls (Madzwamuse & Fabricius 2004). Tourism has added an import new strategy to local livelihoods, advancing diversification and reduced reliance on any single sector (e.g. Appendix 2 - Case Study 6). Tourism in the Okavango Delta generates more than the direct-se value of resources (Box 31).

In South Africa, the concept of pro-poor tourism is gaining acceptance though an increasing number of community-based and/or managed ecotourism ventures. Evidence suggests that at an economic level one of the key benefits is proving to be income diversification as opposed to sole-source dependence (Ntshona & Lahiff 2003). Hiking trails, community guides, pony trekking and accommodation provision are key local interventions. For example, the NGO-supported Meloding hiking trail in KwaZulu-Natal Province has generated both direct and indirect employment and the project has been implemented in an environmentally sustainable fashion (Hill *et al*. 2006).

4.5 EXAMPLES OF IMPORTANT SUPPORTING SERVICES

4.5.1. Biodiversity

4.5.1.1 Importance of biodiversity for the poor

Biodiversity (the variety of life on earth) is necessary for the delivery of many ecosystem services and underpins the very functioning of ecosystems. It forms the basis for nature-based tourism and provides all the important products needed to meet a range of livelihood needs, including spiritual and emotional fulfilment, as described in other sections. Biodiversity also underlies important supporting and regulating services such as nutrient cycling and soil fertility, pollination, and carbon sequestration. It includes diversity at the genetic level, at species level and of ecosystems and habitats, and involves variety (species richness, genetic variability), abundance (numbers of individuals or populations in a location), levels of organisation, and biological interactions (e.g. predators and prey relations) (UNEP-WCMC 2007).

Box 34: Biodiversity in arid and semi-arid southern Africa

Southern Africa is well known as a region of high biodiversity. This is hardly surprising given the its large size and wide range of biomes and habitats; from coastal deserts in Namibia to tropical forests in Mozambique, large inland deltas and pans in Botswana and Namibia, to high mountains of Lesotho and South Africa. It is also home to the Cape Floral Kingdom, and many internationally recognised centres of endemism and species richness such as the Karoo and the Maputuland centre (e.g. Myers *et al*. 2000, van Wyk & Smith 2001). The southern African region south of the Zambezi and Kunene rivers as a whole comprises only 2.5 % of the world's terrestrial surface area, but boasts over 10 % of the world's vascular plants (approximately 30 000 species), of which over 60 % are endemic to the region (van Wyk & Smith 2001). Southern African savannas harbour approximately 8 500 plant species, more than half of which are endemic. Similarly the Karoo and Kaokoveld contain over 7 000 plant species of which over two-thirds are endemic. Considering both richness and endemism of plants and vertebrates together, the arid ecoregion is classified as globally outstanding, and the savannas as bioregionally outstanding from a conservation perspective (Burgess *et al*. 2004). This overwhelming concentration of species offers unique potential for use of genetic and species diversity to support local livelihoods and alleviate poverty, whilst simultaneously posing many challenges for the seven developing countries charged with conserving such a rich and globally renowned heritage. Some 90 % of diversity hotspots in the region occur on private or communal land used mainly for grazing (Milton *et al*. 2003).

Box 35: Importance of biodiversity for the poor (Source: UNPE-WCMC 2007)

"Maintenance of a heterogeneous local environment provides the widest possible range (or interacting 'bundles') of ecosystem services, reduces the exposure of local people to risk and lessens their dependence on the vagaries of global markets or on development assistance. When considered from the perspective of poor people it is the local level of biodiversity that is important: the distribution and abundance of wild species, the range of crop plants and livestock and the diversity of ecosystem types directly available to them".

Habitat, ecosystem and landscape diversity: Most of the poor in southern Africa reside in what have been termed 'cultural landscapes'. These are geographic areas in which the relationships between human activities and the environment have created ecological, socio-economic and cultural patterns and feedbacks (Farina 2000). Sacred sites, in particular forests in the savanna ecoregion (see section 4.4.1.1), are part of this landscape and contribute to both habitat and species diversity. These sites generally have a different size and age structure to non-protected areas, higher species diversity and a different species composition, often supporting species that are rare or absent in surrounding non-protected areas (Table 33). They can provide a fire refuge allowing evergreen forest species to survive and harbour wild vertebrate species.

Table 33: Contribution of sacred forests to habitat diversity in Mozambique and Zimbabwe (adapted from Virtanen 2002)

Locality	Shannon-Wiener index of biodiversity	No. of species absent from surrounding areas
Chindu (protected)	2.22	All
Mungwa (protected)	1.45	12 out of 23 species
Dzete (protected)	1.63-2.40	
Njere (non-protected)	0.90	
Dani (non-protected)	0.65	
Mukarakate (non-protected)	1.36	

Multiple human disturbances are a feature of all rural landscapes. These disturbances are varied in time, space and intensity creating a diversified natural, cultural and economic landscape mosaic (Farina 2000). In many instances the environment is 'shaped' to support particular provisioning services and there is evidence that people have introduced useful wild species to areas where these were uncommon, as is the case with marula (*Sclerocarya birrea*) in parts of Namibia. These diverse landscapes are key for local livelihoods as illustrated in the Mozambican case study by Mapaure *et al.* (Appendix 2): "Landscapes are important for the bundles of ecosystem services that local communities derive from each location in the landscape". Landscape units such as thickets and forests had the highest local livelihood importance scores.

However, more recently, several trends are leading to greater homogenisation of these landscapes including the **expansion of settlement areas** (Giannecchini *et al*. 2007) **and cropland** (Campbell *et al.* 2002). Aerial photographic analysis by Giannecchini *et al.* (2007) in Limpopo Province, South Africa indicated a general decline in the patchiness of the landscape over the period 1974-1997. In particular, there was a loss of relatively lightly disturbed mixed woodland patches. It was notable however that the patterns of change varied considerably from village to village making it difficult to generalise in terms of drivers and to predict future trends. Furthermore, changes were often non-linear and reversible, with some cropland and shrubland becoming undistinguishable from woodland within a period of 10 years. Despite the uniqueness of each village, a number of interacting factors could be linked to some of the changing landuse patterns including: population growth; the influx of Mozambican refugees and their need for arable land; a breakdown in traditional institutional control after the 1994 political transition with locals and outsiders treating land and natural resources as a free for all; a doubling of household involvement in the informal sector with a strong reliance on the sale of natural products particularly fuelwood; a sharp increase in goat ownership and thus browsing pressure on the woodland; and an increase in the number of fields (generally smaller in size) held per household due to declining yields. Similar homogenisation of landscapes is occurring widely across the region (Dahlberg 2000) with the overall trend being one of decreasing resilience of these systems with potential negative impacts on their ability to recover from drought and to cope with climate change, potentially reducing the livelihood options for local people.

Almost three quarters of southern Africa is non-arable and still under indigenous vegetation which supports both subsistence and commercial ranching (see Section 4.2.1 - Fodder). Habitat diversity within these areas is extremely important for livestock production (Box 36). Such diversity provides fodder to livestock at different times of the year, buffers against extreme fluctuations and enhances the probability of their survival during the lean dry season. Different areas compensate for possible nutrient deficiencies in

Box 36: Habitat diversity and forage: Key resource areas

"Cattle foraging strategies (through free grazing or herding) involve both concentration on these key resources areas and switching between a variety of habitats and forage sources, including browse. These strategies differ between both savanna types and seasons of the year. Planning for livestock management in the dry areas of Zimbabwe should take into account the importance of landscape heterogeneity in design of grazing interventions. Policies also need to ensure that flexible movement responses to a highly spatially and temporally variable resource base are possible." (Scoones 1995)

one or another grazing site. Such local sites are termed 'key resource areas' and may include, old fields, crop residues on dry fields, fringes of wetlands, seep lines and other moister areas in the landscape, nutrient hotspots as well as wooded areas where livestock can browse once grazing has disappeared (e.g. Scoones 1995, Samuels *et al*. 2000). Consequently, it is important that herders have mobility to access such areas, and **extensive fencing** of the commons can have serious consequences for livestock and local livelihoods, as commented by Dahlberg (2000) in Botswana and Shackleton *et al*. (2002) in South Africa.

As corridors of high productivity in semi-arid and arid areas, rivers and their wetlands are clear zones of high biodiversity. As zones of water availability, they support adjacent ecosystems and provide refuge during the dry season and, more especially, during droughts. The trend towards increased regulation and uniformity of flows can, however, have negative impacts on river, floodplain and wetland habitat and species diversity, especially in the lower reaches where spatial variability is reduced as these areas become drier.

In highly modified urban environments, open spaces and green areas provide numerous ecosystem services and contribute to landscape heterogeneity. For example, in eThekwini Municipality in Durban (South Africa), the replacement value of the ecosystem services supplied by 63 000 ha of open space was valued at R3.1 billion per year and tourism linked to these areas at R3.3 billion in 2001 (DEAT 2007).

Box 37: Number of species used

There is no complete inventory of every species used at a specific site. However, there are some illustrative numbers:

- 94 % of canopy and 77 % of sub-canopy forest species in South Africa have at least one recorded use (Geldenhuys 1999).
- Dovie (2006) recorded use of woody plants at ten different villages and found a mean of 90 % of all woody plants were used for one or more purpose.
- Communities typically use several hundred species, and individual households dozens to meet their energy, nutritional, medicinal and construction needs (Shackleton & Shackleton 2004a).
- Hundreds of different medicinal plant species are traded daily in each of the markets of major cities (Mander 1998, Williams 2004, Cocks 2006).

Species diversity: The importance of natural products based on the diversity of 'wild' species for the livelihoods of the poor has already been described in Section 4.2.1. There is evidence that the greater the diversity of species the more the products for people to use or develop. For example, for woody plants there is a reasonable correlation at both SADC regional (O'Brien 1988) and local scales (Dovie 2006) between the total number of species present and the proportion that can be harvested for livelihood purposes. In the arid ecoregion species richness is often lower, but these areas are often characterised by high degrees of endemism (Box 34) and by species that contain high value products for industrial and pharmaceutical uses. Maintaining biodiversity therefore also maintains important use options, including prospects for the development of new products based on promising plant extracts. However, for the latter to be of benefit to poor people it is essential that policies and mechanisms are in place that ensure recognition of intellectual property rights, equity and benefit sharing. The landmark case of the Kalahari succulent Hoodia spp., developed as an appetite suppressant, has resulted in substantive benefits in royalties for the politically marginalised San people as the original holders of knowledge on this plant, but not without confrontation and legal action (Wynberg 2005). A long period of negotiation eventually resulted in a benefit sharing agreement (one of the first in the world) between the San and the CSIR (the South African parastatal research institute that extracted the active constituent). Systems that ensure rewards for indigenous knowledge such as through patents and royalties for herbal remedies and medicinal plants need to be given more consideration (Madzwamuse et al. 2007).

Species diversity also underpins a much wider range of ecosystem services. For example, the microbes that transform waste and contribute to nutrient cycling and soil fertility, the insects that pollinate crops and wild plants, micro-fauna that contribute to water quality, and the organisms that are important in pest and disease control. Biodiverse ecosystems are also essential as buffers against adverse climate events, as carbon sinks and as filters against water and air borne pollutants. Biodiversity also contributes in multiple ways to agricultural production and to extensive livestock production. While technological alternatives are available for some of the

Box 38: Pollination as an important regulating service provided by biodiversity. Source: UNEP-WCMC (2007)

Pollination is essential for the production of fruits and for plant reproduction. There is a strong relationship at a local level between effective pollination and pollinator (bee, butterfly, flies, beetles, etc.) diversity. Yield is influenced by the number of pollinator visits, while multiple species help stabilise pollinator services against variation in any single pollinator population. Effective pollination services are most likely to be derived from a mosaic landscape comprised of a mix of agricultural and natural vegetation.

Payment for pollination services from natural forests and woodlands provides an economic incentive for conservation, and bee and honey production (although more important in the sub-humid miombo areas of southern Africa) can provide an income generating opportunity. The value of pollination services to crop production in South Africa was estimated as R3.2 billion in 1998 (Allsopp 2004).

services provided by biodiversity, they are typically more costly, and out of reach of the poor, than the benefits obtained from well-managed ecosystems (UNEP 2007). Many substitutes also have coincident and externalised costs, e.g. the use of fertilisers may have water quality implications often for downstream users, and pesticides affect human health. Presently within the region there is limited understanding of the value of these regulating services, although recent work from a case study region in the Kalahari has demonstrated the value of some of these services (Box 39) and pollination services have been valued at R3.2 billion in South Africa (Box 38).

At a regional scale, less than 20 % of the arid ecoregion has been transformed, whereas the semi-arid savanna ecoregion varies between 20 % and 80 % transformed, being higher in the moister east (Burgess *et al*. 2004). In general, fresh water species are under greater threat than terrestrial taxa, and savanna ecoregion species more so than those in the arid regions (UNEP 2007). Species losses within southern Africa are relatively small, with about 99 % of the number of wild organisms present 300 years ago still persisting (van Jaarsveld *et al.* 2005). More important than species extinction for poor people dependent on biodiversity is a declining abundance of useful species, reduced size classes (such as for carving woods, shellfish, medicinal plants), species composition changes (such as from perennial to more drought sensitive annual grasses in rangelands), local species losses and altered distribution ranges of particular species. A number of useful and commercially harvested species especially those used for medicines (e.g. bulbs), horticulture (e.g. desert succulents, cycads) and woodcarvings (e.g. *Dalbergia melanoxylon*) are considered threatened. There is a desperate need for approaches that can ensure the sustainable utilisation of these species while still providing market opportunity (see section 4.2.1, Madzwamuse *et al.* 2007).

Box 39: Aggregate annual value of selected regulating services provided by biodiversity in the Kgalagadi South subdistrict of Botswana (Appendix 2 - Case Study 7, Madzwamuse *et al.* 2007)

- Carbon sequestration – US$111 300
- Protection from wind erosion – US$68 400
- Wildlife refuge value – US$15 000
- Value of groundwater recharge was estimated as negligible

Genetic diversity: Genetic diversity provides the basis for adaptation, allowing living organisms to respond to natural selection and adapt to their environment. Genes therefore play a strong role in the resilience of biodiversity to changes in climate and new diseases (UNEP 2007). In dryland environments many species have developed a range of adaptive traits that make them important sources of genes for breeding resistance to drought, salinity, pests and diseases. However, while genes have provided the basis for improving yield and disease resistance of crops at the same time such developments can contribute to losses of genetic diversity (see section on trade-offs below).

Box 40: Local breeds and cultivars in Paulshoek, Namaqualand (Appendix 2 - Case Study 7).

The local sheep breed known as 'Damara' (fat-tailed Afrikaner) is one again gaining popularity in Namaqualand, with a shift towards this breed from Mof, Karakul and Doper with increased drought incidence. Damaras are hardier and cope better with drought and are superior climbers in rocky areas. The marketing of Damara is now also being promoted.

Old wheat cultivars (witvol and rooivol – unique to this area), on the other hand, are now seldom cultivated and do not fetch a good price on the market. The cultivars were particularly important at stock posts in the past, as they are easy to grind.

The genetic diversity of crops and livestock is key to sustainable agriculture and livestock production especially in risky dryland environments (Wollny 2003, Eyzaguirre & Dennis 2007). Genetic variation is evident in the cultivars and landrace varieties that farmers use, in the wild relatives of domesticated species, in

useful indigenous species that may be cultivated, and in local breeds of livestock. Namibia, for instance, is the centre of origin for *Citrullus* (water melon) where these and other cucurbits are an extremely important food source for humans and animals (Maggs *et al.* 1998). Southern Africa has several local breeds of small ruminant that are ideally adapted to the harsh climates characteristic of the arid rangelands of the region (Lebbie & Ramsay 1999, Box 40).

In Namibia, in the wetter and fairly isolated northern regions, considerable geographic and phenotypic variation has been found amongst traditional crops such as pearl millet, sorghum, cowpeas and groundnuts giving rise to a variety of local landraces (Maggs *et al.* 1998, Madzwamuse *et al*. 2007). Different landraces are often used to match the microhabitat conditions in cultivated areas, to spread risk and labour requirements, and in some areas because no modern varieties have been developed (UNEP-WCMC 2007). Local farmer selection of wild marula has resulted on larger fruits in trees in homesteads and fields (Leakey *et al.* 2005).

The loss and erosion of genetic diversity, particularly where poor farmers are concerned, is associated with reduced food security, increased economic uncertainty, increased vulnerability to pests and diseases, reduction in the possibilities for adaptation and for future generations and accelerated loss of local knowledge about diversity (Eyzaguirre & Dennis 2007). These consequences, and the need for conservation of genetic diversity, are especially critical given the looming threat of climate change, genetically modified crops and the need to build resilience and adaptability.

4.5.1.2 Drivers of change in biodiversity

Box 41: Impacts of biodiversity change on human well-being and vulnerability in arid and semiarid southern Africa

Loss of ecosystem/habitat diversity
Loss of water regulation and other key regulating services like pollination.
Loss of traditional knowledge and cultural sites.
Loss of inputs into agriculture and increased costs.
Increased environmental risk and decreased resilience.
Slower post-drought recovery.
Loss of key resources areas for grazing – e.g. flood plains.
Changes in disease patterns - some ecosystem changes particularly in wetland and river systems can create new habitat niches for disease vectors such as malaria.
Loss of potential alternative land use options and economic diversification opportunities such as tourism.

Species composition change and local loss of species
Loss of traditionally available resources and potentially useful species.
Decreased options for income generation.
Loss of inputs into agriculture.
Need to buy in substitutes (feed, building materials, energy) and impacts on cash flow (cost of substitutes in degraded rural areas was estimated to be about 25% of income in Namibia)
Reduced productivity of rangelands and forage shortages during dry years.
Increased food insecurity.

Genetic erosion
Increased drought vulnerability.
Loss of crop diversity.
Loss of traditional knowledge and cultural traditions.
Increased food insecurity.
Loss of local adaptive options and future societal options (option values)
Reduction in the range of biophysical environments that can be utilised.
Increased vulnerability to disease and livestock population crashes.

The direct drivers of changes in species diversity and composition are much the same as those outlined for natural products (Section 4.2.1.4) and some of the other ecosystem services (Table 34), including: **land transformation; selective harvesting; climate change; burgeoning exploitation** especially for commercial trade; **encroachment of 'weedy' or alien species; pollution; mining** and **infrastructure development** (e.g. the areas of rangeland affected by surface mining are increasing along the west coast of southern Africa); **habitat fragmentation;** and **heavy grazing** (Maggs *et al.* 1998, Milton *et al.* 2003, UNEP 2007). Underlying causes include the **undervaluation of biodiversity; market failures; population growth and demand** (although less so in the arid countries of the region) linked to past social engineering (e.g. apartheid) that concentrated poor people in a small proportion of the land area and resulted in overcrowding; **globalisation** and **large farming enterprises; loss of cultural values** that protect biodiversity; and **weak governance** at all levels. The recent World Environmental Outlook (UNEP 2007) report emphasises how demand for energy underlies much of the loss of

biodiversity through exploration, mining, pipelines, hydroelectric dam construction, global warming, biofuel cultivation (not yet a real issue in southern Africa) and fuelwood harvesting.

The drivers and causes of genetic erosion are not well understood but include the penetration of **global agricultural commodity chains**, **modernisation**, **migration and civil strife, distribution of improved seed**, market and **intervention failures** in market orientated agricultural systems, **ill-informed animal crossbreeding/improvement programmes**, **inter/inbreeding**, past and present **neglect of local knowledge** on landraces and livestock breeds and traditional breeding practices, perceptions that local varieties and breeds are inferior, and the **erosion of collective action institutions** involved in the control, exchange and propagation/breeding of landrace varieties and local breeds (Wollny 2003, Eyzaguirre & Dennis 2007, Anderson & Centonze 2007). Genetic erosion is also possible through **fragmentation of wild populations**, and thresholds for population viability are apparent.

Table 34: Key drivers of change in biodiversity a supporting ecosystem service for the poor in arid and semi-arid regions of southern Africa (Key for magnitude: 1 = Low and 5 = High)

Drivers of change biodiversity	**Ecoregion**					
	Arid		**Savanna**		**Rivers & wetlands**	
	Direction of change	Magnitude	Direction of change	Magnitude	Direction of change	Magnitude
REGIONAL SCALE						
Land transformation	▼	1	▼	3	▼	4
Climate change	▼	1	▼	1	▼	1
Poverty	▼	1	▼	2	▼	2
Net direction and magnitude of change	▼	**1**	▼	**2**	▼	**3**
LOCAL SCALE						
Land transformation	▼	1	▼	3	▼	4
Habitat fragmentation	▼	1	▼	2	▼	3
Heavy grazing	▼	1	▼	1	▼	1
Over-harvesting	▼	2	▼	3	▼	2
Over-reliance on a very restricted number of agricultural species	=		▼	1	▼	1
Invasive species	▼	2	▼	2	▼	5
Weak governance or regulation	▼	1	▼	3	▼	2
Designation of private and state protected areas	▲	1	▲	1	▲	1
Erosion of traditional knowledge	▼	1	▼	1	▼	1
Net direction and magnitude of change	▼	**1**	▼	**3**	▼	**1**

4.5.1.3 Trade-offs in the continued provision of biodiversity services

A key response to ensuring biodiversity conservation has been and still is the designation of protected areas (Box 42). In the past, and still in many regions, this approach has had negative impacts on local livelihoods, particularly if people are displaced and relocated or excluded from using resources within protected areas. Increasingly, conservation approaches that recognise the needs and rights of local people are gaining support within southern Africa and new

participatory co-management approaches for state owned conservation area are evolving. There are now a number of examples where people continue to live in parks such as for some of the new Transfrontier Parks and in the Richtersveld National Park in South Africa. These new approaches have helped to reduce the trade-offs between biodiversity conservation and the well-being of the poor. Conservation outside of protected areas particularly in conservancies (several hundred in each of Namibia, Botswana and South Africa) and biosphere reserves is increasingly seen as a vehicle for merging development and social issues with biodiversity conservation (DEAT 2007, see below).

Box 42: Extent of terrestrial protected areas (UNEP 2006)

Country	% conserved
Botswana	30.2
Mozambique	8.6
Namibia	14.6
South Africa	6.1
Swaziland	3.5
Zimbabwe	14.7
Total	12.8

In terms of genetic diversity there are trade-offs between productivity and resilience. Frequently, the desire to sustain and utilise traditional breeds and landraces conflicts with the need to promote economic development through improved crop varieties and breeds based on a reduced genetic range (Lebbie & Ramsay 1999). There are trade-offs between intensified, more productive and market orientated systems which tend to result in the homogenisation of genotypes and the need to maintain adaptability (e.g. adaptive fitness in animals) as a risk aversion strategy in harsh environments. Ex-situ conservation has been the dominant intervention for plant genetic resources, but is of limited practical relevance for animal genetic resources (Wollny 2003). New approaches to popularising local breeds and supporting breeding programmes are required as well as the promotion of these in the market place, which could include the use economic instruments such as certification and labelling (see section on interventions) (Lebbie & Ramsay 1999, Anderson & Centonze 2007).

While much still remains to be understood about the relationship between biodiversity and regulating services, it is clear that if biodiversity is not managed effectively future options will become ever more restricted (UNEP 2007) and the resilience of these complex socio-ecological systems to disturbance and shocks compromised. Furthermore, species losses in dryland systems may result in the reduction of resilience, productivity and livelihood security far more quickly than in more humid environments (Madzawamuse *et al*. 2007). It is critical that decisions mainstream the full values of ecosystem services provided by biodiversity and a precautionary approach is taken given the gaps in our understanding. As a supporting service, there are constant tradeoffs involved in any decision pertaining to landuse and biodiversity. Sometimes decisions benefit biodiversity, such as establishment of protected areas, management plans for species and areas, maintenance of indigenous species and natural patches within human landscapes, etc. At other times the trade-off results are negative for biodiversity as land is transformed to high impact areas such as mines, cities, dams, and infrastructure. These trade-offs are made daily and at every scale from a single household to a community, to development planners and government departments.

4.5.1.4 Interventions that ensure biodiversity conservation

Declines in biodiversity have been broadly communicated and debated in numerous international fora, resulting on a multitude of policy statements and plans to reverse it. These include the Convention for the Conservation of Biological Diversity, Cites, Agenda 21, Ramsar Convention, and the like. But it is at the national and local level that commitment and implementation of these policies and conventions are realised. Typically the focus is on biodiversity, with relatively little consideration of how to link the interventions to poverty alleviation, although there are exceptions. Indeed, in some instances the focus solely on biodiversity has impacted negatively on local livelihoods as described under trade-offs. Below are several interventions that do, or have the potential, to address both biodiversity and poverty alleviation needs.

- Community-based natural resource management (CBNRM)
  Southern African countries have a wealth of experience in CBNRM, with ongoing projects in all six countries covered by this review (see Section 4.8.4.5). These experiences have seen both success and failures, which provide a valuable learning opportunity. The broad principles of CBNRM are largely understood, but implementation on the ground to achieve biodiversity aims is variable, largely due to governance-related factors (Fabricius *et al*. 2004).
- Biosphere reserves/integrated conservation and development projects (ICDPs)
  As with CBNRM, there are multiple projects in southern Africa designed as either biosphere reserves or ICDPs (the former largely in South Africa (five registered ones), the latter mainly in Botswana, Zimbabwe & Namibia). These have the explicit goal of both biodiversity conservation as well as local development.
- Conservancies
  These are areas where neighbouring landowners voluntarily agree to act as a unit and promote landuses and practices that are beneficial to biodiversity and the environment generally. This frequently then allows expanded ecotourism and hunting opportunities thereby attracting external revenues.
- Protected areas
  Southern Africa is renowned for its large and diverse protected areas. Currently 12.8 % of the area of the six countries is under some form of conservation protection (UNEP 2006), ranging from 3.5 % in Swaziland to 30.2 % in Botswana (Box 42). Many of these protected areas were established decades ago, and often to the detriment of local people who used to live in or use the areas now designated for reserves. But the last two decades have seen initiatives to attempt to address the past injustices in the name of biodiversity conservation, with various projects in co-ownership, co-management, or access to resources in protected areas.
- Certification
  Certification aims to inform consumers of biodiversity products regarding what products are sustainable harvested or not. Products that are from sustainably managed or harvested areas, are certified and labelled as such, and thereby attract certain consumers and potentially a slightly higher price to the harvester or producer.
- Fair or ethical trade
  This closely akin to certification, but in this instance the products are promoted under affair trade banner indicating that the local farmer or harvester receives a “fair” share of the final price, which is targeted directly at poverty alleviation. For example a number of products being marketed via PhytoTrade Africa.
- Cultivation or substitution
  In instances where specific species are in severe decline due to commercial harvesting, cultivation of that species or substitution with another potentially offers a means of supplying market and thereby relieving pressure on the wild populations. This has occurred with medicinal species, and substitution has been achieved to some extent for wood carving products through substitution indigenous hardwoods with alien species.
- Payment for ecosystem services (PES)
  There is much discussion around the potential benefits of PES, but relatively concrete examples in the region. Payment for carbon offset credits for restoration of degraded lands seems the most advanced, payment for biodiversity credits is likely to develop within the medium-term.

4.6 DRIVERS OF ECOSYSTEM CHANGE

A definition and typology of drivers following the MA (2005) is presented in Section 1.2. Multiple and overlapping direct and indirect drivers of change specific to each of the ecoregions and ecosystem services reviewed are discussed in detail in Sections 4.2, 4.3, 4.4 and 4.5. Summary tables of the trends in each of these drivers are also presented. It is evident that many of the drivers are common across several ecosystem services and ecoregions. Such drivers are often

also important in influencing larger scale landscape and regional processes such as land degradation, deforestation and desertification, which impact multiple ecosystem services (see Box 43). This section highlights some of the more ubiquitous drivers as identified during the in-country consultations, as well as their occurrence under most of the ecosystem service descriptions. The changes in ecosystem structure or function resulting from the effects of one or more drivers may be either positive or negative, i.e. some drivers serve to increase ecosystem services (or a single one) whilst others lead to a decrease. This is also dependent upon the state of the ecosystem. Drivers of change in largely unimpacted ecosystems are usually negative for several ecosystem services. Drivers of change in an already degraded ecosystem may act to degrade it further, or to reverse previous degradation.

Box 43: Multiple and overlapping drivers of desertification in Nambia (Source: Jones & Mosimane 2007)

Namibia is the driest country in the subregion and droughts are common. Desertification is taking place in the form of land degradation in many parts of the country driven by the following:

Overgrazing: excessive trampling and consumption of grasses by livestock so grass cover is reduced or destroyed; caused by overstocking.
Bush-encroachment: the increase of woody species at the expense of grass, leading to large areas being encroached by thorny bushes reducing pasture, and resulting in a decline in carrying capacity; caused by overstocking, suppression of fire, and lack of bulk grazers.
Deforestation: conversion of wooded areas of northern Namibia to open grassland through clearing for crops, fuelwood and pole harvesting, and too frequent fires.
Overtilling: in the northern and north-eastern areas where people cultivate land without using fertiliser or resting the soils resulting in impoverished soils.

Underlying and policy factors (indirect drivers) affecting the above include:

- Insecure tenure.
- Sedentarisation with expansion of permanent water points (and reduced options for transhumance as a result of private fencing).
- Increasing pressure on communal lands caused by individual fencing of communal land and population growth.
- Livestock and limited crop production being considered as the only possible land use due to factors such as state control of wildlife and forests.

4.6.1 Examples of important drivers within the region

4.6.1.1 Rainfall and climate change

In arid and semi-arid systems, climate, and rainfall in particular, is a key driver of usually short-term and dramatic change. In fact, these systems are characterised by major fluctuations in rainfall from one period or year to the next, with variation and extremes being an important part of the functioning of these systems. Drought has major impacts on the delivery of a range of ecosystem services, while periodic floods can wrack havoc on people's lives. Fluctuations in rainfall trigger parallel fluctuations in other ecosystem services such as crop production, forage, and water recharge and supply, often resulting in cyclical patterns of change. It is argued that what is often considered as resource degradation may, in fact, be the system going through a stressed period (in-country consultations). Many arid and semi-arid systems demonstrate an amazing capacity to 'bounce back' from events such as drought. Box 44 from Chivi, Zimbabwe, illustrates the importance of rainfall as the main driver of ecosystem processes in the Romwe and Mutangi catchments (Appendix 2 - Case Study 1). Irrespective of this resilience, peoples' livelihoods can be acutely stressed during a drought, and not unsurprisingly poor people experience the negative effects most keenly.

Furthermore, various pressures on ecosystems and their services (as discussed in earlier sections) are impacting on the integrity of these systems and thus their ability to recover from climate extremes. This is likely to be exacerbated by human-induced climate change, which is expected to increase the frequency of extreme events, as well as result in higher temperatures, and therefore higher evapo-transpiration, and an overall decrease in rainfall.

Box 44*:* Rainfall as the key driver to which all other linkages are secondary: Evidence from Chivi (Appendix 2 - Case Study 1)

Whilst linkages among most ecosystem services and drivers still remain tenuous and uncertain, their significance is overshadowed and often conditioned by the availability of water, which - by and large - remains the key determinant of ecological functioning and household production in typical semi-arid savannas. The main driver of various aspects of water balance throughout catchments in southern Africa is the occurrence of long-term cycles of above-average rainfall (roughly nine years) alternating with ones of below-average (also about nine years duration). The implications for natural resource management are enormous. Related fluctuations can be expected in grain yield, vegetation cover, fodder production, erosion and siltation. Modelling studies on catchment hydrology in Romwe showed that rainfall is the greatest determinant of natural resource status, with long-term trends in groundwater reflecting the cumulative variation in rainfall over time (Butterworth *et al*., 1999). The main cause of water point failure in the region is natural recession associated with extended dry periods, with human impact through present groundwater abstraction being trivial compared to the natural discharge of groundwater. Human impact through changes in land use in the catchment is of secondary importance (Butterworth *et al*. 1999).

The in-country consultations revealed that a number of participants felt that rainfall patterns were changing, but sometimes were not sure if this was due to global warming and/or long-term cyclical patterns in climate. Scientific evidence points to human-induced climate change as the underlying cause of the rise in hydro-meteorological events over the last decade. In Mozambique it was said that rainfall is becoming more erratic and less concentrated in the rainy season, and that there is an increasing cycle of droughts and floods. The country was hit with three natural disasters in the last growing season – flood, cyclone and drought. Cyclones are likely to become more intense and the belts move further south. Floods in Namibia are thought to be increasing, with floods in the Caprivi and Hardap Dam area in 2006. Greater frequency of droughts was mentioned throughout the region. The trend in increasing fire incidence, while driven by a number of factors, could be exacerbated by the more extreme weather conditions and greater drying and high winds towards the end of the dry season. In Botswana a shortening of the rainy season is already impacting on planting patterns. Climate change is expected to have a huge impact on the Okavango Delta, with ecological and economic repercussions related to the tourism values associated with it.

Box 45: Observation on effects of climate change on woodlands in Mozambique

"It is obvious to everyone, as you drive along those hundreds and hundreds of kilometres of forest landscapes in the semi-arid regions. The dry branches in the treetops indicate the trees are not getting enough moisture anymore. There are signs of degradation of the dry forests, the miombo".

Climate change will increase human vulnerability in the region by affecting the millions of people dependent on rainfed agriculture. Ecosystems are likely to take longer to recover from droughts and other events and may undergo regime shifts. Carrying capacity for livestock and wildlife is likely to decline. Natural disasters are increasing in number and intensity with severe costs in human life, health and social and economic infrastructure. Interventions and capacity to deal with climate change are discussed in Section 4.9.8.

4.6.1.2 Land transformation

Land transformation was mentioned by multiple stakeholders across the different countries. It is manifest as a change of land use or vegetation cover from reasonably extensive with high levels of cover, to significantly modified systems with reduced or no cover, such as housing, roads and fields. Conversion of largely natural lands or extensive rangelands to agricultural fields or plantations is the most widespread cause. This typically has negative impacts on the provision of most ecosystem services such as water quality, flood regulation, biodiversity, cultural services and the like. Nonetheless, modified ecosystems continue to supply some or all services, albeit usually at a reduced magnitude or rate. It represents a common trade-off occurring across the globe, where services are foregone in order to improve the reliability one or two, most commonly food production. The 2005 Global Forest Resource Assessment indicates that the rate of deforestation of forests and wooded lands between 2000 and 2005 is accelerating in Botswana, Namibia and Zimbabwe, relative to the preceding ten year period (FAO 2005). Rates of loss are between 0.2 % per year in Botswana and 1.4 % per year in Zimbabwe The rates are static in South Africa and Mozambique, although in-country consultations suggest that the picture has recently changed in Mozambique with significant investments in logging by Chinese interests.

Transformation is probably most severe in the rivers and wetlands ecoregion. At the local scale small wetlands and seep lines are ploughed up by both subsistence farmers as well as large commercial enterprises, often irreversibly so. They are drained and canalised, built up, covered over, and invaded by alien species. This impacts water quality and flow regimes, as well the supply of key resources such as weaving reeds, and biodiversity. At a larger-scale streams and rivers are impounded usually to secure water supplies to distant urban populations and industries. These impoundments (e.g. Kariba Dam in Zimbabwe; Cahora-Bassa Dam in Mozambique, Maguga dam in Swaziland; the dams of the Lesotho Highlands water project) alter flow regimes, flood cultural sites, homesteads and grazing lands, and negatively impact biodiversity and local livelihoods. The costs and disruptions are borne by local communities, who in comparison, typically receive relatively few of the benefits (Mwangi 2007). The poor are the least able to adapt to these externally imposed changes

4.6.1.3 HIV/AIDS

It is not possible to discuss poverty in southern Africa without considering the devastating impacts of HIV/AIDS. During the in-country consultations many participants reported this to be a major issue in the region, affecting all spheres of life and development. Southern Africa has the highest prevalence rates in the world (UN AIDS 2007), although there is some evidence of them beginning to plateau or even declining in some countries, e.g. Zimbabwe (Fig. 12). Nonetheless, it remains the leading cause of death in the region – estimated at approximately 670 000 deaths in 2007 (UN AIDS 2007), equating to over one every minute. With women dying faster and in greater numbers than men, this has a serious impact on household and community food security. The situation with respect to children is similarly shocking, with an estimated four million orphans in southern Africa (UNICEF 2004). In Swaziland, the number of orphans is estimated to have doubled between 2000 and 2002. “One of the most unique characteristics of the crisis has been the emergence of child-headed households. In the absence of adult caregivers, these children are particularly vulnerable to exploitation, abuse and HIV infection. In Zimbabwe, for example, girls, especially those from child-headed households have been forced into commercial sex, early marriage or child labour as a means of survival.” (UNICEF 2004).

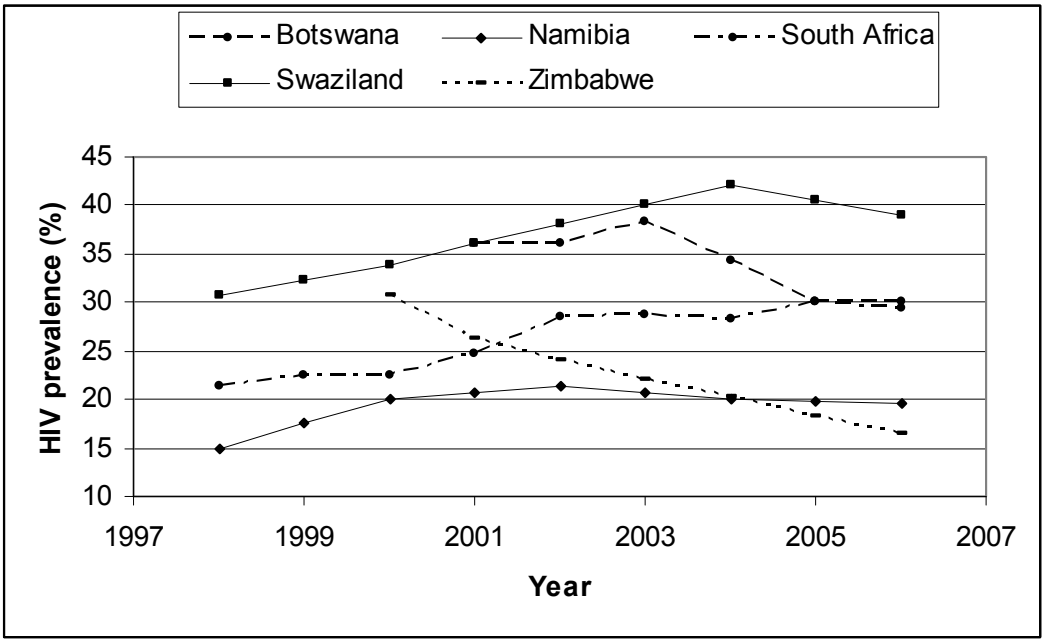

Figure 12: Median HIV prevalence among women (15-49 years) at antenatal clinics (Source: UN AIDS 2007)

HIV/AIDS is a double-edged sword, acting both as a direct driver that increases household vulnerability, as well as an indirect one affecting ecosystem change. The former is well known

and recognised due to the prolonged illness and untimely mortality of infected people, which frequently results in loss of a breadwinner, household labour, and sale of assets. This leaves the household vulnerable to other shocks, and a descent into deeper poverty. The longer term implications of escalating numbers of orphans are unknown, but do require urgent interventions to provide support structures, nutrition, life skills and education.

However, the impacts of HIV/AIDS with respect to ecosystem change are less direct. Firstly, it is having an unprecedented impact on the skills pool of environmental and resource managers and professionals (see Box 64). This also undermines institutions tasked with ecosystem management. But secondly, its effect of increasing the vulnerability of households can change use patterns of natural resources and landscapes (see Section 4.1 – natural products for further details and Box 14 in Section 4.2.3 – water). This has been reported for a range of livelihood strategies, ranging from agriculture (Byrne 2002, de Waal & Whiteside 2003), to pastoralism (Morton 2006) as well as coastal and inland fisheries (Torell *et al*. 2006, Ngwenya & Mosepele 2007). Affected households are: (i) increasing the use and sale of resources from the wild to buffer the shock, (ii) selling assets including livestock to provide much needed cash, and (iii) because of household labour shortages are leaving fields fallow and planting home-gardens to less labour intensive crops or relying more on wild foods. The last two strategies, especially, serve to increase household vulnerability further. All of these strategies combine to have what are as yet largely unknown local or wider effects on the delivery and use of ecosystem services and species populations. There is widespread perception amongst the in-country respondents that AIDS is driving greater exploitation of local resources, especially as urban relatives return to rural kin for care. All of the countries in the region have upscaled their various responses to the HIV and AIDS pandemic in recent years, but there is no doubt that the situation remains at crisis level.

4.6.1.4 National and international policies and processes

At a national and international level, policies, aid and trade agreements are important indirect drivers of change having both positive and negative impacts on ecosystem services and their linkages to poverty. This section briefly mentions some examples, with this issue being dealt with in more depth in the background papers produced by IIED.

Box 46: Globalisation as a driver (Source: UNEP-WCMC 2007)

Intensification of production and reliance on global markets may not always be of benefit to the poor. The changes associated with globalisation tend to "reduce the capacity of the local area to meet the needs of the local population, increasing dependency on the vagaries of markets" (UNEP-WCMC 2007). Global markets tend to seek the lowest priced supply, so that producers are vulnerable to being undercut and losing market share. Because of this, producers often try to maximise short term gains, usually leading to accelerated rates of environmental degradation and eventually leaving local people in the position where they have neither the capacity to produce commodities for sale nor the local resource base on which to fall back.

At an *international level* globalisation is a significant process having numerous impacts in many different spheres. Regarding its effect on the delivery of ecosystem services, limited information exists, but it is clear that it is not always positive and is likely to involve trade-offs, especially for the poor, as highlighted in Box 46. In Mozambique, pressures on forests are growing due to Chinese interests in hardwood (a trend also mentioned in tropical Africa) (Box 48). Such commercial timber harvesting often occurs at the expense of the poor as they lose access to a host of important ecosystem services and receive few returns from timber sales. In Botswana, international trade policies for beef are likely to further drive the negative trends in rangeland condition identified in other parts of this report (Box 47).

Box 47: Beef trade agreements in Botswana (Source: in-country consultations)

Under the existing Cotonou trade provisions, Botswana benefits from a beef protocol that grants it a tariff quota of 18 916 tonnes per year with a 92 % reduction in customs duties. Trends related to cattle farming, referred to above and elsewhere in this report, can be expected to increase as this driver has recently been intensified through the Interim Economic Partnership Agreement (IEPA) signed recently between Botswana and other SADC countries and the European Union. Under the IEPA the eight percent levied on Botswana beef entering the EU under the Cotonou Agreement will be lifted. Despite the EPAs saying Botswana should open up 100 percent of its market within 12 years, beef will not be opened for competition because it is viewed by Botswana as a sensitive product.

Box 48: Quote from in-country consultations on the Chinese in Mozambique

"The Chinese are a really big problem for forestry in Mozambique, because they have cash and they pay straight away, in contrast to the government who will try to conscientise you to conserve, etc. The Chinese will go to local communities and say 'we have this amount of money and we will give it to you tomorrow. All you have to do is pile up 100 logs next to the road.' So it's a very big problem and it is not easy to get rid of the Chinese because they are strategically linked up very high, have agreements with the government, have built a big conference centre. But there is also the unofficial side to the Chinese business ... they know the weaknesses of the politicians here, they are good at establishing joint venture businesses with politicians. It becomes complicated because when a forest guard finds someone out there not abiding by the rules, it will be the politician calling you to tell you not to interfere. If we could be stronger and control them, we could get much bigger benefits out of them. But we are happy with the peanuts they give us."

At a *national level*, problems in governance can have huge repercussions. The political and economic difficulties in Zimbabwe have served to increase the reliance of the poor on natural resources, including wild foods. Large-scale changes in land use since 2000 (under the land reform programme) have resulted in a great deal of flux in terms of both ecosystem services and the socio-economic conditions of poor people, with feedback effects. Indeed, stakeholders interviewed in Zimbabwe widely held the perception that trends in ecosystem services have accelerated downwards since 2000. The incidence of fire has increased on previously commercial farmland, as has deforestation mainly for fuelwood for sale, and the silting of dams and rivers. The consequences for people in the current situation of extremely high levels of unemployment and vulnerability are considerable, with a large proportion of the skilled peopled seeking opportunities in neighbouring countries. Consequently, remittances from outside of the country have increased in importance (in-country consultations). In this case, politics and the collapse of the macro-economy appear to be overriding or controlling most other drivers, as would also be the case in situations of political strife and war.

Sometimes national policies directed at supporting provisioning services can have unintentional impacts. One example of this is the promotion of cattle farming in Botswana in the area between the Kgalagadi and the Central Kalahari Game Reserve, where there is continual pressure. Cattle production is promoted through a range of subsidies, including borehole drilling, veterinary care, feed, and by land and water being provided at no cost. As discussed in Section 4.2.4 (Forage and Fodder) this is having negative feedbacks on the condition of range as well as numerous other resources important for poorer people.

Several of the case studies (Appendix 2) highlight the impacts of past policy measures and historical events on current ecosystem states and management, as these manifest within specific local contexts (Table 35). In particular, southern Africa has been plagued by past policies of land alienation and the concentration of people into spatially limited and often marginal communal areas, creating substantial pressure on natural resources.

Table 35: Direct and indirect drivers of change at Mt Coke (Case Study 3, Appendix 2)

Period	Direct drivers	Indirect Drivers
1960-1990	Agricultural intensification, tight state control	Betterment planning, Ciskei Co-operatives Programme
1990 – 2000	Field abandonment, lack of co-operation between farmers, local rules collapse	Political unrest, dissolution of state extension services
2000 – present	Emphasis on home gardens, reliance on woodlands and natural streams declining, reliance on cattle increasing	Basic service provision, increased involvement in the formal economy.

However, in recent years there have been many encouraging policy developments. Box 39 in Section 4.8.1 (management interventions) lists some of the positive policy trends across the region that hold promise for enhancing the links between ecosystem services and poverty. In many areas the improved delivery of basic services such as electricity and water has been seen as an important positive driver, reducing reliance on natural water sources and fuelwood and creating more time for activities such as home gardening (Appendix 2 - Case Study 3 and 7). For example, in Paulshoek, Namaqualand, South Africa (Appendix 2 - Case Study 7), the time spent collecting fuelwood reduced from 2.7 trips in five days in 1998 to 0.9 trips in five days in 2005 after electrification. The amount of wood consumed dropped from 8.5 to 1.7 kg per day in the same period. Other positive policy 'drivers' are discussed in the interventions section (4.8).

4.6.1.5 Governance

The preceding sections have amply illustrated the links and dependencies between ecosystem services on the one hand and use by the poor and potential for poverty alleviation on the other. However, as aptly stated by the WRI (2005) "*an abundance of natural resources* (or in our case, ecosystem services) *does not necessarily translate into wealth for the poor*". This is because the prevailing governance institutions and regulations at local and national levels mediate access to and use of ecosystem services. Thus, many situations exist where the more wealthy actors at local and regional levels have negotiated or enforced differential access rights that allow them to capture a disproportionately higher ratio of the ecosystem benefits. For example, ownership of cattle is typically the domain of wealthier households, and the poorest households rarely have cattle, or if they do, only one or two, which collectively represent only a small proportion of the local herds on communal lands. But cattle owners may have significant influence in how the commons are managed in terms of access to dams for watering, burning of the rangelands which influences supply of other resources (e.g. thatch grass, medicinal plants), influence on soil erosion levels that impacts local water quality, damage to crops in fields and home gardens and so on (e.g. Ntsohona 2001). Thus, governance is a driver of both the supply of ecosystem services, as well as how they are distributed between different stakeholders, especially the poor. Changes in governance structures and institutions at local or other levels can seriously affect the supply of ecosystem services in quantity, quality and access. For example, the local San inhabitants of the Botswana section of what is now the Kgalahadi-Transfronteir National Park fought along legal battle against the State to remain in the reserve and maintain their traditional access to a wide range of ecosystem services. The State sought to evict them or restrict their access and use of resources, with potentially devastating effects on their livelihoods and relative poverty status (Survival International 2006). King (2007) describes an oft repeated situation of conservation authorities cutting off people from access to grazing lands or resources such as fuelwood. Balint & Mashinya (2006) outline how local leadership unilaterally changed the governance structures of a local CAMPFIRE project with significant loss of income for local communities and consequent loss of support. Frequently the poor have insufficient power to challenge poor governance, although the example of the San above is a success story. Governance is not just a driver at local level, but also at national and international levels (Duffy 2006). The analysis of Smith *et al.* (2003) show a correlation between governance scores at the national level and numbers of elephants and rhinoceros across several African countries.

Several commentators have indicated that in many areas governance of natural resources and ecosystem services is declining, especially in situations where there is a transition from traditional authorities and institutions to more 'modern' ones (e.g. Benjamensen *et al*. 2002, Fabricius *et al*. 2004, Lawes *et al.* 2004, Mwalukomo 2007). In such periods of transition, several governance functions are undermined or division of responsibilities is unclear and therefore several functions are not implemented. Precise reasons for this remain speculative.

4.6.1.6 Urbanisation and expansion in peri-urban areas

Urbanisation continues at a rapid pace in the surveyed countries, but all still retain a significant rural population. Only Botswana and South Africa have more people living in urban areas than rural areas (Table 36).

Table 36: Proportion (%) of population that is urban (Source: UN 2004)

	1980	1990	1995	2000	2005	2010 (est)
Botswana	18.5	42.3	47.7	50.2	52.5	55.0
Mozambique	13.1	21.1	26.2	32.1	38.0	43.5
Namibia	22.8	26.6	28.6	30.9	33.5	36.4
South Africa	48.1	48.8	52.6	55.5	57.9	60.3
Swaziland	17.8	22.9	23.0	23.2	23.9	25.1
Zimbabwe	22.3	29.0	31.5	33.6	35.9	38.4

Urbanisation has myriad effects both in the rural areas as well as the urban and peri-urban ones, which are too numerous to summarise here. In short, urbanisation patterns affect rural areas by typically removing those with better education and formal, marketable skills. In some instances the land may be reallocated to those remaining behind, but there are strong cultural links to the birth place, and so many urban households maintain their ties and claims to land in the rural areas (Hebinck & Lent 2007). But there is a steady erosion of local knowledge as the next generation grows up in the urban areas.

In the growing towns and cities, the pace of urbanisation is frequently too rapid for authorities to keep up with service provision. Hence there are burgeoning shanty towns in many areas, inadequately serviced with water, sanitation or refuse collection. Contamination of water supplies from growing urban and peri-urban populations where water and sanitation systems may be badly sited and are not safely managed is a threat to the ecosystem service of water provisioning and is an emerging regional theme as urbanisation increases. In Maputo, there are fears of contamination of underground water, of which there is a lot, possibly through unlicensed small-scale providers. Social conditions are frequently poor, with erosion of traditional structures and cultures, not yet replaced by civic organisations and state authority. Newly arrived migrants are open to abuse and economic exploitation. They have swapped their environmental vulnerability of the rural areas for social vulnerability in the peri-urban shanties.

The urban sprawl results in large-scale and devastating land transformation, negatively impacting the degree of provision of a range of ecosystem services at the local scale. There is limited consideration of ecosystem services in urban planning or management processes. Urbanising populations also become sinks for many resources from rural areas, including charcoal, fuelwood, medicinal plants, and food. For example, charcoal is now being produced in Gaza province, hundreds of kilometres away, for use in Maputo; large dams are constructed to supply water to far away urban populations.

4.6.1.7 Drivers at a local level

While many of the drivers of ecosystem change are universal, the way in which they manifest and their impacts at a local level often depend on the specific context and situation, and the

interactions between different sets of overlapping drivers. Table 37 illustrates the influence of a series of drivers on the provision of ecosystem services in two villages in Gorongosa, Mozambique.

Table 37: Key ecosystem drivers and their potential consequences in Muaredzi and Nhanchururu, Mozambique (Appendix 2 - Case Study 2).

Key local-scale ecosystem drivers and trends	Consequences for provision of services
Increase in human populations and expansion of households (population pressure)	▪ Reduction in wilderness areas due to extensification (Muaredzi) and intensification (Nhanchururu) of agricultural crop fields. Leads to decline in range of services from natural ecosystems (natural capital). ▪ Land degradation and soil erosion (seen in Nhanchururu) will be exacerbated leading to reduced land productivity. May necessitate changes in agricultural production technologies and more purchased inputs. ▪ Greater demands for the resources that the Park seeks to conserve, hence intensified conflict between Park management and the people will be inevitable.
Build-up of livestock populations (especially in Nhanchururu)	▪ More supply of meat, milk, and other animal products, substituting some goods derived from natural ecosystems. ▪ Changes in ecosystem structure, composition and functioning, with possible land degradation, depending on stocking rates.
Increase in commercial timber extraction/ deforestation (especially in Nhanchururu)	▪ Short-term monetary gains at the expense of long-term provision of goods services from the wild as forests and woodlands are fragmented and/or degraded (changes in ecosystem function and structure).
More frequent floods and droughts than before (Climate change)	▪ Increases in food inputs from purchased commodities due to scarcity and reduced land productivity.
More extensive and uncontrolled wild fires (especially in Muaredzi)	▪ Changes in ecosystem function and structure impacting on provision of services (magnitude and direction of change depend on the fire regime).
Increase in wild animal populations in the park	▪ Increased human-wildlife conflict, especially with large herbivores (e.g. elephants), predators (e.g. lions) and pest species (e.g. baboons).
Changing human values, beliefs and norms.	▪ Leads to changes in the way people view their environment; how they manage their landscapes, etc.; may be beneficial or detrimental, depending on the nature of change. e.g. increased trade between villagers in Nhanchururu and Villa Gorongosa (urban) is leading to more importation of supplements into villages.

4.7 TRENDS IN ECOSYSTEM SERVICES

Because the poor are so reliant on ecosystem goods and services, any change in the supply of these services, or their access to them, can have profound impacts on the sustainability of local livelihoods, vulnerability and human well-being. If the change is a decline in availability or access, then the impacts on livelihoods will be negative and could potentially force people deeper into poverty. For example, declining fuelwood stocks can result in harvesters (usually women and children) having to walk longer distances, or use inferior fuels and hence change cooking duration and types of foods. If the trends are positive, and of sufficient magnitude, then the increased services could reduce vulnerability and improve local livelihood options; for example, rehabilitation of degraded wetlands provides clean water, reeds for fibre, and opportunities for subsistence or commercial fisheries. The trends may be expressed in and manifest in absolute terms or on a per capita basis. For instance, while the availability of fish in the Nile basin is relatively stable (slightly decreasing), the human population is expanding rapidly and thus, fewer fish are available per capita. In consequence, trends of a specific ecosystem services may appear to be stable or positive while their availability to the poor might be diminishing.

From the above it is clear that policy-makers, donors, development organisations and management agencies require information on trends in ecosystem services. In most instances knowledge of the trend over a meaningful period of time (decreasing, increasing relatively static (even if wide fluctuations)) is more important than that of absolute amounts or status. They may then use the information on trend to (i) investigate its magnitude, and (ii) design and implement policies, strategies and programmes to slow or reverse negative trends and enhance positive ones, so to help facilitate greater opportunities for developing sustainable livelihoods, especially for the poor. Consequently, there is an important role for monitoring of trends by community institutions, local, national and international agencies.

However, detecting and monitoring trends to provide reliable, meaningful and defensible information is not as easy as it might seem. There are numerous factors that underpin such an activity, including issues relating to scale of collection, which variables to monitor, over what duration, what ecosystem services, how to differentiate trend from background variability, how to deal with synergistic or cascading effects, and so on. These are challenges facing monitoring agencies worldwide, but are particularly pronounced in the arid and semi-arid lands of sub-Saharan Africa which are characterised by inherently high environmental variability and limited human and financial capacity. In-country consultations repeatedly identified the lack of monitoring services and data storage as the primary hinderance to understanding and managing ecosystem services better.

4.7.1 Detecting trends

Analysis of, and general statements pertaining to, trends in ecosystem services are complicated due to:

- the inherent variability of arid and semi-arid systems, which makes detection of trends more difficult because intra- and inter-seasonal changes are inherently large which results in a great deal of background 'noise' that potentially masks trends.
- the spatial and temporal scales employed – thus a regional- or continental-scale analysis of a short time period may suggest a particular trend, but at the local- or district-scale many exceptions can be found.
- the absence of long-term monitoring systems and data sets for many ecosystem services in most southern countries, which (i) limits the ability to detect trends, and (ii) means that rarely can we know if an observed short-term trend is part of a longer cycle or not.
- local adaptive responses may hide the imputed nature or impact of trends.

Consequently, detection and analysis of trends frequently relies upon triangulation from a range of different methods, including remote sensing, patching together results across several independent and disparate investigations, expert opinions and community perceptions. The danger, however, is that frequently larger scale (e.g. national or continental) reports on the status and or trends in ecosystem services are based on extrapolations from disparate, context specific, local-level studies. Remote sensing is a useful and increasingly used tool for several services, but cannot be used for many (e.g. soil fertility, drought mitigation, species richness, cultural services).

4.7.2 Scale of analysis

The MA (2005a) iterated the need to consider all scales when appraising ecosystem attributes. Nonetheless, the final outcome was largely embedded in coarse, continental or biome level statements, with limited enrichment from local level studies. However, the local level is the scale at which policy and project implementation occurs, and is commiserate with the global trends in devolution of power and decision-making. Consequently, it is at the local level that analysis of trends in ecosystem services needs to be focused, albeit not to the detriment of other scales. Indeed, it is not hard to locate strong evidence at the local scale in most countries that run counter to the national or continental scale summative trends. This does not mean the national

or continental scale summaries are of little use, but they need to be interpreted as such and care taken in using them to develop local level interventions. There is a compelling case for more emphasis on local level assessment of trends, and in each instance for a concomitant capturing of contextual details. Analysis of trends in relation to the local context would then allow development of predictive capacity.

4.7.3 Community knowledge of trends

Although formal monitoring programmes are lacking in many countries and for many ecosystem services, there is a wealth of community and household level information on trends in those services on which people strongly rely to meet their immediate needs (e.g. Dahlberg 2000, Lynam *et al*. 2003). Indeed, recording and capturing trends via community-based monitoring is a fertile area for intervention and support. Similarly, significant knowledge of trends of many ecosystem services rests with officials and extension officers, (e.g. Hoffman & Ashwell 2001) albeit rarely documented or regularly updated. Our extensive consultations with officials and experts in several countries as part of this CEPSA process revealed that most feel that the general state of ecosystems is declining and rarely receives adequate attention from national government agencies. There is a strong perception of increasing land degradation due to clearance of land for agriculture, heavy grazing and the promotion of commercial livestock production, changed fire regimes, introduction of fixed water points, over-harvesting, localised loss of species and poor regulation and controls at all levels. A decline in water availability, quality, and in the health of aquatic systems was also mentioned as a major concern in most countries, driven by over-abstraction, altered flow regimes brought about by large dams, and a lack of control of effluent discharge into water bodies. These perceptions are vital in the absence of formal monitoring systems, but also need to be triangulated against other sources.

4.7.4 Access to ecosystem services

Not only is the trend in the actual individual ecosystem services important, but also trends in access to each of those services. Many situations have been reported where changes in tenure regimes, monopolisation or expropriation of resources by elites or the State, or development of infrastructural barriers (e.g. canals, dams, fences) have limited the access of the poor to selected ecosystem services (Fabricius *et al*. 2004), which has the same impact on their livelihoods as if the ecosystem service itself was in dwindling supply. Indeed, by virtue of their poverty, the poor are particularly vulnerable to expropriation of their resources and are more often than not relatively powerless to oppose such actions (PANRUSA 2001). Thus, consideration of access goes hand-in-hand with analysis of trends in ecosystem services themselves.

4.7.5 Cascading effects

Generally a more holistic approach is needed when interpreting trends in dryland ecosystem services. An increase in woodlands, as it is the case in Mt.Coke (Case Study 3), might be desirable in terms of potentially increased carbon sequestration and local climatic conditions. However, in the case of Mt. Coke this woodland expansion was the result of an invasive indigenous tree, *Acacia karroo*, which resulted in a decrease in services such as fuelwood, building materials, wildlife and recreation activities. The example shows on the one side that global or regional trends might at the local level have different results than expected and secondly that there is a need to consider the interconnectivity of different trends.

Looking at trends in ecosystem services it is important to consider the implications that one trend can catalyse trends in other ecosystem services as well as their inter-relatedness. For instance, the loss of traditional taboos is closely related to the protection and thus provisioning of emergency food in times of drought and in consequence the ability of the ecosystem to buffer against natural hazards. Similarly, the combination of soil fertility, vegetation cover, wild food and

plants and intact wetlands have an impact on the capacity of ecosystems to absorb and buffer the impact of natural hazards and in consequence influence the vulnerability of dryland dwellers. Stakeholders in the southern African consultations identified the link of declining woodland cover forcing locals, especially the poor, to use cow dung and crops residues for energy, which in turn contributed to declines in soil fertility.

4.7.6 Coping with declining ecosystem services

It is frequently implied that declines in a particular ecosystem service automatically immediately translates into negative impacts on local livelihoods, especially those of the poor. However, the relationships between ecosystem services and livelihoods are complex and rarely linear. The inherent variability in arid and semi-arid lands means that communities already employ a range of coping and adaptive strategies in the face of local and external changes. This then distorts the nature of presumed direct impacts, and may also delay their manifestation. However, persistent and or synergistic negative changes may erode coping strategies leading to the loss of capital assets available to households, and consequent demise of livelihood viability; for example the combined effects of drought during a period of economic downturn, or decline in fuelwood may result in harvesting of taboo species and loss of cultural services; for loss of fruit productivity because pollination services are disrupted through clearance of land (Leakey *et al*. 2005). This process is inevitably faster for poor households than the less poor because the poor have fewer assets on which to call. Declines in woodland cover in Bushbuckridge in South Africa over an eleven year period resulted in people having to spend significantly longer searching for fuelwood; they also had to collect poorer fuelwood species, so the total number used increased by 36 % (Madubansi & Shackleton 2006).

A particularly important point to stress is that for the poor the reduction in one or more ecosystem service cannot simply be replaced by purchasing external supplies or alternatives. This is because they lack the cash resources to buy the alternatives. Moreover, many communities in the arid and semi-arid lands are remote and distant from markets. Transport to the nearest markets is costly and irregular.

4.7.7 Summary trends

There are indications of overall continuous degradation of drylands in terms of deforestation, degradation of soil fertility and conversion of rangeland to cropland as well as unsustainable agricultural practices (MA 2005a; Molden 2007; S-Africa Synthesis p. 56,57). Examples include the decrease in woodland by 10% in the Romwe catchment between 1984 and 1999 due to a clearing for expanded cultivation (Campbell *et al*. 2002, Case Study1) or the decrease in forests in Kenya from 3% to 1.5% (WRI/ILRI 2007).These in turn have negative effects on the potential of drylands to sequester carbon as well as their local and regional climate regulation.

Trends in each of the ecosystem services selected for in-depth review are presented in Section 4, and readers are referred to this section for a finer-scale and more nuanced discussion of these trends, their drivers and their impacts on human vulnerability and adaptability. In this section we briefly summarise some of the main trends, drawing on the findings from the in-country consultations as well as previous discussion.

While it is possible to generalise some trends to the southern African region or specific ecoregions, many are quite patchy and locally specific and dependent on the interaction of a wide range of complex interacting biophysical and socio-economic factors. At a broad scale, trends are often spoken about in terms of degradation, deforestation and desertification. Overall, the sense is towards an increase in these processes and a decline in many important ecosystem services, but due to a lack of effective long-term monitoring (see Section 4.9.7 - capacity) there is limited hard evidence to support this and little is known about the rates at which change is happening and how much of it is reversible. Indeed, there is still a great deal of uncertainty about

many of the observed and perceived trends and their drivers (in-country consultations). Moreover, the impacts on human well-being and vulnerability are even less sure, with limited data available.

A common trend mentioned by stakeholders across the region was an increase in land degradation/desertification due to heavy grazing and the promotion of commercial livestock production, bush-encroachment, increased fire incidence, introduction of fixed water points, overharvesting, poor regulation and controls at all levels, and governance and policy impacts such as the land reform programme in Zimbabwe (see Section 4.6.1.4). In Mozambique deforestation is on the increase due to commercial timber and fuelwood harvesting (often for conversion to charcoal) for burgeoning urban markets and widespread fire as a result of slash and burn agriculture and hunting. A decline in water availability, quality and in the health of aquatic systems was also mentioned as a major concern in most countries. The deterioration of various aspects of inland water, due to over-abstraction and a lack of control of discharge, was identified by a number of stakeholders as one of the most pressing ecosystem challenges in South Africa. Furthermore, it is expected that climate change will interact with these various disturbances and trends to accelerate and intensify change and possibly even push some ecosystems into 'switching' or crossing a threshold (e.g. from savanna to grassland) as has occurred in the past (Intergovernmental Panel on Climate Change 2001). Underlying theory to predict the extent and nature of future ecosystem switches in Africa is lacking and there are few case studies from the region (Intergovernmental Panel on Climate Change 2001).

A key overarching trend often mentioned during local consultations was the decline and change in natural resource governance and institutions. Whilst there are many local exceptions, the general trend is frequently reported as one of increasing privatisation of land or resources, as well as the demise of formerly functional communal systems into open access ones (Bernard & Kumalo 2004, von Maltitz & Shackleton 2004). This is associated with a decline in the power of traditional leaders and local regulations, frequently resulting in a power vacuum. State officials and national and local government lack the skills, logistical support or respect in dealing with ecosystem management and resource access issues. The increasing privatisation and development of open access systems affects the poor the hardest. Privatisation restricts access to land and resources. Open access systems results in inequities in access and appropriation of resources, often with outsiders coming into such areas (Twine *et al*. 2003b).

A major manifestation severe trends and even thresholds is when ecosystem services decline to such an extent, that people are forced to move. Often this is in response to some other shock as well, such as drought or disease. But if the safety-net function of ecosystem services has been compromised, then people are forced to migrate to urban centres, frequently to urban slums and a far more precarious and vulnerable livelihoods and severe poverty. Many commentators in the region identified this as the main index of the decline in ecosystem services, so that livelihoods could no longer be supported.

Not all trends are, however, negative and in some instances negative trends have been slowed or reversed by appropriate interventions (see Section 4.8). In some cases, such as biodiversity (e.g. wildlife), there have been localised improvements through conservation initiatives such as conservancies, conversion from stock to game farming, CBNRM programmes, etc. Bush encroachment in some areas can increase the availability of fuelwood, browse and other natural products, and so can have variable impacts on different sectors of society. Rehabilitation of many systems is possible and this can also create employment opportunities as has been described elsewhere in this report.

4.8 MANAGEMENT STRATEGIES AND INTERVENTIONS

This section considers 'what can and needs to be done' at all levels to address the trends, challenges and issues highlighted in the preceding sections. It asks the question – what are the

opportunities for intervention and which actions and responses have had positive benefits for both poor people and ecosystems? The MA revealed that development and poverty alleviation prospects for arid and semi-arid lands are especially dependent on interventions that reduce or reverse ecosystem degradation (WRI 2007). During the in-country consultations respondents mentioned a number of interventions designed to address natural resources and livelihoods/poverty, but were sceptical of their ability to successfully achieve both objectives simultaneously. Indeed, there is much literature internationally regarding the difficulty in reaching 'win-win' situations when attempting to tackle both ecosystem management and poverty reduction simultaneously, with a number of commentators being quite pessimistic about the prospects. For this reason the numerous challenges that the interventions mentioned below still face are highlighted.

This section should be considered in conjunction with the interventions sections provided under each of the key ecosystem services discussed in Section 4.2, 4.3, 4.4 and 4.5.

4.8.1 Complexity of interventions

Just as the problems of ecosystem change and subsequent impacts are complex so are the solutions. Responses and actions that facilitate the linkages between ecosystem services and poverty alleviation and that improve the capacity of ecosystems to continue to deliver services important for poor people can be found at multiple levels from local to international. They may operate at different spatial scales (from landscape to species or community to household), and may be led by different actors in society (e.g. international agencies, national governments, local governments, civil society organisations, private sector, local people or combinations of these). These actions can range from policy, i.e. creating the enabling conditions for integrated responses and successful implementation, to specific strategies, programmes, projects, planning frameworks or 'tools' for intervention that may operate at a variety of scales, to processes such as multi-stakeholder decision-making, and finally to local innovations and adaptations at community and household level. Furthermore actions may be targeted at different spheres or areas of influence, e.g. education and awareness raising for behavioural change, cooperation and integration between sectors, building capacity, economic incentives for more sustainable use of ecosystem services, local land and resource management approaches, research and monitoring for decision-making, technological solutions, etc. (see Table 38 for examples). Box 49 outlines the broad areas (or entry points) used by the MA (MA 2005c), the WRI (WRI 2007) and the South African Environmental Outlook Report (DEAT 2006) to classify and discuss potential actions. Some interventions may crosscut a number of areas and ecosystem services while others may be specific to a particular service.

Box 49: Typology/broad areas for action (can also be thought of as entry or leverage points)

MA (2005c)
Institutions and governance including legal responses
Economic responses and incentives
Social and behavioural responses
Technological responses
Knowledge and cognitive responses

WRI (2007)
Developing and using information about ecosystem services
Strengthening the rights of local people to use and manage ecosystem services
Managing ecosystem services across multiple levels and time frames
Improving accountability for decisions that affect ecosystem services
Aligning economic and financial incentives with ecosystem stewardship

DEAT (2006) (Cross-cutting priorities)
Strengthening implementation and enforcement
Mainstreaming the environment
Building capacity
Environmental information for decision-making

Box 50: Preconditions for successful soil and water conservation (SWC) approaches for sustainable land management (Source: Schwilch *et al.* 2007)

Analysis of 42 SWC case studies revealed that: "There are a number of preconditions for success, including a focus on production aspects, security of access, long-term commitment and investment, participation of stakeholders, capacity building, and a willingness to draw on human resources: people's knowledge, creativity and initiative. The analyses made clear that local innovation and traditional systems offer at least as much potential as project-based SWC experimentation. SWC requires long-term commitment from national and international implementation and research institutions. Here a clear strategy and partnership alliances are needed to sustain results beyond the project life-span."

Often different types of actions at varying scales or in different spheres act synergistically or conditionally to have an impact on ecosystem management at the local level. For example, policy that ensures secure access and tenure

rights for local people can assist in the successful implementation of programmes such as CBNRM, an important approach in southern Africa. Box 49 outlines some of the 'pre-conditions' necessary for effective implementation of soil and water conservation measures to ensure sustainable land management. Many national level biodiversity conservation and land management programmes (e.g. Cape Action Plan for the Environment (CAPE), Land Care) include an awareness raising, educational and capacity building component resulting in considerable overlap between columns 2, 3 and 5 in Table 38.

The motivation behind particular actions can also differ. Some interventions may be proactive – i.e. designed to promote better ecosystem management for enhanced livelihoods security and poverty alleviation (such as devolved, participatory and integrated responses to ecosystem management like CBNRM, INRM, co-management, land care, etc.) while others may be reactive in response to a crisis or in recognition of the declining capacity of ecosystems to deliver services (e.g. rehabilitation and restoration programmes). Sometimes the entry point may be poverty alleviation (as in Poverty Reduction Strategy Papers (PSRPs) or other poverty action plans), while in other instances ecosystem management may be the key objective with subsequent positive impacts on poverty (e.g. Catchment Management Agencies). Numerous strategies and programmes have the simultaneous goals of achieving poverty alleviation and improving ecosystem management (e.g. poverty relief and rehabilitation projects such as 'Working for Water' in South Africa, CBNRM). Interventions are generally most effective if directed at the better management of ecosystem services and at the direct and indirect drivers that are influencing these services (MA 2005a).

Table 38: Some illustrative *examples* of different types and scales of interventions that enhance poverty alleviation and human well-being through improving ecosystem service management (note some interventions span more than one area/sphere and scale and are difficult to classify)

Scale/level	**Nature of intervention, broad area**					
	Institutions, governance, coordination, integration	Integrated ecosystem management	Poverty, sustainable development	Economic incentives	Awareness/ education, behavioural change	Knowledge, research, monitoring
POLICY – international treaties, national policies, laws, strategies, frameworks						
International & Africa wide	►AU - e.g. African Convention on the Conservation of Nature & Natural Resources ►NEPAD – e.g. Environmental Action Plan ►TerrAfrica	►CBD ►CCD ►RAMSA	►MDGs, ►Agenda 21 ►WEHAB framework for action	►CDM (carbon trading) ►International Export Standards	►UN Decade on Education for Sustainable Development (DESD)	► UN Declaration on rights of indigenous people
Southern Africa	►SADC Protocol on Shared Watercourses	►SADC Forestry Protocol ►Regional Strategic Action Plan (RSAP) for Integrated Water Resources Development and Management in SADC countries ►Regional Biodiversity Strategy and Action Plan	►SADC Environment and Land Management Sector (ELMs)		►DESD Guidelines for Southern Africa	
National	►Mainstreaming ►National forest environment, agriculture, water,	►Participatory Forest Management Strategy (SA)	►Biodiversity benefit sharing strategies	►Tax breaks		

Scale/level	Nature of intervention, broad area					
	Institutions, governance, coordination, integration	Integrated ecosystem management	Poverty, sustainable development	Economic incentives	Awareness/ education, behavioural change	Knowledge, research, monitoring
	etc. policies, acts, and regulations (e.g. water licences in SA) ►Devolution and decentralisation ►Access rights and tenure reform ►Co-management strategies	►National action plans required by international conventions (All)	(All) ►PSRPS or Poverty strategies (All) ► Land Reform programmes (All)			
Regional/ sub-national	►Parks policies re resource access				►Municipal Local Environmental Education Programmes (LEEP)	
PRACTICE – approaches, programmes, plans, tools, processes, local adaptations						
International		►Gene banks for ex-situ conservation of genetic resources		►Certification schemes	►International days (Environment day, Arbour day), weeks (Water week) and years (International Year of Deserts and desertification – IYDD) ►International awards ►MESA - UNEP	►Environmental Outlook reports, State of Forests reports ►Funding for action research ►Global research initiatives like the MA
Southern Africa		►Transfrontier Conservation Areas (All)	► Southern African Trust (learning on regional poverty policy) ► Southern African Regional Policy network			
National	►Capacity building for implementation ►Multistakeholder, interdepartmental committees – e.g. Indigenous Plant Use Task Team (Nam) ►Environmental courts (SA)	►CAMPFIRE (Zim) ►Conservancies (Nam) ►Indigenous vegetation programme (IVP) (Bots) ►Ecological water requirements of rivers (e.g. SA RDM procedures (ecological reserves)) and River Health Prog.	►Land Care (SA) ►Public Works Rehabilitation Programmes – e.g. WfW (SA) ►Million trees programme (SA) ►Poverty programmes, e.g. EU-funded Rural Poverty Reduction Programme (RPRP)	► Proud Partner Programme (SA) ►Eco/ethical labelling of natural products (All)	►National awards for 'role models'/best practice (e.g Sustainable cities in SA) ►Million trees programme (SA) ►Endangered Wildlife Trust Ecowarriors (SA) ►WESSA Ecoschools (SA) ►SCOPE (Zim) ► Cheetah Conservation Educ. Prog (Nam)	►Monitoring programmes (All – but capacity weak) ►National state of environment, etc. reports (All) ► Wetland Management series and WET roadmap (SA)

Scale/level	Nature of intervention, broad area					
	Institutions, governance, coordination, integration	Integrated ecosystem management	Poverty, sustainable development	Economic incentives	Awareness/ education, behavioural change	Knowledge, research, monitoring
			(Nam)		►Landcare programme has an educational component (SA)	
Regional	►Integrated conservation planning processes, e.g. STEP/CAPE (SA) ►Catchments management agencies	►Bioregional conservation plans and programmes, e.g. STEP/CAPE (SA) ►Stocking regulations ►River classification			►CAPE (SA) (EE plus Agricultural Stewardship Educational Prog.)	
Local	►IDPs (SA) ►District zonation plans	►Restoration projects ►CBNRM/PFM projects (All) ►Woodlots ► Grazing management schemes (Bots, Nam)	►Local Agenda 21s	►PES projects ►Certification projects ►Natural product commercialisation projects (All) ►Ecotourism projects (Bots, Nam)	►Environmental education programmes ► School based Environmental Clubs (Bots) ► Indigenous tree nurseries (All) ► Many NGO training programmes on NRM, sustainable agriculture, etc. (All)	►Cost benefit analysis for projects ► Valuation of ecosystem services
Community/ household	►Informal institutions (e.g. resource user groups) ►Customary and religious/spiritual institutions ►Grazing management committees	►Local rules, taboos, etc. (All) ►Substitution of species ►Cultivation of useful species ►Local land management practices	►Livelihood diversification	►Water tanks		►Local technical & ecological knowledge ►Local land management practices

CAPE (Cape Action Plan for People and the Environment), STEP (Subtropical Thicket Ecosystem Planning Programme), WEHAB (water, energy, health, agriculture and biodiversity), MESA (Mainstreaming Environment and Sustainability in African Universities), WESSA (Wildlife Society of South Africa), SCOPE (Schools and Colleges Permaculture Programme), CBD (Convention on Biological Diversity), CCD (Convention to Combat Desertification), AU (African Union), CDM (Clean Development Mechanism)

4.8.2 Dealing with trade-offs

A principle challenge in managing ecosystem services is that many are interdependent and attempts to optimise one service (through human actions such as dam building for water provision) often leads to reductions or losses of other services (e.g. less 'visible' regulating services), i.e. they are traded-off, sometimes unintentionally (Rodriguez *et al.* 2006). Moreover, the impacts on future provision of services are often unknown or can have unanticipated outcomes (Rodriguez *et al.* 2006). Trade-offs, however, not only occur between ecosystem services, but also between conservation and poverty outcomes and, linked to this, short- and

Box 51: Balancing poverty and ecosystem management (adapted from "Water Book" – a summary – SADC technical report n.d.)

Two fundamental assumptions link ecosystem services and poverty alleviation:

- Strategies to reduce poverty should not lead to further degradation of ecological functions and services.
- Sustainable natural resource use and improved environmental quality should contribute to reducing poverty.

However, trade-offs between (i) types of interdependent ecosystem services, especially provisioning and regulating services, (ii) ecosystem services and immediate economic returns and poverty reduction, and (iii) different social groups for particular services are common. Managing trade-offs is one of the biggest challenges in making the links between ecosystem services and poverty alleviation. Impacts of decisions on the future provision of services also require consideration.

long-term benefits, as well as between different societal groups dependent on natural resources (e.g. diversion of water from a river to provide irrigation for commercial farmers may leave downstream flood plain cultivators without water for their needs) (MA 2005c, Rodriguez *et al.* 2006). This situation is made even more complex by the fact that decisions invariably revolve around trade-offs between different value systems, needs and desires amongst communities, with the poor, who have the least power, often loosing out (van Jaarsveld *et al.* 2005). This section considers some of the interventions that can help to minimise or ameliorate the impacts of trade-offs. More details on trade-offs can be found under each ecosystem service and in Sections 4.2 – 4.5.

4.8.2.1 Market-based approaches that encourage ecosystem management

Market-based approaches such as payment for ecosystem services (PES), community-based natural resource management (CBNRM) (e.g. CAMPFIRE in Zimbabwe, Conservancies in Namibia, Box 65) and small and medium enterprises based on 'wild' products (Box 59) are seen as a ways to increase the value of natural ecosystems in an effort to offset possible short-term trade-offs for alternative land uses/other ecosystem services (although the success of these is mixed). The same applies to community-based tourism initiatives that rely on nature tourism (these are often part of a CBNRM approach, see Section 4.4.2). In these interventions, the revenue derived from ecotourism is shared with local communities *in lieu* of activities that may impact biodiversity such as hunting and land conversion.

PES describes a new set of environmental policies, voluntary agreements and contractual instruments (Swallow *et al.* 2007), and is defined narrowly as "a voluntary transaction where a well-defined environmental service (or land use likely to secure that service) is being bought by a (minimum one) buyer from a (minimum one) seller, if and only if the environmental service provider secures the environmental service provision" (Wunder 2005). Other definitions are broader and may include a number of the financial instruments listed below as well as activities such as ecotourism. The benefits, or potential benefits, of PES schemes for the well-being of the poor is a much debated area with some commentators being quite optimistic, while others less so. There are also questions regarding whether, and under what circumstances, PES will be able to compensate fully for foregone alternative land uses. Also, PES tends to benefit those who have degraded their ecosystem services rather than rewarding those who have protected these, which are often poor, remote communities.

To date there are limited examples of fully implemented PES schemes in southern Africa although there is considerable interest and a number of initiatives are in the early stages. Some long standing projects such as CAMPFIRE can in many ways be considered as PES projects (Campbell *et al*. 2007). Box 56 provides an example of a carbon trading initiative in South Africa.

Certification, such as that offered by the Forest Stewardship Council, is an economic tool related to consumer preferences that can assist in the more sustainable management of forest ecosystems and improved social benefits while providing market advantages to the implementer. Most forestry companies in South Africa have FSC certification. Other examples of economic incentives and financial instruments that help reduce negative impacts on regulatory services include tax breaks, subsidies, fines on prohibited activity, various types and investments in social or physical assets, environmental off-set schemes (e.g. carbon credits), and eco-labelling

(Swallow *et al*. 2007). Most economic and financial interventions require a well-organised legal framework to be effective. While the poor rarely benefit directly from these interventions as many are targeted primarily at businesses, they do indirectly through, for example, reduced emissions, decreased land conversion, better water management, etc.

4.8.2.2 Approaches that ameliorate the negative impacts of trade-offs

Where trade-offs for provisioning services, such as crop production, are inevitable, interventions may be implemented to ameliorate the negative impacts of landuse change on key regulating services such as soil fertility and biodiversity. Illustrative examples include conservation farming, ecoagriculture, organic farming, integrated pest management, participatory sustainable land management approaches and agroforestry. In most of southern Africa such approaches have received relatively little attention, although Namibia has a programme exploring conservation tillage in the North-Central region in recognition of the need to build up soil structure and fertility and the area under conservation tillage in South Africa has increased from 500 000 ha in 1975 to 1.5 million ha in 2005.

4.8.2.3 Integrated, landscape approaches that address trade-offs at different scales

Integrated planning and management approaches at regional or landscape level are important when considering trade-offs at different scales. Many ecosystem services, particularly regulating services, only manifest at landscape or higher scale (van Jaarsveld *et al*. 2005). The issues then become what features of the landscape are needed to maintain these regulating services, what percentage of the landscape must contain these features and how do these relate to one another within the landscape mosaic? Multi-stakeholder, bioregional land and conservation planning processes such as those used in the CAPE (Cape Action Plan for People and the Environment) and STEP (Subtropical Thicket Ecosystem Planning Programme) programmes in South Africa are important interventions in this regard. Integrated natural resource management (INRM) is another approach that operates at the landscape level and that attempts to consider the interactions between a number of ecosystem services rather than focussing on one or a few services as is the case with many other community-based approaches (Frost *et al*. 2007, Appendix 2 - Case Study 1). Catchment management approaches and Catchment Management Agencies (e.g. South Africa Water law) provide a mechanism and the institutional framework for water resource management at a landscape scale.

4.8.2.4 Reducing poverty trade-offs in biodiversity conservation

Conflicts and trade-offs between biodiversity conservation and local livelihoods are common and can be related to the different values attached to biodiversity at local and global levels. A key response to biodiversity threats at a global level has been and still is the designation of protected areas (see Section 4.5 – Biodiversity). In the past, and to some extent even now, this approach has had negative impacts on local livelihoods, particularly if people are displaced or excluded from using resources within these areas. Increasingly more ethical conservation approaches that recognise local rights, needs and priorities are gaining support within southern Africa. In a number of cases people continue to live within parks (see Appendix 2 – Case Study 2). Such approaches can help to reduce the disproportionate costs of conservation that are often carried by the poor living next to parks and other protected areas. The majority of parks agencies have ‘People and Parks’ type programmes that aim to benefit local neighbours. These ‘outreach’ type projects range from allowing resource access and use to enterprise development initiatives, environmental education, local employment creation through for example as tourism guides and greening and infrastructural development (see Box 52 for the example of South African National Parks).

Box 52: South African National Parks' (SANParks) "People and Parks Programme" (Source: in-country consultations)

SANParks has a range of community-based projects, which include park- and community-driven projects, as well as community-based economic empowerment projects, sustainable resource use projects and broad-based black economic empowerment (BBBEE) programmes. As of October 2007, the total number of projects was 61. Eight of these were resource use projects, which is a more recent area of focus, and include harvesting of *suurvy* in the Agulhas National Park, harvesting of *waterblommetjies* in the Bontebok National Park, the Khomani San Resource Use project in the Kgalagadi park, the Rastafari *Rooiwortel* Nursery project in the Knysna park, mopane worm harvesting in Mapungubwe, and the Rastafari and Traditional Healers Medicinal Plant Training Facility of the Table Mountain National Park. The range of projects linked to Kruger National Park included a medicinal plant nursery, a number of greening projects, debushing and arts and crafts projects, but none were classified as resource use projects. Ongoing BBBEE programmes linked to Kruger are the Emerging Contractors Development project and the Community Fencing Project. SANParks has commissioned research to determine exactly what the impact of its Extended Public Works Programme (EPWP) and Poverty Relief projects is on communities adjacent to parks, which is due to start in early 2008.

4.8.2.5 Recognising when alternatives are needed

Where pressures on ecosystem services are excessive, resources are thinly spread and interventions are unlikely to alter people's state of well-being, the most appropriate responses may be those that reduce reliance on natural resources through for example job creation, facilitating migration, social welfare payments, and supporting small business development. The Chivi integrated natural resource management (INRM) case study stressed that, while local interventions can improve resource management and strengthen safety nets, what is really needed, to have any significant impact on rural poverty, are major external changes, economic opportunity and large infusions of capital (Appendix 2 – Case Study 2, Campbell *et al*. 2002, Frost *et al.* 2007). Public works/poverty relief type restoration projects such as Working for Water, Working for Wetlands and Working for Woodlands in South Africa are examples of potential approaches to creating income opportunity where ecosystem services are degraded and cannot continue to support local livelihood needs (see below and Box 55).

However, there is a fine balance. Findings from the in-country consultations for Botswana suggest that too many subsidies and extensive welfare support can reduce rural self-reliance and create a disincentive for natural resource management. This is captured in the following quote – "In the Okavango Delta, there used to be a very rich tradition of crafts, carving and basketry that is almost dying out. People say to us "what's the incentive? Government is going to bring us food anyway" (in-country consultations).

4.8.2.6 Knowledge for sound decision-making when faced with trade-offs

Knowledge and awareness of the interactions between ecosystem services as well as their different values are necessary for (i) making sound decisions when faced with trade-offs, and (ii) for avoiding unintentional trade-offs and unexpected consequences (Rodriguez *et al.* 2006). Decision–making tools, cost benefit analysis, natural resource valuation, modelling and landscape mapping, and scenario planning can also greatly assist in making informed decisions. Development and use of such tools is a key area of intervention necessary when considering changes in landuse or trade-offs between services. Furthermore, for trade-off assessments to balance highly value-laden human needs and aspirations with the maintenance of ecosystem services it is essential "to secure an appropriate social contract with civil society" (van Jaarsveld *et al.* 2005). Interventions that are transdisciplinary and incorporate local knowledge, participatory and include all stakeholders are critical.

While a number of interventions have been mentioned above that can assist in dealing with trade-offs, there has been little evaluation and analysis of their success or failure from this particular perspective. This is a gap that needs attention.

4.8.3 Barriers to intervention

Despite considerable progress across the region in recent years regarding frameworks, policies, laws, strategies and interventions that recognise the importance of environment and ecosystems

services for the poor (Table 38, Box 53) there are still numerous barriers to moving forward and to making a real difference on the ground (DEAT 2006). Some of these are listed below.

Box 53: Positive policy trends across the study region

- ► Most countries are signatories to international conventions.
- ► Adoption of SADC regional approaches and strategies.
- ► All countries have national poverty reduction strategies in place.
- ► Increasing devolution and decentralisation of natural resource management responsibilities.
- ► More secure land and resource rights (but progress with land reform slow and results mixed).
- ► Recognition that protected areas must benefit local communities and establishment of contractual parks.
- ► Greater recognition of need for conservation and natural resource management outside of parks.
- ► Greater recognition of local knowledge and rights.
- ► Improved access to environmental information and improved environmental reporting (although still lacking).
- ► Greater consultation and stakeholder participation in policy development processes, governance, planning and decision-making.
- ► Increasing budget allocations (but still limited).
- ► Greater consideration of incentives for natural resource management rather than punitive fines and regulations.
- ► Pluralist legislation that supports endogenous local and customary institutions for natural resource management – e.g. concept of cultural-historic protected zones in Mozambique's Forest Law.
- ► Move towards landscape level approaches (e.g. catchment management).
- ► Legislation in Namibia, Zimbabwe and South Africa that require mining companies to rehabilitate when the mines are decommissioned.
- ► Improved service delivery reducing reliance on natural water sources and fuelwood (some countries such as

- While there are often progressive policies linking poverty and ecosystem services in departments dealing with environment and natural resources, this rarely extends to departments whose mandates are social welfare, health, land affairs, energy, economic development, rural development, etc. Understanding of the conceptual connection between poverty and ecosystem services is still weak amongst role players not directly involved in the environment and this may be one factor impeding the 'mainstreaming' of this issue. Mainstreaming is important as many of the most significant drivers of ecosystem change and users of ecosystem services originate outside the sectors responsible for their management.
- The exclusion of the environment from national accounts, which reflect only the flow of economic activity and ignores the stocks and degradation of natural capital, undervalues ecosystem services and their importance and leads to them being overlooked or taken for granted (DEAT 2006).
- Strategies, programmes and projects are often sector specific with few examples of cross sectoral/ departmental strategies that are critical to address the multi-dimensional nature of ecosystem-poverty linkages and to enhance opportunities for synergy (e.g. many of the CBNRM programmes in the region are wildlife specific rather than dealing with natural resources as a whole). The CBD, for instance, calls for the integration of conservation and sustainable use of biodiversity into relevant cross-sectoral plans, programmes and policies.
- There is often low policy coherence between different sectors/ departments – e.g. between agriculture, environment and forestry. This can give contradictory messages. Agricultural polices are rarely aligned with the protection of biodiversity and ecosystem services with the result that innovative approaches like integrated natural resource management and ecoagriculture remain marginal. At an international level, increased coordination is also needed between different multilateral environmental agreements, and between these and other international economic and social institutions (MA 2005c).
- Ecosystems and environment are often neglected in overarching strategies such as PSRPs (Bird 2003) and rural development strategies. Ecosystem services are seldom given adequate attention in integrated development plans such as those implemented by local government in most southern African countries.
- In most southern African countries problems have been experienced in moving from policy to practice. Implementation of ecosystem and poverty programmes have often been slow (DEAT 2006). This may be due partly to the complex local and context specific nature of these, especially when attempting to implement collective action solutions, and partly to bureaucratic inefficiencies, weak institutional capacity, and a lack of human and financial resources (see Section 4.9).

- Scaling up from a few localised projects or initiatives to more regional or national levels has also proved difficult, possibly for similar reasons to those mentioned above. For example, in terms of rangeland restoration in southern Africa, Milton *et al.* (2003) write: "Although there have been many successful local restoration initiatives, the primary challenge is at the regional scale."
- Difficulties are often experienced in translating some of the international treaties/agreements into something workable at national and subnational level (MA 2005c, Adeel *et al.* 2007).
- Poor monitoring and a lack of timely and accurate information and data have undermined informed decision making and the adoption of appropriate responses and actions (DEAT 2006, see Section 4.9.7). The interaction between policy and science in general remains weak (Adeel *et al.* 2007).
- There are often scale mismatches between the biophysical units of ecosystem management and the corresponding social and administrative units affecting successful implementation (Frost *et al*. 2007).
- Most of the poor in the region live in communal lands and therefore actions to address poverty and ecosystem services are generally related to better management of common pool resources. This can be a notoriously difficult and complex area to address (e.g. Frost *et al.* 2007) and usually takes considerable time and long-term investment. Often projects have too short a time horizon.

4.8.4 Examples of promising interventions at different scales that strengthen the links between poverty alleviation and healthy ecosystem services

Although the picture painted above is frequently pessimistic, there are many positive experiences and numerous examples of 'best practice' that can be drawn on from the region (WRI 2007, in-country consultations). Where interventions have been effective they have aimed at overcoming some of the above-mentioned barriers. The remainder of this section provides *selected case study examples* of 'promising' interventions, particularly related to local ecosystem management, that strengthen the links between poverty alleviation and ecosystem services and that foster healthy ecosystems. However, it is important to bear in mind that there are no simple solutions, but rather considerable and ongoing challenges. The clusters of complexities that prevail, particularly in arid and semi-arid lands, means that any interventions to reduce poverty through enhanced ecosystem management will require substantive investment and "integrated, multi-tiered and long-term interventions that expand economic opportunities and empower people to drive their own development" (Frost *et al.* 2007, Appendix 2 - Case Study 1). Furthermore, changing views on what constitutes sustainability and the importance of resilience (Box 54) point to the need for holistic, flexible approaches that are capable of responding to change in the external environment. For example, in the Chivi case study "hydrological studies show that an opportunistic strategy aimed at making maximum use of water when it is most available and only seeking to conserve it during times of stress, would be most efficient, a conclusion that runs counter to most conventional management recommendations" (Frost *et al.* 2007).

Box 54: Changing views of sustainability and implications for interventions (Source: WRI 2007)

"Increasingly, scientists think about sustainability in terms of the ability of social and ecological systems to adapt and benefit from change, rather than as a static balance between people and nature. Societies and the ecosystems on which they depend are said to be resilient if they are able to absorb change while maintaining their basic structure, identity and function. Societies are adaptable if people can manage the links between society and ecosystems to maintain resilience. Information on ecosystem services can help decision-makers distinguish between options that are likely to enhance ecological and social resilience (and thus sustainability) and those that are likely to undermine it."

4.8.4.1 The Expanded Public Works Programme (EPWP), South Africa: Restoring ecosystems and creating jobs

A programme that combines the multiple objectives of ecosystem restoration, resource conservation, job creation, skills development and poverty alleviation that has 'taken off' in South

Africa and that well might provide an important example for other countries in the region is the Expanded Public Works Programme (EPWP). The EPWP is one of the South African government's short- to medium-term programmes aimed at alleviating poverty and reducing unemployment. It is a nationwide programme coordinated by the Department of Public Works that aims to draw significant numbers of unemployed people into the public sector of the economy, gaining skills while they work and increasing their capacity to earn an income. The EPWP covers all spheres of government and State owned enterprises. The programme has been divided into four sectors: environment and culture, social, economic and infrastructure, each consisting of a number of government departments with one department nominated to lead each sector. The National Department of Environmental Affairs and Tourism (DEAT) leads the environment and cultural sector. Their Social Responsibility Programme (SRP) operates under the auspices of EPWP. The main objectives of the labour intensive EPWP are job creation (mainly through temporary employment) and skills development. Criteria for the allocation of DEAT's SRP project funds include, amongst others, the following: Community wages should comprise a minimum of 30 % of the project budget, 90 % of the employed people should be local, 60 % should be women, 25 % should be youth, 2 % of jobs should be reserved for people with disabilities and 10 % of job days should be dedicated to training. This has resulted in a plethora of sub-programmes that combine the objectives of poverty relief and ecosystem restoration including: Working for Water, Working for the Coast, Working for Woodlands (including a successful restoration project in heavy degraded Sekhukuneland in the north of the country), Working for Wetlands, Working for Fire, a National Botanical Gardens development programme, and a South African National Parks programme to name but some. Many of these programmes also have an important awareness raising and educational dimension. Two particularly interesting subprogrammes which are having positive impacts on regulating services as well as creating income opportunities are presented in Boxes 55 and 56. These could also be considered as a type of PES scheme (see Section 4.8.2.1 above).

A similar approach is being used in Namibia to deal with the problem of bush encroachment. Opportunities are created through both bush clearing and charcoal production (with the charcoal being certified by the Forest Stewardship Council). It is believed that there is much potential to expand this programme (in-country consultations).

Box 55: Working for water

In recognising that biodiversity is probably the key supporting service which underpins nearly all other ecosystem services that are beneficial for human well-being, there is much international commitment to arresting declines in biodiversity. The benefits of doing so are readily apparent in the restoration, provision or protection of the other ecosystems services. However, if the actual process of addressing the decline (rather than the outcome *per se*) is also approached within a poverty alleviation paradigm, there are then double benefits to poverty alleviation. This is the approach adopted by a number of programmes in South Africa, which have been purposefully designed to simultaneously meet both conservation and poverty alleviation goals. The first, and largest of these is the Working for Water programme.

The programme was borne out of the recognition that invasive alien plants are a serious threat to the biodiversity and water resources of South Africa. Approximately 8 % of the land area is invaded by such plants, and they consume approximately 7 % of the mean annual runoff. This is a significant amount for a semi-arid country where water is a valuable commodity. Consequently, a programme was launched in 1995 to attempt to arrest and ultimately reverse the spread. However, the vision was to do so by using local skills and labour, and so contributing directly to poverty alleviation. Thus, the primary objectives were (Binns *et al*. 2001):

- The enhance water security
- To improve ecological integrity
- To restore the productive potential
- To invest in the most marginalized sectors of South African society

To date approximately 1.5 million hectares of invasives have been removed, through teams working on 300 projects around the country. There are numerous studies showing increased water yield in catchments, and others regarding the return of indigenous species (Binns *et al*. 2001). It has provided 20 000 jobs to local people. There is a strong commitment to training, with most workers attending several courses per year (the target is 24 days per year), in a range of skills that enhance their ability to undertake the clearing operations, as well as employability later on. There are also a range of life skills training, such as savings schemes, HIV/AIDS awareness, citizen rights, literacy and numeracy, and first aid. There is also a commitment to equity, with just over half of the workers being female, and about 5 % have some form of disability (www.dwaf.gov/za/wfw/ 2007). The annual budget in 2003/04 was approximately R420 million (± US$ 60 million). The total expenditure on the programme since inception is approximately R2.5 billion (US$ 360 million). Despite these impressive achievements, it is anticipated that for the key invasive species to be successfully eliminated the programme will have to continue for several decades to come at current or improved funding levels (Marais *et al*. 2004).

Not only is the programme having immediate benefits for wage employment of rural communities, as well as restoring biodiversity and water yield, it has managed to do so in many areas in a cost-effective manner. At many sites (but by no means all), economic models of the benefits of the improved water yield have been shown to greater than the costs of clearing (Binns *et al*. 2001). Moreover, secondary industries are been initiated based on the wood and bark of the cleared invasives, such as small-scale charcoal or furniture making enterprises.

A key challenge is the fact that the work is only temporary and little is known about how contractors fare once they exit the programme. People are exiting into a situation of very high overall unemployment. WfW has recently commissioned a study to explore what has happened to contractors once the programme has moved on (in-country consultations).

Box 56: Subtropical Thicket restoration – an example of a PES and a job creation (EPWP) intervention

Mike Powell (Rhodes Restoration Research Group)

The Subtropical Thicket biome is centred largely within the Eastern Cape Province, and has recently received extensive classification and mapping. This has provided new insights into its ecological functioning and degradation. Prior to colonial settlement the intact vegetation was characterised by a low, dense, evergreen (often impenetrable) canopy of spinescent and succulent shrubs and trees. Vines, creepers, dwarf succulents and bulbs are also abundant, with overall plant endemism in the region of 20%. Degradation of the vegetation has largely been effected through unsustainable pastoral practices, culminating in a staggering 42% of the land area being severely degraded, producing a highly altered state with a loss of phytomass, carbon stocks and species diversity. These degraded states approach classical desertification and many thicket types have poor levels of resilience and remain in these altered states of lowered productivity indefinitely. The rural agricultural economy has been in gradual decline for a number of decades resulting in a steady exodus of farm workers and their families to urban centres. Unemployment levels in the region are critically high with some 41% of the active work force unemployed. Furthermore unemployment levels have been increasing at a rate greater than population increase. In 2002, nearly 24% of the population was surviving on an income of less than $2 per day – a further 10% on less than $1 per day. It has also been shown that the highest rates of poverty occur in the non-white agricultural sector of the economy.

The carbon trading economy provides a financial opportunity to restore the lost natural capital on the landscape, thereby improving the delivery of ecosystem services. Intact or non-degraded Subtropical Thicket has been shown to store remarkably large volumes of carbon (~250 t C ha^{-1}). Degraded areas have typically lost nearly half of these landscape carbon pools. Many thicket types (especially the xeric forms) have *Portulacaria afra* (spekboom) as a canopy dominant species – upwards of 50% canopy cover. Research has shown that this succulent tree can be propagated en masse in field, with no aftercare, resulting in carbon accrual rates of 4 t C ha^{-1} yr^{-1}. In accordance with the Clean Development Mechanism of the Kyoto Protocol, reforestation of these degraded areas with the missing species (principally *P. afra*) will qualify for carbon credits. Current small stock farming in the region provides gross incomes of approximately R150 per ha^{-1} yr^{-1}. Although the carbon economy is far from stable yet, it is feasible that income from carbon credits could be 3-4-fold more profitable than livestock farming. Current livestock farming is typically a non-intensive labour land use form, except for during seasonal peaks (sheep shearing for example). The major plus with restoration is that it is a highly labour intensive activity and will provide vast numbers of permanent jobs and skills. With severely degraded Subtropical Thickets totalling around one million hectares, the employment would be secure for 30-50 years or more. Typically a contractor team of 10 people would restore around five hectares on average in a 20 day work cycle. Restoring the one million hectares at a restoration rate of 42 person days per hectare provides the opportunity for 42 million workdays! An added benefit for post-restoration would be the wider variety of opportunities for sustainable forms of land use (game farming, hunting, eco-tourism, and pastoralism). Thanks to the restored natural capital and greater carrying capacities – more work opportunities will be created.

The programme has a strong focus currently on carbon sequestration as a key ecosystem service. Without the suitable soil fertility (soil carbon included), most other ecosystem services will be severely retarded. It is noted that baselines and quantifying the other ecosystem services (water, pollination, biodiversity, etc.) is required and needs urgent attention.

Currently the project has operational scale restoration projects in the three megareserves of the Eastern Cape (Baviaanskloof Wilderness Area, Addo National Park and Great Fish River). Trial plantings are planned in 300-400 ¼ ha plots across the biome to account for the influence of biotic and abiotic gradients on *P. afra* mortality and carbon accrual rates. The vision for the project was to upscale and to mainstream the restoration to the private landowners as fast as possible. When the programme becomes main stream - i.e. profitable for farmers to restore the degraded rangelands, unemployment should be vastly reduced in most of the rural villages and towns in the xeric forms of Subtropical Thicket.

The South African government is committed to the redistribution of 30 % (nationally) of agricultural land by the year 2015. A real danger exists that the recipients of this process (lacking agro-ecological understanding) will be inheriting ecologically bankrupt estates – with minimal chances of long-term financial or ecological sustainability. With the appropriate level of government support, restoration (via the carbon economy) can provide the financial capital for restoration (effected through job creation), allowing time for the new landowners to acquire the skills and training needed to become proper farmers.

A number of major implementation challenges exist for the project:
- Economic equity with the funding of restoration. Currently the carbon economy provides the environmental degrader with the financial rewards for depleting the inter-generational natural capital. The landowners who have stocked sustainably and retained their natural capital receive no payment. A policy vacuum exists.
- Institutional frameworks and carbon sequestration permanence in communal lands.
- Securing interdepartmental cooperation and accountability. The implementation of the Conservation of Agricultural Resources Act is crucial to ensure post-restoration natural capital is not depleted. Sustainable farming guidelines and the monitoring of stocking rates is vital.
- Securing an improvement in the quality of life for the workers (equity sharing from investors and landowners).

Research challenges include:
- Predicting *P. afra* mortalities temporally (annual climatic factors) and spatially (environmental correlates).
- Establishing assembly rules and restoration protocols for biodiversity credits.
- Quantifying water security and water quality benefits from the restoration of degraded sites.
- Quantifying the variability in carbon stocks across 112 Subtropical Thicket types and the abiotic gradients within each (slope, aspect, catena position, soil type, rainfall regime, etc.).

4.8.4.2 South African Water Act 1998: a successful policy intervention

The South African Water Act has paved the way for similar water acts in numerous countries in Africa. It is founded on the principles of equity, sustainability and efficiency (“some for all for

ever"). The law seeks to redress the results of past discrimination as well as provide for future generations. It promotes access to water as a basic human right and aims to provide 25 l of safe water within 200 m of the home for all South Africans, sustainability by protecting aquatic ecosystems through ecological reserve requirements (Box 57) and resource protection measures and efficiency through water allocation and pricing strategies. As a social contract the Act allowed South African Water authorities to define an ecological reserve for each catchment across the country by weighing the trade-offs between human needs and aspirations and ecological integrity (adapted from van Jaarsveld *et al.* 2005).

Box 57: Interventions in water management: the Reserve and River Management Class

The main legal instrument for protecting South Africa's water related ecosytems is the Reserve (Republic of South Africa, 1998). The Reserve is made up of two components: the Basic Human Needs Reserve (BHNR) and the Ecological Reserve. The BHNR ensures that all South Africans have the right to a basic amount of potable water of (normally taken to be 25 litres per day) for their personal use: drinking, cooking and personal hygiene. The National Water Act of 1998 defines the Ecological Reserve as "the water required to protect the aquatic ecosystems of the water resource" (NWA Chapter 3, Part 3).

The purpose of the Ecological Reserve is "to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource" (Republic of South Africa, 1998 definitions and interpretations). The Ecological Reserve therefore aims to protect ecosystem services that benefit humans. This is achieved through recommending a flow regime that meets the requirements of aquatic and riparian organisms in terms of quantity and quality, taking into account natural variability. This also acknowledges the relationship between flow and habitat and recognises the importance of floods in maintaining the dynamic nature of riverine ecosystems. The Ecological Reserve is determined separately for rivers, wetlands and estuaries.

The level of the Reserve depends on the Management Class of the river, determined through the National Water Resource Classification System (DWAF 2006). The classification aims to balance the level of ecosystem protection with the need to develop the water resource for economic and social good. It is the intention that catchment communities should be involved in this process as stakeholders who can have input into decisions regarding trade-offs between protection and use of the water resource. Where the social good is closely dependent on ecosystem services there is strong justification for applying a high level of protection. It is important, however, that water resource managers identify the needs of poorer, marginalised communities with respect to ecosystem services, because their voices are often drowned out by those of more powerful stakeholders, such as commercial irrigators and industrialists.

4.8.4.3 Multi-stakeholder planning processes: People centred, reality grounded plans for land and ecosystem management at regional and landscape scale

There are a number of land use planning processes in the different countries of the region that attempt to merge the requirements for human and infrastructural development with environment constraints and biodiversity conservation. Significantly these are based on (i) the involvement of multiple stakeholders and consultations throughout the process and (ii) a good understanding and communication of the value of major ecosystem services. These two facets allow early identification of trade-offs and informed decision-making in terms of understanding the real and full costs and benefits of development proposal and actions. Examples include the Cape Action Plan for People the Environment (CAPE) in South Africa, community landuse plans in Botswana under the Indigenous Vegetation Project (see Box 21), the Subtropical Thicket Ecosystem Programme (STEP) in South Africa (see Box 58), and CAMPFIRE in Zimbabwe. In Botswana, the Dept of Wildlife and National Parks recently launched a project to strengthen conservation, sustainable use and mainstreaming of biodiversity resources into economic development plans, based on institutional reform and local livelihood opportunities. South Africa's Integrated Development Planning (IPDs) process at municipal level holds promise too, but is relatively new and suffers from a lack of expertise at municipal level able to communicate and highlight the importance of ecosystem services within overall development plans (Sowman *et al*. 2002).

The involvement of stakeholders is vital, but poses challenges when opinions or needs are not uniform and that the process seeks to simultaneously optimise more than one goal. An important feature of multi-stakeholder processes is that consensus decisions and trade-offs frequently have to be made on the basis of imperfect knowledge and information of the real situation or status because of (i) complexity of environmental systems, (ii) uncertainty of links and consequences, (iii) variable quality, (iv) the need to combine both qualitative and quantitative information and interpretations and (v) differing value systems to multiple stakeholders. The are

several techniques that have this core structure, including cost-benefits analysis, risk assessment analysis, goal matrices and the like, but one with growing application in the region is Multi-criteria Decision Analysis (MDCA) (Joubert *et al.* 1997, Scott 2005, Linkov *et al*. 2006, Mendoza & Martins 2006).

Box 58: The Subtropical Thicket Ecosystem Planning (STEP) Programme

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The Subtropical Thicket biome forms the south-west portion of the Maputaland-Pondoland-Albany 'hotspot', one of three 'hotspots' of biological diversity located in South Africa (Steenkamp *et al*. 2004). Subtropical Thicket, locally known as valley bushveld, comprises a range of structurally diverse types of evergreen, spinescent and semi-arid vegetation which typically lacks easily identifiable strata, and a grassy or herbaceous groundcover. It most often comprises a network of inter-connected bush-clumps, sometimes within a matrix vegetation resembling adjoining biomes. It contains high numbers of endemic plant species (20 %), many of which occur along ecotones where Subtropical Thicket meets adjoining biomes (Vlok *et al*. 2003). In contrast, faunal endemism is low. Land-use is dominated by commercial small stock pastoralism (i.e. goats and sheep), along with eco-tourism which occurs across extensive areas of private game reserves (e.g, Langholz & Kerley 2006). Hunting of indigenous ungulates is also an important industry. Irrigated cropping and forestry occurs across small areas along the regions many rivers. Approximately 70% of the Subtropical Thicket biome has been described as moderately to severely degraded (Lloyd *et al*. 2002), and significant vegetation has been cleared, particularly along the coast for development.

In response to this rapid and extensive destruction, the Subtropical Thicket Ecosystem Planning (STEP) Project was initiated in July 2000. Phase One was funded by the Global Environment Facility through the World Bank. It aimed to raise awareness of the plight of the Subtropical Thicket biome and to present a strategy for its conservation. "*Living on the land in living landscapes*" – the project motto – captures the objective of the STEP Project to meet the dual aims of nature conservation and sustainable livelihoods. It included development of 1) an operational model for regional conservation planning (Knight *et al*. 2006), 2) a public participation programme to engage key implementing organizations, 3) a systematic conservation assessment to design priority conservation areas (Rouget *et al*. 2006), 4) an implementation strategy, inclusive of its mainstreaming (Knight *et al*. 2003), and 5) conservation planning products (i.e. maps and a handbook), inclusive of training, to improve land-use decision-making, thereby ensuring the retention of nature in priority areas (Pierce *et al*. 2005). Phase One concluded in December 2003.

Phase Two – the implementation stage – began in January 2004, marking the transition of the STEP Project from an externally-funded, short-term project to an on-going programme. Responsibility for the implementation of the STEP Implementation Strategy was assumed by the Bioregional Planning Directorate of the South African National Biodiversity Institute (SANBI), supported by the Eastern Cape Department of Economic Affairs, Environment and Tourism (DEAET). Implementation activities were focused upon the mainstreaming of the STEP planning products, the enabling (i.e., training) of land-use decision-makers and consultants to apply these products (e.g. Pierce *et al*. 2005, Pierce & Mader 2006), the strategic implementation of proactive conservation initiatives, particularly throughout the Fish-Kowie STEP Corridor (one of seven priority corridors identified by Rouget *et al*. 2006), and the formation and support of social learning institutions which promote these processes (e.g. Knight & Cowling 2006).

The STEP Project conservation planning operational model (i.e. the project structure) was explicitly designed to integrate the diverse suite of processes required to effectively deliver conservation action on-the-ground. Fundamentally, it linked the scientific activities of spatial prioritisation of sites important for achieving conservation goals, with the normative activities of strategy development. The outputs were then supported with processes for mainstream, enabling and implementation. The aim was to achieve consilience – the fusion of knowledge traditions (Wilson 1998) – throughout the activities of the STEP Project.

Box 59: District Environmental Action Plan process in Zimbabwe (Source: in-country consultations)

An intervention that was felt to be positive in Zimbabwe was the District Environmental Action Plan process that had been funded by UNDP and implemented through the Ministry of Environment, with linkages to the district Strategy Teams of the Ministry of Local Government. This had aimed to mobilise communities to identify their own problems and priorities and develop action plans to address these. Donor timeframes were felt to have had a negative impact on the participatory methodologies and ultimately to have resulted in the stalling of the process. A further issue was the need to have a wider-ranging and more integrated programme, which could link up with other actors to address identified priorities and provide alternatives. However, funding ended before there could be any actual implementation.

4.8.4.4 Natural product commercialisation: Creating opportunity through markets

Natural product commercialisation is seen as a way to link sustainable natural resource management and livelihood improvement, and often forms a part of larger CBNRM programmes. In most parts of the region rural people, and women in particular, have traded in a wide range of

natural products for decades, primarily in local markets (see Section 4.2 – Natural Products). Some of these products such as woodcarvings and craft have been adapted for external tourist markets providing producers and traders with additional sources of income, while urbanisation is resulting in the further expansion of markets for numerous products especially traditional medicines and fuelwood/charcoal. Thus, in many areas a vibrant local and regional trade in natural products exists. This provides the foundation to build on existing activities and develop new initiatives.

An area with high potential, and that is receiving increasing attention in the region, is the new emerging market for certified natural product derivatives used in the health, food and cosmetic industries. The trend in consumer demand for organic, ecologically sustainable, socially responsible and fair traded products is resulting in greater interest by private sector industrial companies in some of the more high value products, and the possibility of working directly, or through intermediary partners, with local groups of producers and processors. This opportunity has been recognised by a number of NGOs in the region including PhytoTrade (Box 60), CRIAA in Nambia, IUCN in South Africa, and Veld Products in Botswana. Products sold in these markets provide greater opportunity for local value-addition than many traditional products. The cases of the Kalahari plants, *Hoodia* and *Harpagophytum*, have already been discussed in Section 4.1 (Natural Products).

Box 60: Tapping new markets: PhytoTrade Africa's approach to natural product commercialisation

Lucy Welford, PhytoTrade Africa

PhytoTrade Africa (www.phytotradeafrica.com) is the Southern African Natural Products Trade Association. Since its inception in 2001, PhytoTrade Africa has been committed to its objective of improving rural livelihoods through developing a sustainable natural products sector in Southern Africa. PhytoTrade works with over 50 members in southern Africa (Botswana, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia and Zimbabwe), who in turn work with tens of thousands of rural natural products producers in the region.

PhytoTrade Africa has developed environmentally sustainable and ethical supply chains for natural cosmetic and food ingredients that are wild harvested from indigenous plant species found across southern Africa. The association is currently researching over 300 species of useful plants, but focal species include manketti/ mongongo (*Schinziophyton rautanenii*), baobab (*Adansonia digitata*), sausage tree (*Kigelia africana*), kalahari melon (*Citrullus lanatus*), marula (*Sclerocarya birrea*), mobola plum (*Parinari* spp.) and sour plum (*Ximenia* spp). Categories of products produced include herbal teas, essential oils, gums and resins, lipid oils, fruit pulps and a variety of botanical raw materials and extracts.

With training and capacity building from PhytoTrade Africa, and utilising both internal audit measures and external Fair Trade and environmental and organic certification schemes, association members are able to assure industry of reliable supply chain management and adherence to strict quality control measures. PhytoTrade's members supply industry with products for the nutraceutical, phyto-medicinal, botanical, flavour and fragrance, herbal remedy, dietary supplement, functional food, cosmeceutical and personal care industries. In order to so this, the association develops commercial opportunities on behalf of its members based on partnerships with commercial companies in key natural products markets. This involves not only developing long-term trusting partnerships with international commercial companies, but also ensuring that strong legal and technical agreements are in place. Commercial partnerships are based on a sound approach to both market and product development that demonstrate meaningful financial and technical commitment by both parties.

To measure its impacts, PhytoTrade is planning studies on a range of social and environmental issues associated with natural product commercialisation including sustainable harvesting, the nature of the relationship between companies and community producers, and whether the nature of the business model/institution affects poverty benefits.

As with other promising interventions a number of challenges exist. Firstly commercialisation does not necessarily result in more sustainable natural resource use and in fact the opposite may happen, particularly where this process is self-driven and poverty is rife. More attention needs to be given to promoting the sustainable harvesting of a wide range of products. Where commercialisation is externally driven, particularly by the private sector, issues of royalties for intellectual property, equity and benefit distribution become relevant (Wynberg 2006). Good policies/strategies on intellectual property rights and benefit sharing are required. Most countries in the region do have such strategies in place but government oversight and enforcement is often weak. In general, natural product markets are poorly recognised and underdeveloped. Natural product commercialisation, for local, national and international markets, needs to be given more attention by governments and seen as a viable landuse and rural development

option that can link ecosystem services with poverty alleviation (Madzwamuse *et al.* 2007, Appendix 2 - Case Study 7).

4.8.4.5 Community-based natural resource management (CBNRM): An important approach in southern Africa

Launched over two decades ago, community-based natural resource management (CBNRM) has been the key intervention for the conservation and management of natural resources in communal areas across the southern African region (co-management initiatives on State owned land or People and Parks programmes are also sometimes included in the definition of CBNRM but are not discussed here) (IRG 2007). Zimbabwe (CAMPFIRE), Botswana (Wildlife Management Areas) and Namibia (Communal Area Conservancies) have the largest CBNRM programmes, established in 1989, 1992 and 1996 respectively (Arntzen *et al.* 2007) Initially, CBNRM focused primarily on wildlife management, but efforts are now being made to expand this to include other resources. In Mozambique and South Africa the emphasis has tended to be on forests rather than wildlife (in South Africa there are no few communal areas with meaningful wildlife populations outside of parks). Generally, the gains from wildlife (from which rural communities were historically alienated) are more favourable in creating incentives than other natural resources that in many cases communities are already using (Arntzen *et al.* 2007).

CBNRM is founded on the principle that if a resource is valuable and land holders and resource users have effective rights to use, manage and benefit from it then sustainable use is more likely to ensue. CBNRM initiatives thus aim to achieve improved conservation and governance of the region's commons by devolving rights and management responsibilities to the local level, integrating local knowledge, providing economic (and other) incentives that improve livelihood outcomes for local people, and building institutional capacity. In most countries economic incentives are linked to tourism and trophy hunting (see Section 4.4.2 – Tourism) although revenues are also derived from the sale of forest, veld and game products, and increasingly ecosystem services. Over the years, the rural development and poverty alleviation dimensions of CBNRM have gained more prominence with most programmes now working harder at trying to achieve the dual goals of conservation and development (Arntzen *et al.* 2007). The importance of implementing CBNRM as a multistakeholder, participatory process has been repeatedly stressed by practitioners.

CBNRM has had positive impacts in several spheres including:

- the development of new policy and legislation that provides communities with more secure rights and benefits over natural resources,
- empowerment of disenfranchised groups,
- improved organisational capacity at the local level and better, more democratic, local governance,
- financial benefits at community and household level,
- livelihood diversification and reduced vulnerability,
- employment, and
- improvements in biodiversity and the resource base, breaking the downward spiral of poverty, resource dependence and degradation (IRG 2007, Box 64) But, there are still many challenges and not all initiatives have been successful - sometimes because the geographical location and ecological and socio-economic environment is not suitable for such an approach.

CBNRM has been criticised for

- delivering marginal benefits that do not fully compensate for the costs of living with wildlife,
- favouring elites,
- paying lip service to participation,
- restricting rights to some resources,
- failing to transfer real power and decision making,

- neglecting traditional knowledge and management mechanisms (i.e. eroding cultural capital), and
- failing to contribute effectively to the combined goals of conservation and development.

Other problems have included financial mismanagement, particularly in Botswana, reliance on external donor funding and limited self-sustainability of projects, poor local capacity and insufficient backstopping or mentoring, and unfair/uneven sharing of revenues between the State and communities that reduces the incentives for local management. In terms of the latter, the new CBNRM policy in Botswana requires that 65 % of revenues are returned to the State where they will be put in a trust at central government level (to which contributors may apply for project funding) - a move, thought by many, to be a step backwards (in-country consultations). In the CAMPFIRE programme in Zimbabwe, District Councils have often been lax at passing on, or have even deliberately withheld, the community's share of revenues. This has recently been challenged by affected communities and some revenues are now going directly to wards (in-country consultations).

Thus, while CBNRM is a promising approach (Box 61), there are many areas that still need improvement and more information is required on the economic and poverty alleviation impacts of CBNRM. Indeed, many feel that the link between CBNRM and poverty reduction is not firmly established. Recognising this, and the fact that CAMPFIRE has contributed mainly to improving community infrastructure rather than tacking poverty *per se*, the programme has recently introduced several innovations to achieve greater poverty alleviation at household level. In 2006, a scheme was piloted to support this reorientation. Guidelines were developed to set up a micro-credit revolving facility to support natural resource-based projects such as guinea fowl rearing, fish breeding and medicinal gardens. This has now begun in the Mbire District (formerly Guruve) in the north of the country, which is institutionally strong. A project for providing direct benefits to communities will also be started in 2008. To mainstream gender and HIV/AIDS, guidelines have been developed re who benefits first from the micro-credit facility – for example, widows and orphans are to get first priority (in-country consultations).

Box 61: Conservancies in Namibia (adapted from WRI 2006, Arntzen *et al.* 2007)

The communal area conservancy programme in Namibia is often put forward as an example of an intervention that successfully links ecosystem services and poverty.

Wildlife conservancies, covering hundred of hectares, are run by elected committees of local people, with technical and capacity support from government and NGOs. As a result of these conservancies wildlife populations are recovering and there has been a positive impact on household welfare. Communities are benefiting from income from hunting and tourism, jobs, new skills and empowerment, craft markets, community infrastructure and game meat (the latter being important in food security). Since 1998 some 95,000 people have received some form of benefit. In 2004, the UNDP recognised Namibia's Torra Conservancy by awarding it the Equator Initiative Reward for their work in using biodiversity to tackle poverty issues. There are, however, *still numerous challenges* such as ensuring equitable distribution of benefits, balancing individual and community benefits, involving and benefiting more marginalised groups such as women (although progress is being made), integrating with other natural resource/ecosystem service sectors, providing sufficient income/incentives for households to forego other land use options (presently CBNRM tends to be an additional source of livelihood - and sometime a cost to other livelihood strategies - and can only replace agriculture in areas with abundant high-value wildlife or amongst employed households), dealing with the individual rent seeking behaviour of stakeholders, and the need for constructive joint venture partnerships with the private sector.

The CAMPFIRE programme in Zimbabwe has had similar results and faces similar challenges.

In terms of research on the poverty impacts of CBNRM, there has been little contextualisation of these and therefore the evidence to convince policy and decision makers that CBNRM is a viable approach for poverty alleviation is weak. For example, household dividends could be compared with the poverty line, local wages, the minimum wage or agricultural income; employment creation could be related to the number of local households or unemployment figures; the income share contributed by CBNRM could be assessed relative to other household income streams (Arntzen *et al.* 2007). Moreover, baseline assessments are rare, making it difficult to evaluate the outcomes of a project/programme. More effort thus needs to be made to determine how people's lives have changed after the introduction of a CBNRM programme.

4.8.4.6 Local level community responses and adaptations to ecosystem change: Building on local innovation

Members of local communities are not passive recipients of ecosystem change. They constantly find ways to cope and adapt, using their resourcefulness to make ends meet despite low levels of capital assets (Campbell *et al*. 2000, Box 62). Continual adaptive and opportunistic adjustment is thus part of life in arid and semi-arid regions as highlighted in the following quote from a semi-arid savanna area in Zimbabwe: "Rural economies and societies appear as a shifting kaleidoscope of activities, household types, conflicts, alliances and manoeuvres" (Campbell *et al*. 2002).

Box 62: Resourcefulness of poor rural dwellers (quote from Mike Mortimer in Frost *et al*. 2007)

"There are solid grounds for regarding resource managers, even poor ones, as autonomous, responsible, experimental and, through risk averse, also opportunistic. Constraints, not ignorance, deter poor households. It follows from such an opportunistic interpretation that they don't need to be cajoled, pressured or motivated but offered choices of technology or mode, access them, information, experience and the enabling economic environment that makes the effort worthwhile".

Examples of local responses and adaptations recorded across the region include an increase in home-gardens, use of rain water tanks, income diversification, a return to traditional foods and livestock breeds, adjustments in local rules, transhumance, shifting of species preferences for specific uses, substitution of some natural resources – e.g. building materials, new social networks, to name but some (Appendix 2, Case Studies). Frequently trade-offs are evident in terms of immediate short-term 'survival' responses (such a natural product commercialisation with little regard for the resource base) versus more long-term sustainable responses (Box 63).

Box 63: Local responses and adaptation to change in Mount Coke, South Africa (Appendix 2, Case Study 3)

Local residents in Mt Coke have responded to ecosystem change by employing a number of short-term coping strategies and more long-term adaptive processes.

Short-term coping strategies have included technological adaptation (e.g. investing in rainwater tanks during drought); shifting preferences to faster growing and more abundant species (e.g. *Acacia karoo)*; drawing on social networks (e.g. sharing food during 1982 and 1992 droughts); and turning a blind eye to rule breaking (e.g. during the 1990 political crisis).

Long-term adaptive responses have included: investing in diversity (e.g. multiple sources of income, food and livestock); ensuring flexibility (e.g. in resource boundaries, preferences, the role of women in food production); internalising ecosystem change (e.g. slow growing species like sneezewood not even mentioned in preferences), keeping options open (e.g. maintaining and letting go of taboos).

Given the responsiveness of local people to changes in their environment, it is critical that external interventions build on what they are already doing for themselves. This has been identified as a key success factor in much of the literature (see Box 61 above).

While the above 'best practice' examples look optimistic there is still in most cases inadequate data to quantify and value their ecological, social and economic impacts both on and off-site. For example, as alluded to above, it has been argued that the poverty benefits of CBNRM have not yet been clearly demonstrated and in some cases are even questionable. On the other side of the coin, the poverty relief restoration programmes in South Africa have been relatively effective in measuring and demonstrating poverty impacts but, other than for Working for Water, there is less evidence of their environmental benefits with this aspect appearing to have little emphasis in terms of the deliverables required by the programme (L. Olivit pers. comm.). These areas are major research gaps that need to be addressed.

4.8.5 Generic features that contribute to effective interventions and the management of trade-offs

As is described above, there is a wide range of different types of inventions, operating at different scales in different contexts, and championed by different agencies. Consequently, there

are limited generalities that can be drawn. Nonetheless, some oft encountered attributes of successful interventions include:

- Supportive and enabling policy environment.
- Adequate knowledge for improved decision support.
- Underlying causes/drivers as well as outcomes of ecosystem change addressed.
- Local knowledge and innovation acknowledged and built on.
- Integration of complementary actions across scales, actors and spheres/ coordination across sectors and scales.
- Good understanding of the related issues of risk and vulnerability as key to improving human well-being.
- Participation of multiple stakeholders and transparency.
- Local priorities recognised and accommodated.
- Strengthened local rights to resources.
- Longer time frames for implementation (10 years or more).
- Awareness raising amongst and capacity building of all stakeholders.
- Strengthened local institutions and recognition of endogenous institutions.
- Inclusion of the private sector can facilitate some interventions.
- Substantive infusion of capital to ensure projects are large enough to address the complexities that exist.
- Appreciation of the complexity of coupled social and ecological systems.
- Approaches that build on the mutually reinforcing relationships between components of these complex systems to create synergistic effects.
- Flexibility and responsiveness to changing ecological and socio-economic environments (see Box 61) – see the intervention as a social learning process.
- Enhanced adaptive responses (see Box 62).

4.8.6 Regional initiatives that share objectives with EPSA

The IUCN Regional Programme on Drylands and Livelihoods represents a regional intervention that is addressing the same content and geographical areas as the proposed DfID ecosystem services for poverty reduction programme, as described in the box below. It would be important to look at synergies between the two programmes and explore possibilities for partnership actions.

Box 64: The IUCN Regional Programme on Drylands and Livelihoods

This programme aims to explore the relationship between poverty and natural resource use and management, and to implement interventions to address the underlying causes of degradation and poverty in dryland areas of southern Africa. The priority countries for the Drylands Project are Zimbabwe, Botswana, Namibia, South Africa and Lesotho. The programme was initiated in 2005 and work has recently begun on developing the 2009-2012 programme phase and fundraising for it. Work completed includes a drylands valuation case study in Botswana, five case studies linking CBNRM to the implementation of the UNCCD, and some policy work on the UNCCD. Areas that will fall under the umbrella of the programme include: land tenure and security of tenure, access to natural resources, studies to demonstrate the value of drylands ecosystem services, improving the status of knowledge of biodiversity in drylands, exploring how climate change will affect drylands livelihoods strategies, and appropriate technology for dryland management.

Further examples of regional interventions were the basin-wide forums for the management of transboundary rivers, involving civil society. One of these has been set up to mirror OkaCom at the grassroots level, and similar structures are proposed for the Zambezi and Limpopo catchments too.

4.9 CAPACITY GAPS

An important consideration for the situation analysis is the capacity of local, national and regional institutions to mange ecosystems to deliver services for the poor. The term ‘capacity’ is here used to denote more than just the availability of human resources but also the existence of

the necessary skills, awareness, and motivation, as well as logistical support to allow the skilled people to do their job in an efficient, well-planned and cost-effective manner which fulfils key mandates in terms of social responsibilities, long-term planning and sustainability. Challenges noted with capacity levels in Africa generally include: its supply-driven nature, skills limitations, inadequate local financial management systems, inappropriate administration procedures and a lack of effective coordination (Ministry of Local Government, 2005; ILO, n.d.). Issues of capacity need to be seen within the context of widespread incidence of decentralization initiatives in southern Africa, which have devolved new responsibilities to lower levels of government which often lack the capacity to take on board new mandates (Selman 1998, DEAT 2006).

Key to strengthening government capacity for policy development is a suite of attributes identified by the United Nations (1995) (Table 39). By implication, the absence or limitation of any or all of them will indicate capacity shortfalls.

Table 39: Different elements of human resource capacity (adapted from UN Secretariat 1995)

Capacity	Attribute
Knowledge of the subject	adequate basic knowledge of the subject area
	integrate different knowledge systems
	eagerness to continually learn
	apply critical thinking to knew knowledge
Appreciation of the bigger picture	think in grand strategies
	understand and learn from historical processes
	adopt a systems approach
	rationally prioritise critical choices
Plan proactively for the medium & long term	question, innovative, and design better options
	project planning and monitoring of outcomes
	undertake future planning
	focus on institutions, legal frameworks and regulations
Respond to pressing and overarching inequities	have concern for resources
	adopt moral reasoning
	act in a non-political fashion
	adopt societal related thinking
Reaction to change and uncertainty	proactively plan for unexpected changes
	implement short-term crisis management

Capacity not only relates to the availability and abundance of the quality and quantity of human resource skills, but also to the institutional organisation, motivation and deployment of those skills, along with the logistic resources of equipment, vehicles, and operating budgets. A number of key aspects relating to capacity to manage ecosystem services were identified during the in-country consultations which are discussed below (it is of note that there is limited information on capacity within the literature). Anonymous direct quotes by interviewees are presented in italics.

4.9.1 Improving policy and institutional environment

While many participants in all of the countries noted many serious capacity constraints, it is important to balance this with what many also saw as a growing will for stronger environmental governance (see Section 4.8.1). This has been indicated by the introduction of environmental impact assessment (EIA) regulations – for example the EIA Policy introduced in Botswana in 2005 - and positive institutional restructuring in a number of countries. Examples of the latter

include the creation of the Department of Environment and the re-orientation of the Ministry of Wildlife and Tourism in Botswana into the Ministry of Environment, Wildlife and Tourism; and the creation of the Environmental Management Authority in Zimbabwe.

In Zimbabwe, there have been several positive developments in terms of the policy and legislative framework, and participants also noted high levels of motivation of some institutional leaders. Institutional development includes the new Environmental Management Authority, and the establishment of a Cabinet Action Committee on Sustainable Development, in response to a recommendation in Zimbabwe's 2004 National Strategy for Sustainable Development. But, in line with other countries in the region, capacity for implementation is still limited. CAMPFIRE and Ward Wildlife Committees are seen as key for implementation of the Environmental Management Act. Zimbabwe does have good regulations, but these are not being enforced, whereas in Mozambique, good law is in place but few regulations.

To capacitate these new institutions and to implement these new mandates systematically and effectively will require additional efforts. Less positively, it has taken the Namibian Environmental Management Act 10 years to go through Parliament – which cannot reflect well on high-level commitment.

4.9.2 Need for greater high-level awareness, understanding and commitment

A fundamental point is that stakeholders in the region feel that levels of awareness, understanding and commitment to ecologically sustainable development amongst high-level decision-makers still need to be improved, despite recent improvements due to bombardment of information about climate change.

> *"There is a trend in the region to try to avoid paying for ecosystem services, governments say they are too poor etc. Until this attitude changes, we will not really have sustainable development."*

However, even were awareness and understanding are strong, there are relatively few who make explicit links between the state and functioning of ecosystems and poverty, other than the land degradation rhetoric. Additionally, several respondents noted that even when awareness was high, competing political agendas could undermine or divert commitment.

> *"Political will? It depends. In some areas the knowledge is available, but it is subject to political considerations – so unless there are short-term benefits, it is unlikely to get acted upon. We humans are poor in detecting the slow changes – like bush encroachment. It happens. Our time frames are too short."*

4.9.3 Limitations of the skills base

Reasonable knowledge regarding poverty and ecosystems services exists in the region, but the skills base is extremely small in most countries. In Botswana, Namibia and Swaziland the numbers of skilled and qualified people are extremely small, linked to their small populations, which translates into limited critical mass to plan, innovate and implement policies and programmes. Thus, the labour pool is very small, for both government and the private sector. This is compounded by the large size of the countries and large distances officials need to travel.

In Namibia, many line ministries, including the Ministry of Environment and Tourism, are seriously understaffed, related to the huge shortage of skilled people. The high numbers of vacant posts in key ministries present a risk for any kind of programme of trying to set up something where there will not be continuity. This is exacerbated by people who do have skills moving around a lot. Frequently, key capacities lie with consultants. The latter very often hold the most detailed information, which does have implications for government institutional memory, and raises important questions about effectiveness of state institutions. CBNRM in Namibia is seen as "an innovative programme that is being implemented by scholar

practitioners" – and therein lies both some of its success as well as source of largely unspoken tensions, some of which may play out on a racial basis, and possibly some resistance. These social and political tensions are important to acknowledge if one wishes to break down barriers to broader uptake and to create more supportive policy environments.

South Africa too has many capacity constraints. For example in the Department of Land Affairs, the main driver of the critical land reform programme, one-third of the staff positions are unfilled, which means that the capability for the department to re-align and do things differently, as the new Settlement and Implementation Support Strategy requires, is very limited. Junior people at provincial level have to deal with complicated processes for which they do not yet have the skills and experience. Similar, the capacity to manage woodlands and the range of non-timber forest products that they contain is limited at provincial and local level, despite some recent improvements at national level. The policy and legislative framework is felt to be good to support action on woodlands – what was lacking previously was management will.

HIV/AIDS was also noted by several respondents as devastating the already small pool of skilled professionals. This also drains the training budgets of departments because of the need to replace the lost skills and experience, as well as results in lack of continuity in planning processes and interactions with communities on the ground (Box 65).

"AIDS is also taking its toll on the workforce. We got two good new people in this department and one died of AIDS at the age of 31 years."

4.9.4. Capacity at the district and local level

Throughout the region, resource limitations at district and local level are the biggest challenge.

Box 65: The impact of HIV/AIDS in southern Africa on the capacity to manage

Southern Africa has the highest prevalence rates of HIV/AIDS in the world. Several countries will experience a decline in human populations over the next few decades, including Botswana and Swaziland, further stressing the already relatively low skills base of these countries.

HIV/AIDS has a number of significant impacts in countries that already have limited formal capacity to manage ecosystem services for poverty alleviation. In particular, there is (Gelman *et al*. 2005, Erskine 2005):

- loss of education and training investment (millions of dollars per year)
- loss of experience
- loss of institutional memory
- loss of networks and partnerships
- loss of worker productivity through illness and absenteeism
- increased financial burden as a result of the above losses

This is exacerbated further by the increased reliance of communities and households on ecosystem services as they too experience the effects of HIV/AIDS. Thus there is greater demand on ecosystems but reduced capacity to respond. For example: the provincial conservation authority in KwaZulu-Natal province in South Africa has lost 9 % of is 3 000 staff to AIDS; "a national fire awareness programme in South Africa lost 10 of its 12 extentionists, and the Wildlife & Environment Society in Malawi has lost 14 % of its 60 staff to AIDS" (Gelman *et al*. 2005). Thirteen environmental managers working in and around Saadani National Park in Tanzania died from AIDS related illnesses in a five-year period (Torell *et al*. 2006).

This includes human resources, vehicles, equipment and fuel. In Mozambique, a number of government ministries have staff at district level, but there may be only one government vehicle in the district, usually belonging to the Ministry of Agriculture. There are significant capacity gaps for skilled facilitators to work with communities on developing integrated livelihood and resource management initiatives. The general situation is one in which extensionists or other local-level workers dealing with water, crops, etc. come in and work with the same communities, giving quite different advice. An integrated approach that puts communities in the drivers' seat is needed.

"The situation is upside down and this is common in most of the countries in our region. You need most of the work done in the rural areas and that's where capacity is most lacking. For instance in the rural District Councils, people have low qualifications and resources are lacking. Most of the resources are at headquarters, and things get worse as you move from headquarters to the province, to the district to communities. The

extension worker has no vehicle. The only time the person from the ground can go into the field is when the person from headquarters comes to the area."

The capability to run projects – including proposal development and project management skills – needs to be developed in national and local institutions, to reduce dependence on external funders and consultants.

Human capacity, finances and equipment are all lacking at the local level in South Africa too, particularly for the crucial community development and facilitation role. South African National Parks (SANParks) only has one People and Conservation person per park, except for Kruger, Golden Gate and Table Mountain National Parks which each have a few. The mandate of these people includes environmental education as well. This means there is insufficient capacity to kick start, or even to facilitate implementation. Problems are compounded by high turnover of staff in key partner institutions, such as the Department of Environmental Affairs and Tourism.

Uneven decentralisation further compounds the skills and human resources shortages at district and local level – for example in Zimbabwe health is decentralised to district level and not to local councils. Mozambique is now placing concerted effort on the district as the level for development and the seeking to improve infrastructure through integrated programmes that result in the districts being seen as attractive places to live. Mechanisms to integrate the role of traditional leaders, formerly the key decision makers about resource allocation at local level, have also not been found. This is discussed further below.

"Why are conservation efforts failing despite more education, more funding, more NGOs, etc? One basic point why this happens is the disintegration of the authority system at the very local level. You have to first address this. There are so many players in forestry management, none of them are locally based, they are at national, provincial or district level. In order to control and conserve natural resources, the policeman should be on the spot, in situ, within the compound. The district can only oversee and monitor. Control should be at the village. The donor or sector institutions that support conservation are all too aloof from the village to make an impact. It's an institutional set-up problem."

There are some signs that things are improving at a regional level in Namibia, with increasing emphasis on broad-based community development officers. This role is sometimes played by NGO staff – for example, regional offices of the Namibian Nature Foundation reportedly play this role.

4.9.5 Lack of integrated planning and management

"There is not a great deal of integration of approaches between Ministries. And Ministries tend to launch projects without any environmental assessment."

"The Ministry of Labour is running the MDG show, the Ministry of Environment is running the WSSD show, and then you have the Macroeconomic Policy Framework. They are not integrated."

Many participants spoke of line ministries still working in silos and the lack of integration. This is not to say that there has been no improvement in this regard, but it does point to an ongoing highly sectoral way of working, which is apparent across the region. Some areas of improvements were mentioned, such as the integrated approach to planning in Ngamiland in Botswana, to develop the Okavango Delta Management Plan. However, the situation where even water supply and management officials do not talk to each other reportedly exists in several countries. The lack of integrated analysis and feasibility studies that move away from a narrow focus is a problem – for example failure to consider environmental impacts has led to pit latrines polluting the aquifer in Ramotswa in Botswana. Wells in this area have now been closed due to the pollution.

In Botswana structures have been developed to improved integrated planning and implementation, most notably for rural people the Rural Development Council, chaired by the Ministry of Finance. This is a high-level structure which includes Permanent Secretaries, as well as NGOs, unions, the private sector, the Botswana Association of Local Authorities, the Botswana National Youth Council, and the Chair of the House of Chiefs. While the structure is

translated at the district level, in the form of the District Development committee, and at the local level, there are some weak links. Extension structures are felt to be problematic, as integration of these structures has been very difficult. There are a range of extension workers that need to be integrated, such as social workers, veterinary workers, etc. A proposal has been made for a Co-ordinating Extension Worker at the district level, who would be an integrator. Currently, participants noted that agricultural extension workers are not doing what they should be, and the system in general is not promoting a developmental orientation.

> *"In a small village in Kgalagadi, the Village Development Committee Chair was forthright, saying 'We have all these committees, but they are here to serve government, not us."*

In South Africa, recent advances include the focus on Inter-Governmental Relations, which is trying to provide a framework for government improving the way to plan together, in order to stretch the limited resources of government to get maximum output. At the local government level the process of Integrated Development Planning is gaining credence, but still remains focussed on infrastructure development rather than holistic integrated planning within a framework of environmental sustainability.

> *"Environment is still a gap for many of us dealing with social and poverty issues. I've never heard much about a link with the environment department."*

Discussions with focal points dealing with poverty reduction and social development did reveal a lack of familiarity with the linkages between poverty reduction and ecosystem services, but also a willingness to engage with these issues. In some cases this related to a growing awareness of climate change and how this may impact on poor people, and in other cases to a realization that as populations grow, the number of welfare grants will increase. As one participant noted, governments are interested in reducing the number of grants and the way to do that was to find other ways to help people.

4.9.6 Capacity in civil society

> *"With the TFCAs, the project is only as good as people's capacity to participate."*

The capacity for local people to manage ecosystems, which was traditionally always there, may no longer be as strong due to complex changes in ecosystems, related to climate change, which have changed the dynamic functioning of ecosystems in ways that may not be understood by communities. Furthermore, there is a need to promote community resilience and build confidence in communities themselves. UNDP in Botswana has an initiative with pilots in seven areas on community-driven development, which aims to increase a community's self-awareness, awareness of the opportunities open to its members, and the resources available to it – which inevitably gets back to natural resources.

In Botswana, participants pointed to the failure of government to adopt an empowering approach towards rural development, and the failure of the NGO sector to develop strongly to fill this gap, due both to a lack of support for NGOs and the nature of those NGOs which do exist, many of which are HIV-focused, or more narrowly conservation focused, with very few rural development specialists and few really enterprise-based. With the NGO sector not really playing its role, communities are largely left alone. There is a need for more active involvement of the 'beneficiaries'.

> *"We leave people behind a lot, there is too much planning at the centre. The feedback systems from the ground up are still not good enough."*

Lack of capacity amongst supportive NGOs is a regional trend.

4.9.6.1 Traditional leadership

In some places sweeping changes in ecosystems services are related to various interventions, such as the land use changes in Zimbabwe related to the land reform process, which have been

exacerbated by the macroeconomic situation. Thus the capacity for communities to reverse changes may be limited, and the resources to assist with this process are also lacking. Traditional leadership institutions have played a strong role in the past in assisting with these kinds of capacities, but these have also been affected. Chieftainship is felt to be stronger in countries like Mozambique, Zambia and Malawi than Zimbabwe, where political linkages have become stronger – although the quote below offers a different perspective on this. One area suggested for capacity building with respect to local-level natural resource management is to bridge the gap between the political and traditional institutions.

> *"When you talk about local environmental governance in Zimbabwe, the local traditional institutions in the communal areas are still intact. But they are being let down by the overall governance framework. When you move into the areas where new farmers are being settled, there is anarchy. Who is in charge: the best commander? The newly appointed traditional authority? Where do they derive their authority from – a permit or letter from the Ministry?"*

This quote points to the need to harmonise the dual system of governance in rural areas – traditional and 'democratic'. There is no longer any time for ambiguity on this. Positions need to be clearly defined to reduce conflicts and improve enforcement (von Maltitz & Shackleton 2004). Degradation is directly related to lack of clear authority and the breakdown of the traditional sanctions system.

> *"In my area, the incidence of fires has gone down. People come to me complaining of fires, and I tell them to find the culprit and fine him a goat. If the village does not know who caused the fire, the Village Head will have to pay the fine, so the whole village will have to contribute to this. This approach has worked wonders ... you need to throw the challenges back to the people directly."*

4.9.7 Capacity for monitoring

> *"We haven't inventorised our resources, we don't know the potentials, the limits, etc. We need to ground truth SAfMA. It was pioneering – but if you pioneer, you don't do it. It is high time we did it now. "*

The lack of monitoring of the use of natural resources and impact on ecosystem services and/or poverty is a significant regional issue, which affects the ability of managers to track trends and to respond effectively and timeously to them. Improving monitoring will require additional skilled human resources, equipment, vehicles and fuel, and updated software. In Zimbabwe there have been rapid changes associated with land reform and there is an urgent need to re-assess the state of the woodlands, agricultural areas and water resources. The 'brain drain' of skilled people from the country in response to the political and economic situation has exacerbated capacity constraints for monitoring as well as other services.

Things that can be monitored well through remote sensing are fire and conversion to other land uses. Satellite imagery can also be used to monitor growth and accumulation of biomass. But this still needs to be supplemented by monitoring on the ground.

In Botswana, permits for use of wildlife are reportedly not based on an accurate inventory of resources. Some Ministries do monitor at the local level but not at national level. Botswana has compiled State of Environment Reports (SoERs), but these have not tracked trends and there have not really been significant attempts at systematically monitoring the environment. The Environmental Support Programme in the Department of Environment Affairs is setting up an environmental information system, which will include indicator development. But this still comes back to the capacity problem – one can set up indicators, but tracking of them requires human resources, and they must be simple and capable of being used nation-wide. Mozambique has developed two SoERs, one in 1998 and the second one is currently being developed. However, capacity for monitoring is not felt to be very good in government and not institutionalised in the state, but instead relies on university research programmes.

The Regional CBNRM Programme has facilitated the introduction of the Namibian-born Management Oriented Monitoring System (MOMS) into Botswana, Mozambique and Zambia

through wildlife management institutions in those countries. By 2005 there were 70 MOMS sites for both CBOs and protected areas. MOMS is a locally-based monitoring and management system, developed in Namibia as the 'Event Book System', based on devolved responsibility for decision making. Local managers are backed up by expert technicians on request, and there are provisions for a standardised methodology while still allowing for localised customisation.

Under the CAMPFIRE programme, monitoring has been ongoing since the end of the USAID support in 2003. However, CAMPFIRE notes that monitoring and reporting systems have not worked well since the conclusion of USAID support, and steps are being taken to improve this.

MOMS is being used in three pilot communities in the Okavango Delta area, each of which had been allocated hunting quotas, encouraging greater levels of participation in the actual management of their Controlled Hunting Area.

Box 66: Regional CBNRM Capacity Building Programme

The WWF-SARPO is running a Regional CBNRM Capacity Building Programme to promote the mainstreaming of CBNRM as a strategy for sustainable natural resource management and rural development by engaging at the policy level and through training and dissemination of best practices. The programme has identified the insufficient capacity for NRM at the community level and the slow pace of legislative reform and policy implementation for CBNRM as constraints to the wider application of CBNRM in the region. In the inception phase, training needs assessment were carried out, materials developed and training of trainers carried out in Zambia, Mozambique and Zimbabwe. The Regional CBNRM Programme has facilitated the introduction of the Namibian-born Management Oriented Monitoring System (MOMS) into Botswana, Mozambique and Zambia through wildlife management institutions in those countries. Regional Thematic Working Groups have been established on the following themes: policy, MOMS, performance monitoring, enterprise development, CBO organisational development and training. A regional HIV and AIDS workshop was held in 2004 to discuss the impact of HIV and AIDS on CBNRM and define appropriate responses for the regional programme.

"When we were working in the Okavango Delta, one of us was challenged by a community member, as to the need for MOMS. He asked why they needed to implement the process when they would at the end of the day still receive their annual quota, and the money that would flow from the sale of the quota!"

4.9.7.1 Regional capacity building programme for CBNRM

As discussed in Box 66 the WWF-SARPO Regional CBNRM Capacity Building Programme is an important initiative to promote the mainstreaming of CBNRM in the region. Work done in the inception phase of this programme indicated that the demand for CBNRM services in the region exceeds the available capacity for research and analysis, policy development, training and community level technical support.

Around US$100 million has been invested in the region in CBNRM over the past 15 years. CBNRM programmes require services that are process-orientated and require high-intensity investment of time, money and technical support, which participants in this consultations process noted have been lacking in most CBNRM initiatives.

4.9.8 Lack of action on climate change

Although many promising initiatives exist on climate change and all of the countries do have national coordinating committees and have developed national communications required in terms of the international UNFCCC process, there has been very little concerted action on adoption to date. Scientific work in the region is rich, often in collaboration with international researchers. Some politicians are also firmly convinced regarding the implications, but as yet there has been no development and implementation of programmes or restructuring of budget allocations to develop options and opportunities for local communities to cope and adapt. Climate change is still not "real" in the eyes or lives of the decision-makers.

"So far, most of the work has been on research, not on outreach. It is something still in the purview of a few technocrats. But we are now focusing on outreach. Much more needs to be done, including awareness raising.

There is not much awareness at the higher levels. We had a workshop for MPs and only one turned up, most of the participants were technocrats."

4.9.9 Capacity to manage selected ecosystem services for poverty alleviation

4.9.9.1 Fuelwood

All countries in the region have established and skilled Forestry departments or ministries. Although most were established on protective colonial paradigms, most have adopted more participatory approaches in the last decade or so, with some even expressly exploring avenues of how their activities can benefit the poor (e.g. Kojwang 2000). Thus overall, there are reasonable knowledge, skills and regulatory frameworks in place for formal management of tree and fuelwood stocks. However, much of the regulations are not enforced, and capacity to do so is thinly spread, as illustrated by participatory ranking of State agencies in three villages in Zimbabwe (Table 40). In the customary tenure areas, allocation and management of land falls under local authorities, both traditional and municipal. Typically, formal forestry and management skills are absent at the local authority level, but in many places enforcement of regulations is typically better, although with exceptions (especially in South Africa). However, in areas with high land transformation rates, even local authorities struggle to enforce local or traditional rules (Box 11).

Table 40: Local peoples' ranking of the effectiveness of organisations in natural resource management and improving local livelihoods (0 = ineffective; 10 = highly effective)

Institution	Organisation	Mangwende	Chivi	Hurungwe
State	Forestry commission	5	0	0
	Natural Resources Board	0.5	0	0
	Village Development Committees	6.5	5.5	0.5
Traditional	Chiefs	9.5	8	7
	Clan heads	9	7.5	5

(Adapted from: Mukamuri *et al*. 2003)

In all countries the relevant government ministries do have programme of varying success to support tree planting, often aided by NGOs and in some instances international donors. A variety of approaches and interventions have been tried with differential success (Box 12 - fuelwood section). The need for integrated approaches composed of a suite of interventions is repeatedly stressed in the region (Shackleton *et al*. 2007c), the continent (Mahari & Howorth 2001), and well as internationally (Arnold *et al*. 2006).

4.9.9.2 Natural products

In contrast to fuelwood, most policy makers, development and conservation professionals and the general public do not realise how important wild natural products are for the poor in dryland Africa nor their value and potential, much less what needs to be done to use these resources to assist the poor (Anderson *et al*. 2002, Madzwamuse *et al*. 2007). Consequently, there are relatively few explicit programmes or skills pools dedicated to better management of the range natural products used by rural communities. Most management that does occur is at the community or individual farmer/household level. More data are needed to make a solid case, to raise awareness and to motivate for greater investment in this subsector. Many of the capacity issues discussed under fuelwood (above) also apply for natural products. In particular, markets for natural products are underdeveloped and new initiatives that include partnerships with the private sector are needed (see Section 4.8.4.4 - interventions). Capacity at all levels for the implementation of effective community-based approaches for the management and monitoring of these resources in communal systems still needs attention.

4.9.9.3 Rangelands

All the countries have extension and scientific services to advise landusers on recommended rangelands practices. However, the effectiveness of these services is variable in relation to the human resources available, and the equipment and transport available to them to interact with landusers. Consequently, in some countries the capacity is relatively limited. For example, in Zimbabwe there are well-trained extension workers. However, they are unable to assist communal farmers to monitor and manage their rangelands because of serious economic problems in the country. This has resulted in the unavailability of fuel and vehicles to travel to rural areas. Furthermore, extension officers are de-motivated and tend to ignore their duties. However, in other countries the extension services run efficiently and are interested in improving range management and peoples' benefits from rangelands. However, most focus is on animal production rather than on prompting sustainable livelihoods, adaptability and poverty alleviation. At the local level, local ecological knowledge of range condition, productivity and management is usually high, including both the communal and commercial sector. Local farmers use this knowledge in the in grazing systems. There are often tensions between the focus of extension workers on herd productivity and the requirements of local owners for multiple products and services from livestock. Consequently ubiquitous recommendations by extensionists to reduce stocking rates rarely meet with any success.

4.9.9.4 Soil fertility

The capacity to manage is good. Farmers are acutely aware of the different types of soils available to them, their fertility levels, and available sources and types of nutrient inputs. Additionally, all countries in the region have well-established agricultural extension agencies and agricultural research institutions. At times there is a mismatch between the latest scientific or local knowledge and that purveyed by extension agencies (Scoones 1997). Moreover there is frequently a distinct bias in the government agencies towards support for commercial farmers rather than subsistence ones, and for western modes of production, rather than local ones. But nonetheless, overall levels of knowledge and human resources can be considered as high. In some places there are shortages of infrastructure or financial resources which hinder the ability of farmers or support agencies to implement the required strategies

4.9.9.5 Cultural services

At the national level across the six countries the capacity to manage ecosystems for delivery of cultural services is limited because very few agencies work within such an interdisciplinary framework. Government departments responsible for culture and heritage are staffed by people without skills in ecosystem management or poverty issues. In those departments responsible for ecosystems (such as environmental affairs, forestry, agriculture), relatively few are trained or have experience in cultural services.

At a local level, capacity, skills and vision exist, but is frequently left expressionless due to overarching emphasis on service delivery of infrastructure and social services, with culture and spiritual dimensions of human well-being receiving relatively little attention.

4.9.9.6 Tourism services

As Section 4.4.2 presents, there are insightful examples of CBET which have been pursued, particularly in Zimbabwe and Namibia. These cases however do reveal significantly varying experiences in management, approach and impact. Whilst USAID (n.d.) have identified a noteworthy range of success factors, there are also clearly institutional and management challenges (Simpson 2007) and concerns over just who benefits and how widespread impacts actually are (Ashley 1998).

At the ground-level, Namibian experience indicates that while communities have high degrees of decision-making power, the most significant impacts are actually experienced through the operation of joint-ventures (Ashley 1998, Sheyvens 2002). While the principal of partnerships is

a sound one, it does cause communities to be dependent on external, private interests which in turn are vulnerable to market and perceptual shifts.

In terms of government capacity, regional governments have endorsed key global environmental and developmental protocols and it is very significant that, in the case of Namibia and Zimbabwe, those governments instituted what are internationally recognised programmes of CBNRM. That said, capacity to actual manage is constrained by staff, financial and resource constraints. In addition, as recent Zimbabwean experience suggests, too strong a role played by the District Councils, can be counter-productive and restrict community benefits, which in turn impacts on willingness to engage in environmental management (Logan & Moseley 2002).

4.10 RESEARCH GAPS AND PRIORITIES

A large number of ecosystem service specific research gaps were identified during the in-country consultations, as well as from the literature and our own collation of the information. However, the focus of this situation analysis is on the links between ecosystems and human well-being. We acknowledge that a thorough understanding of both sides of the link is vital, i.e. the ecology, and the dynamics of human well-being, but it is the complex and dynamic interface between the two that requires most consideration because there are relatively few research agencies or individuals in the region who operate at the interface. Within that context we have limited the research gaps to those that will most inform understanding and management of that link.

4.10.1 Establishing an integrated and comprehensive picture

- Surprisingly, for many ecosystem services there is no or limited information on their magnitude, trends, drivers, or quantification of value to human well-being. This is applies internationally and not just to southern Africa (e.g. Kremen 2005). This is especially so for regulating, cultural and supporting services, but it also applies for some provisioning services. Consequently, there is a constant rehashing of the few bits of good information for a few particular provisioning services. Future research needs to broaden the net of ecosystem services considered, especially quantification of the stock and flows, their management and the design of innovative and efficient monitoring systems. In other words, the fundamental science regarding ecosystems processes and their management is lacking.
- In the same vein, there is inadequate understanding of the distribution and dynamics of poverty at a local scale. Most statistics are aggregated at district level. But local level studies show that poverty is uneven, and hence so too will be the links between poverty and ecosystem services. There is a need to map poverty in space and time to allow (i) targeted interventions and (ii) correlations with ecosystem attributes. This requires development of appropriate tools and establishment and maintenance of adequate monitoring systems.
- There is no study or site in the whole of southern Africa where all services have been quantified and valued. There are a few studies that have looked at several services, but the results are not comparable because the suite of ecosystem services included is not identical. There are many studies that have looked at a single service, or a component of a single one, but usually at one geographic site, and consequently there is no basis on which to extrapolate the information to other sites. Additionally, studies of single services cannot assess trade-offs (Carpenter *et al*. 2006). The same situation applies at an international level, where single service studies predominate (Turner *et al*. 2003). Thus, there is need for a suite of studies examining all ecosystem services in a similar and replicable fashion and assessing scale effects for extrapolation.
- Despite this situation analysis, there are still insufficient case studies demonstrating concrete and defensible evidence of the links between ecosystem services and poverty alleviation. This lament was also voiced by the MA (Carpenter *et al*. 2006).

- Most work on the value and contribution of ecosystem services to livelihoods and poverty alleviation does not contextualise the contribution of ecosystem services relative to other livelihood sectors and opportunities available to the poor. How does it rank relative to these other options?
- The bulk of the information pertains to rural environments. There is a significant dearth of information on environmental services generated in urban environments and consumed by urban residents. This presents a potentially dangerous misconception that urban communities can exist relatively independent of ecosystem services other than water and food from surrounding areas, and that management of urban environments need not consider ecosystem services.
- An oft-repeated statement by in-country officials and experts was that they have limited appetite for a big academic research programme – any research-oriented interventions must have an integral component that relates to action on the ground. This must be clearly required in any call for proposals. The proposed programme must also build on and integrate with what has already been done. The priority should be action, not research.
- In-country consultations revealed significant concern regarding the vulnerability of the poor of southern Africa to climate change, and what strategies and programmes need to be implemented now to minimise adverse impacts.
- The costs of adverse trade-offs are rarely considered, especially (although not solely) when it comes to agricultural policies and projects. In-country participants noted many examples of the negative impacts of agricultural policies on ecosystem services, but which could not be justified economically when a full cost-benefit analysis of the project or policy was undertaken. Consequently, there is a need for a thorough examination of such policies and communication of where they can be justified on economic and sustainability principles.

- Testing and adoption of ecological principles (e.g. the Ecosystems Approach, Wise Use principles, Eco-agriculture, etc.) in human dominated landscapes is limited. There needs to be improved understanding of such principles within the southern African context and across the different environments, but also investigation of the barriers to adoption.

4.10.2 Developing appropriate methodologies/approaches

- The valuation of ecosystem services still suffers from several uncertainties and assumptions, especially for the less tangible goods or services. If the values obtained are to be defendable they will need to be based on improved methods for valuing ecosystem services. This includes a better understanding of what the costs are of ecosystem service degradation and loss.
- There is an urgent need to develop measurement and monitoring tools for regulating services, and subsequently for their inclusion in assessments of project impacts.
- How can use of and dependency on ecosystem services be incorporated into definitions, measurement and monitoring of poverty?
- Many interventions, either for poverty alleviation or ecosystem health, are inadequately monitored. Consequently, it is hard to assess what the real impacts have been. Many of the in-country respondents stated that basic monitoring or assessment infrastructure and institutions are weak and are discipline based, and hence poverty programmes have rarely monitored ecosystem impacts and conservation or CBNRM programmes have rarely monitored economic impacts. Baseline assessments are rare, either in time or space, and hence it is frequently hard to truly assess what the positive or negative impacts have been. More research is needed on the wider macro-impacts as well as the micro-impacts at individual household level. Much of what we believe is good is intuitive rather than based on good information or data.

- Scaling up – need a better understanding on how to modify and adapt particular interventions (technologies and approaches) to locally specific circumstances and opportunities.
- Payment for ecosystem services was recognised by multiple sources as having potential to highlight the value of ecosystem services to planners and decision-makers, as well as compensate land users for environmentally appropriate practices and to internalise costs that are currently deemed as externalities. However, there are insufficient examples in the region as to how such systems could work.
- It was recognised by many stakeholders that it is difficult to identify and optimise trade-offs between short-term provisioning services and long-term supporting and regulating services. A first step would be to examine the properties of those policies, institutions, programmes and projects that allow optimisation of the trade-offs relative to those that don't. What locally applicable tools can be developed and used to help this optimisation process?
- The existence of thresholds of change in social-ecological systems is based on relatively few documented studies. We found very little literature for southern African systems, other than perhaps regarding bush-encroachment and overgrazing. That other thresholds exist is highly probable, but will require innovative research approaches to (i) detect them and (ii) understand how ecosystem management must change to accommodate them.
- Several commentators noted a tension between evolving approaches and technologies on the global scale, dominated by the developed world and increasing materialism, and the need to have long-term and robust policies and plans at the national and local level focussed on conserving natural resources through sustainable land use, as well as for the future.
- Research diffusion and uptake of results was noted during in-country consultations as an important gap. Participants felt that there was probably a lot of dispersed knowledge on arid and semi-arid systems in the region. Research diffusion is important to avoid re-inventing the wheel. Understanding the political or other constraints to research uptake, and findings ways to overcome these, is necessary for greater effectiveness.

4.10.3 Institutional and governance issues

- It was noted that a key component of reducing vulnerability of the poor is to promote adaptive capacity and facilitate diversification. But poverty alleviation programmes rarely consider adaptive capacity. Thus, there is a need to investigate how can State and civic agencies help build the adaptive capacity of local communities as the basis for sustainable livelihoods, or how can they create enabling environments to facilitate adaptability.
- Little overall progress has been made in institutionalising a more diverse approach to production systems and in monitoring its effects. For example, the techniques that would support reduced herbicide and pesticide use have yet to be adopted in most countries and the full value of the ecosystem services provided by ecologically orientated agricultural systems are only very slowly being recognised. Remedial measures required to restore productivity to degraded lands are not being implemented at the scale required.
- The question of governance systems to optimise ecosystem benefits for the poor was a ubiquitous comment across countries. It was observed that a great deal of work has been done and knowledge generated on the attributes of good governance systems, and yet the general trend throughout most countries was a decline in traditional and local government capabilities and authority concerning ecosystem and resource management. The reasons for this, and approaches to reverse it, need to be understood.
- Many in-country respondents were concerned about external agencies and research institutions operating in their countries with limited regard to local capacity development, alignment with national and regional priorities, or partnerships with local institutions. Funding agencies need to promote appropriate protocols in this regard.

- Despite the fact that the livelihoods of many rural people are based on livestock production and are often located in dry and marginal areas, soil and water conservation investments are insufficient in these locations (Schwilch *et al*. 2007). The same applies to arable production.

4.10.4 Biodiversity as the key underlying supporting service

- The amount of biodiversity as the key supporting service required to enable ecosystems to function effectively varies enormously and how much biodiversity is needed for the sustainable supply of ecosystem services in the present and into the future is largely unknown. Monitoring of biodiversity is weak.
- Little is known about the trends in biodiversity of species other than vertebrates and plants. Yet biodiversity is the major supporting service on which nearly all other ecosystem services are dependent, and consequently inventory and monitoring of all major taxonomic groups is required.
- Although soil communities are by far the most species rich components of terrestrial ecosystems soil communities remain poorly investigated and there has been very little research on thresholds for ecosystem change in soil systems.
- Loss of genetic diversity is poorly known, and mechanisms to conserve local varieties are underdeveloped.

5. COMMUNICATION AND OUTREACH STRATEGIES

If research is to be effective it needs to be translated into appropriate policy and management knowledge, which then needs to be communicated (in appropriate form) to the relevant stakeholders so that the necessary actions can be taken. There is lots of academic and grey literature which has no impact in changing knowledge, actions and practices. Even for that which does, it takes time and recognition of the specific context in which the work was performed.

Some research and development programmes in the region, which do include elements of ecosystem services management for human well-being, have large, well-known profiles, e.g. CAMPFIRE, Working for Water, the Namibian Conservancies, the Okavango Research initiatives, CAPE, and so on, whereas many others do not. What are the ingredients of the successful ones that have brought them into the public eye, and kept them there?

- **Demand-led research**. The research focus must be on solving clearly identified and priority problems, the outcomes of which will inform programmes and policies that will enhance human well-being. The demand needs to be articulated by clear constituencies from communities up to national governments, who are then eager to participate in the research process and use the research outputs.
- **A 'political' champion**. For communication to be effective and ensure that it reaches at the very top, successful programmes have political champions who set a vision for the programme, who lobby for support, and who act as a conduit for dissemination of results into government policy and think-tanks.

- **A long-term vision**. It is well appreciated that it takes time to change knowledge, practices and attitudes. Short-term programmes of less than 10 years have less impact on ecosystem management and on poverty than do longer term ones. They also have less internal flexibility to react and change as new understandings develop. Sayer & Campbell (2004), in their seminal work on the link between research and development, make a strong argument for donor agencies and research funders to commit to long-term programmes, with internal flexibility, if they wish to effect real, long-lasting changes in the

lives of underdeveloped communities and households. Longer programmes also have the inherent capacity to 'become known' because of the opportunity to have 'repeated messages'. Short-term projects typically have an annual or end of project briefing which are soon forgotten.

- **A dedicated communication strategy and budget**. Many projects have inadequate budgets for communication of research and development findings. This is particularly so for short-term ones. Successful ones, spanning many years, have either (i) media and communication specialists on the project team, or (ii) adequate budget to consult them at regular intervals. Successful communication takes time, money and the correct skills. The nature of the communication and skills required varies for different stakeholders.
- **Repeated messages**. Irrespective of the stakeholders to whom the message is being targeted, repetition of the message is essential. Thus, communication must be regular, and take diverse forms, i.e. TV programmes, newspaper articles, policy briefs, magazine articles, school pamphlets and competitions, community days, T-shirts, posters, policy think-tanks, and so on. An annual report is insufficient. Residents and officials of the geographic areas of the project must receive exposure to the project, both its activities and its findings, on a regular and ongoing basis; the story must be "kept on the boil".
- **Ownership and a sense of pride in the project by local people and officials**. This in itself has a number of requirements over and above a successful communication strategy. But a good communication strategy helps in fostering ownership and pride provided there is regular media exposure of participants and people affected by the outcomes of the initiative.
- **Participatory research**. Stakeholder support and buy-in is also engendered by emphasis on participatory research, which also shortens the gap between research outcomes and implementation on the ground, and starts the process of communication from the outset.
- **Significant scale**. Reception of the results communicated to officials, donors and policy stakeholders is enhanced if the project has multiple sites or covers a reasonably large geographic area. Small projects are important, and can lead the way with innovation and local impact, but they are constrained by their specific contexts and the personalities of the role-players. Larger projects facilitate comparative analysis and reflection of why some approaches work in some areas but not others, as well as foster internal innovation and reflection by virtue of having a greater critical mass. Consequently, officials have greater acceptance of the messages because they were generated and tested at several sites or regions, and not just one.
- **Cross-disciplinary communication**. Communication of messages must be both disciplinary based, as well as cross-disciplinary. The linkages between the different core components, i.e. ecosystems ***and*** well-being need to be established and constantly reinforced.
- **Make ideas real**. Concepts need to be translated into real tangible projects which can be profiled, highlighted and visited.
- **Understand the context**. Whilst it is important to communicate the success (and failures) of approaches and projects so that they can be replicated elsewhere, it is important that the context of each success is also fully understood and communicated – one size does not fit all!
- **Local language**. Local language communication is important for community stakeholders. Consequently budget allocations need to include translation costs.
- **Clear messages to land managers and planners**. A particularly important stakeholder group are managers and local officials who make decisions about land use and zonation, who need to be targeted with clear materials and messages. The materials need to cover the relevant legislation and responsibilities around ecosystem management, and highlight ways and means of improving local well-being through good management.

6. LESSONS LEARNT ABOUT THE ASSESSMENT PROCESS

Part of the project brief was for the project team to reflect upon the lessons learned in executing this situation analysis. This was done in a workshop session, and the following lessons were identified:

- The scope of the assessment was too large relative to the time, and hence there was insufficient time to engage with stakeholders, and identify, access and digest grey literature.
- Given the complexity of the assessment a long lead time is required to develop frameworks and plans of action, and common understandings and conceptual models.
- Not much literature (nor experts) make the link between poverty and ecosystem services explicit. Literature and experts are largely disciplinary based, thus either economics and poverty ***or*** environmental/ecological. Therefore, the team constantly had to make intuitive links and interpretations.
- Similarly, government departments and agencies are not structured to deal with ecosystem services and human well-being in an integrated manner. Consequently, they do not collect and store data that integrates the two. A few conservation and environmental departments do recognise and operate in a poverty alleviation paradigm, but practically no social development departments make conceptual or operational links to environmental projects.
- The literature has a varied understanding of poverty which complicates its usefulness and application to poverty alleviation, especially through ecosystem services programmes.
- The request to integrate key stakeholders into the situation analysis was compromised by the short time-span. There was consultation and some awareness raising, but no real integration and buy-in. This was further challenged because the next phase (with funding and action) is not yet guaranteed.
- Some countries have a large dearth of literature – e.g. Swaziland, despite exhaustive efforts to locate it. There was also limited literature from Mozambique, but this is partially a result of language barriers.
- With six countries to cover, the budget was insufficient to host interactive workshops with officials and country experts, as it could not cover transport and accommodation.
- The requirement to consider all categories of ecosystem services was at odds with the requirement to consider the ones most important for poverty alleviation, which in the opinion of most in-country experts and officials, are the provisioning services.

7. CONCLUDING STATEMENTS

This situation analysis has accessed and summarised a great range of material and opinions within southern Africa in a relatively short period of time. That is an achievement in itself, and circulation of this document within the six countries, as requested by the stakeholders whom we consulted, will hopefully have some impact, however small, in raising awareness around the irrefutable links between the state of ecosystem services and human well-being.

It would be futile to attempt to draw conclusions across the wealth of material covered because each section and each ecosystem service covered in this report deserves its own few pages of key conclusions. Yet, it would remiss not to iterate those large, overarching, take-home messages that jump out loud and clear from the preceding pages. This we attempt to do below by picking on what we perceive to be ***the most important overarching fifteen***, but not in any specific order.

7.1. THE FIFTEEN MOST IMPORTANT OVERARCHING CONCLUSIONS (IN NO SPECIFIC ORDER)

- Investments in managing and securing ecosystem services alone will not eradicate poverty. It needs to be part, but a significant part, of broader poverty alleviation initiatives.
- There is inadequate consideration of poverty alleviation issues by ecosystem management agencies, and there is practically no consideration of ecosystem resources and impacts by social welfare or economic development agencies (other than tourism projects).
- Provisioning services are a significant component of diversified livelihood portfolios, both for home consumption and income generation. Poverty alleviation initiatives need to build on the inherent diversity of rural livelihoods rather than constrain it, through promoting a diversity of options, of which provisioning services should be seen as only one component of a suite of options.
- Unlike most poverty programme and interventions, ecosystem services are pervasive at all spatial and temporal scales. Consequently, support and management for delivery of ecosystem services will benefit all inhabitants of the region, including the poor. Since the poor are more directly reliant on ecosystem services for a larger share of their livelihoods, then an investment in securing ecosystem services will be of greater benefit to them than other sectors.
- There is growing evidence in the region (e.g. Shackleton 1996) and internationally (e.g. Balmford *et al*. 2002, Turner *et al*. 2003) that land use practices promoting multiple use and sustainable use of resources usually have an equivalent or greater return than converted landscapes when all costs and benefits are accounted for. Thus, unsustainable uses, or intensive production of single resources without quantifying the trade-offs on other services frequently cannot be defended in economic terms.
- As human well-being diminishes there tends to be a concomitant increase in immediate dependence on ecosystem services. The resultant increased pressure often has a negative feedback on the capacity of the ecosystems to deliver services. This can create a downward spiral of increasing poverty and ecosystem degradation. There is growing evidence that the AIDS pandemic may be driving such a situation in the region.
- Analysis of the drivers of change in ecosystem state is complex because of the temporal and spatial variation, as well as in relation to the scale of analysis. Nonetheless, in most instances there have been large changes with the net direction of change being mostly negative (other than for tourism). In other words, ecosystem services are being compromised on a wide scale and to a significant extent (van Jaarsveld *et al*. 2005).
- Local projects to secure ecosystem services can certainly be useful (e.g. the Working for Water and Working for Wetlands programmes, some CBNRM programmes), but the functional scale of ecosystems and their drivers is typically at larger spatial and temporal scales than at which such projects operate. Consequently, better management and appreciation of ecosystem services and their role in alleviating poverty will be best achieved by interventions at the policy level, that serve to change the understanding, attitudes and values that policy-makers, planners and land managers have towards ecosystem services. Participatory Poverty Assessments as well as national Poverty Reduction Strategy Papers need to explicitly include environmental components (Brocklesby & Hinshelwood 2001). In-country experts stated that poverty alleviation programmes or projects rarely consider environmental dimensions. The importance and value of ecosystem services needs to be mainstreamed into planning and decision-making processes from local to international levels.
- The poor are at the mercy of many external drivers and trends, including those impacting the delivery of ecosystem services, against which they are relatively powerless. Therefore, policies and interventions need to support and build the capacity of the poor to

adapt and create and build their own opportunities, rather than imposing external prescriptions or uni-dimensional opportunities.

- HIV/AIDS is a major scourge that is devastating the region especially through the way it drains household assets and resources, and consequently deepening poverty. It is also undermining ecosystem management through loss of skilled people and managers, and increasing short-term exploitation of environmental resources. The effects will be felt for decades, if not millennia. Robust, comprehensive and extensive interventions are required immediately throughout the region based on shared knowledge and practice from the successful programmes in the region.
- Whilst all ecosystem services are important to a greater or lesser extent, water is a particularly important ecosystem service in arid and semi-arid areas. Yet projections indicate that several districts and countries in the region will be severely water stressed within two or three decades. The poor are already at the forefront, having least access to bulk water supplies, and are most prone to water-borne diseases. Dams and redistribution of water from areas of higher rainfall serve to delay the onset of local shortages, but not without impacts on other ecosystem services. Consequently, there is an immediate and pressing need for comprehensive and extensive interventions to increase water use efficiencies, recycling and rainwater harvesting to reduce absolute demands per capita and per unit of production.
- The bulk of information pertains to rural environments. There is a significant dearth of information on environmental services generated in urban environments and consumed by urban residents. This presents a potentially dangerous misconception that urban communities can exist relatively independent of ecosystem services other than water and food from surrounding areas.
- Trade-offs are inevitable in all decisions, at all scales, pertaining to land use, development and ecosystem services. Future programmes need to arm decision-makers (at all scales) with the information, knowledge and skills to make informed decisions based on an awareness and analysis of such trade-offs.
- The capacity to manage ecosystem services varies from country to country, region to region, and for specific services. However, other than for water as a provisioning service, there is a perception in most countries that national budgets should focus on infrastructure development and social services. The share of national budgets allocated to ecosystem management functions is pitifully small because national decision-makers have not been made aware of the value of ecosystem services (in both financial and non-financial terms) in supporting all human endeavours and in supporting the poor. Consequently, as a very generalised assessment, insufficient budget is available for capacity development and maintenance of that capacity.
- There is an inadequate understanding and appreciation of the importance and value of ecosystem services, even provisioning ones, on behalf of planners, bureaucrats and policy makers, resulting in many avoidable negative trade-offs. This is linked to weakening governance systems for environmental services. Consequently, there is an urgent need for better research and communication of that research to these agencies.

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Appendix 1: Composite list of ecosystem services

Provisioning services (material benefits or products from ecosystems)	Building materials for shelter (e.g. thatch, poles, reeds)Fuelwood	**Regulating services** (benefits obtained from regulation of ecosystem processes or buffering capacity)	Air quality regulation
	Crops		Climate regulation
	Fodder		Climate moderation & buffering against extremes
	Fresh water		Detoxification & decomposition of wastes
	Fuelwood		Disease regulation
	Honey		Disturbance regulation
	Materials to craft household utensils (e.g. baskets, mats, tools)		Drought mitigation
	Materials used in cultural practices & rituals		Erosion control
	Natural product derivatives (e.g. oils, dyes, waxes, resins)		Maintenance of biodiversity
	Raw materials for agricultural implements (e.g. fish traps, fencing, hoe handles, cattle pens)		Maintenance of soil fertility
	Wild animal foods		Pest regulation
	Wild plant foods		Pollination
			Protection from natural hazards
Cultural services /enriching services (non-material benefits obtained from ecosystems)	Aesthetic values		Refugia (habitat)
	Cultural heritage/symbolic values		Water quality regulation/purification
	Cultural diversity		Water regulation/flood control
	Education values		
	Inspiration		
	Knowledge systems	**Supporting services** (processes necessary for the production of other services)	Biodiversity
	Recreation & tourism		Photosynthesis/primary production
	Social relations & values		Nutrient formation
	Spiritual uses		Soil formation
			Water cycling

Appendix 2: Summaries of case studies used as a source of information for the situation analysis

CASE STUDY NO. 1

Ecosystem services in semi-arid micro-catchments in southern Zimbabwe and their relationships to poverty

Collated and adapted from the final technical report of the DFID-funded project R7304: 'Zimbabwe Micro-catchment Management and Common Property Resources'

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1. Introduction

The ecosystem services considered in this section are set within the context of smallholder production systems in the semi-arid setting of south-central Zimbabwe. The section draws from multidisciplinary research on integrated natural resource management in two contrasting (Table 1) micro-catchment sites in Chivi district, namely Romwe and Mutangi (Fig. 1). In brief, the Romwe catchment consists of a small valley bounded on both sides by a chain of hills whose slopes consist of relatively undisturbed miombo woodlands. The entire catchment consists of three distinctive areas. The valley consists of a red soil area of 0.025 $km^2$and grey duplex soil area of 0.011 km^2, whilst the extent of the miombo woodland on the hill-slopes is 0.5 km^2. In contrast, Mutangi is much less subdued in physiographic terms and consists of mostly mopane woodland occurring on a mosaic of coarse sandy and sodic soils. Livelihoods are generally based on combinations of dryland cropping (the mainstay of most livelihoods), irrigated gardening, woodland-based activities, local wage labour and remittances. Fields and gardens belong to individual households but water and woodland are common property resources that are subject to collective use and management.

Table 1. The study sites

	Romwe	**Mutangi**
Location	20°45'S, 30°46'E	20°15'S, 30°30'E
Catchment size	4.6 Km^2	5.9 Km^2
Topography	25-65% hillslopes	<2% hillslopes
Mean annual rainfall (1954-2000)	581mm	550mm
Recorded seasonal rainfall (1998/99)	1430mm	755mm
Water resources	Groundwater dependent on 2 boreholes and 32 wells. Acceptable water quality.	surface and ground water provided by 1 small dam, 3 boreholes (only 1 working) and 16 wells. Poor water quality.
Number of households within the physical catchment	32 (250 people)	27 (160 people)
Number of households within the social catchment (based on Borehole at Romwe, or the Dam at Mutangi)	417	453
Population density in the social catchment	86/Km^2	52/Km^2
Number of households in the sample	121	122
Number of persons included in the survey sample, and average number of persons per household	789 (6.5)	795 (6.5)

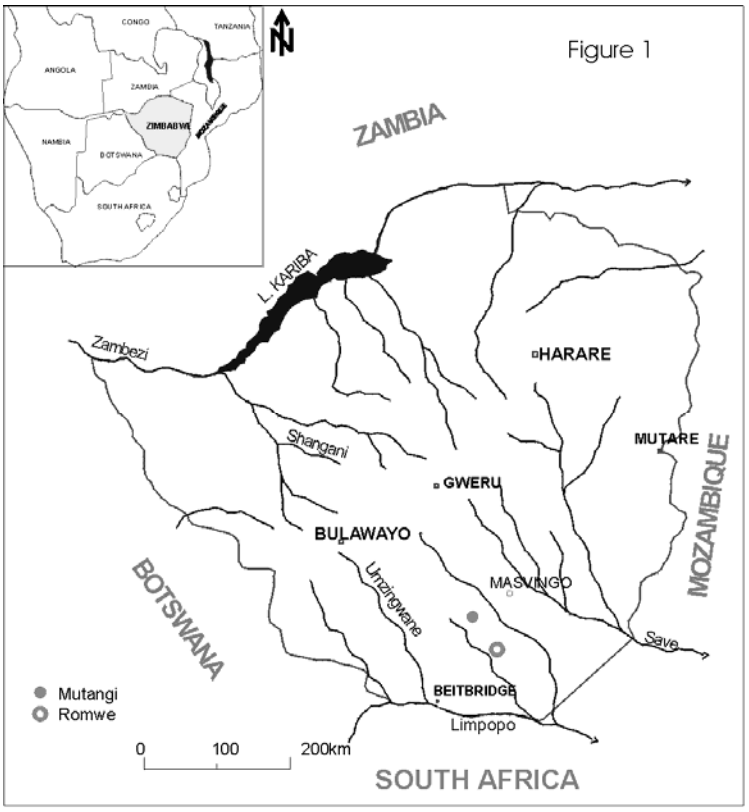

Figure 1. Location of Romwe and Mutangi catchments in Zimbabwe

Given the integrated nature of the project, ecosystem services involved span the entire spectrum from the provisioning to the regulating to the supporting and the cultural. The second part of the report shows that the livelihood impacts of provisioning services are the most clearly understood. Such insights, however, remain somewhat static if they do not take cognizance of how various services are traded off against each other, with the trade-offs being profiled in terms of implications on poverty. The third part of the report highlights the importance of rainfall as the major driver of ecological functioning as well as household production within these semi-arid settings. The fourth part shows that relationships among woodland and water-side regulating and supporting services are complex and that they often turn out to be the inverse of what is normally thought to be the case. In that regard it shows that interventions implemented on the basis of what is thought to be the norm often do not yield the anticipated benefits in terms of anticipated improvements in ecosystem services and on poverty. The penultimate part offers a short glimpse at how cultural services are evolving to mediate access to resources within the context of the existing spatial and social distribution of resources, with particular emphasis on water. The last part suggests that reconciling the complexity of linkages among ecosystem services and their implications on poverty requires adaptive and opportunistic management strategies. But thorough livelihood research to mirror the emerging insights on biophysical linkages, particularly among regulating and supporting services, is required before this can be done.

2. Insights into the role of provisioning services and tradeoffs among them

The implications of provisioning services on poverty in terms of their relative contribution to household income profiles from both subsistence and cash income perspectives are quantified and reasonably well understood (Table 2). The findings draw from detailed accounting of household income and expenditure across a number of livelihood sectors involving quarterly return-to-household surveys designed to reduce non-sampling errors associated with recall data. Provisioning services considered in these calculations included income from crops from drylands and gardens as well as that from a variety of non-timber forest products (NTFPs), including firewood, construction material, wild fruits, mushrooms, medicinal herbs, handicrafts, etc. Considered together these services accounted for on average 47% of the total net income of the households, with income from dryland crops alone accounting for 22% of the net household income.

Table 2. Average net subsistence and cash income per household per sector for the two study sites (Amount in Z$ for 2001).

Sector	Net subsistence income	Net cash income	Total net income
Dryland crops	4340	1155	5495
Gardening	927	1090	2017
Woodlands	3404	380	3783
Livestock	4916	393	5309
Wages & home industries			3004
Remittances/gifts			5157
Total income	13587	11179	24766

Whilst further development of dryland agriculture presumably reinforces this service's role in alleviating poverty, it can only come at a premium because of its uncertain linkages with other services, such as availability of NTFPs, erosion control, water purification, overall water balance, etc. Agricultural development invariably involves the opening up of land for cultivation which reduces vegetation cover. The rate of conversion of woodland to cropland is higher in densely settled areas such as two Chivi study sites. For instance, our studies showed marked changes in land cover in the study sites in recent years. The proportion of cultivated land for an area centred on Romwe increased from 20% in 1984 to 33% in 1999. Woodland declined from 36% to 22% and wooded grassland dropped from 11% to 8%. In 1999, the remaining woodland on the catchment's valley floor was mostly confined to rocky ridges and hills. In terms of relative impact, the opening up of land for agriculture results in quantitative changes in the status of woodlands, whilst extraction-based activities result in more localized qualitative changes in woodland structure and function. The overall (quantitative and qualitative) decline in woodland translates into additional labour required to extract woodland products. In 1994 most households reported that it took under two hours for a firewood collection trip, while in 1999 it was more than two hours (Vermeulen *et al.* 2000). Meanwhile, ecological data from the Romwe woodlands showed a lack of regeneration of the dominant species presumably due to heavy grazing and cutting for poles. Although these findings suggest negative linkages between the provisioning services of crop production and NTFP availability the tradeoffs between these, i.e. in terms of household income or other poverty proxies, are still to be more clearly profiled and demonstrated.

3. Rainfall is the key driver to which all other linkages are secondary

Whilst linkages among most other sets of ecosystem services still remain tenuous and uncertain, their significance is overshadowed and often conditioned by the availability of water, which - by and large - remains the key determinant of ecological functioning and household production in typical semi-arid savannas such as the study sites. The main driver of various aspects of water balance throughout catchments in Southern Africa is the occurrence of long-term cycles of above-average rainfall (roughly 9 years) alternating with ones of below-average (also about 9 years duration). This means that most catchments in the area fluctuate between semi-arid and semi-humid. The implications for natural resource management are enormous. Related fluctuations can be expected in grain yield, vegetation cover, erosion and siltation. Modelling studies on catchment hydrology in Romwe showed that rainfall is the greatest determinant of natural resource status, with long-term trends in groundwater reflecting the cumulative variation in rainfall over time (Butterworth *et al*., 1999). The main cause of water point failure in the region is natural recession associated with extended dry periods, with human impact through present groundwater abstraction being trivial compared to the natural discharge of groundwater (Table 3). Human impact through changes in land use in the catchment is of secondary importance (Butterworth *et al*., 1999).

4. Interventions and their implications on interactions among a variety of supporting and regulating services

Subsequent hydrological modelling results show the effects of soil and vegetation management interventions on groundwater resources do not support the notion of positive feedback linkages between the existence of trees and groundwater availability (Table 4). The results show that large annual variations in groundwater level reflect values of recession that follow high values of recharge. This recession is principally due to evapotranspiration from the aquifer rather than deep percolation or lateral flow. Runoff

control as a management option produces little net gain in ground water as measured at the end of each dry season – if there are any trees or deep-rooted vegetation on the aquifer these consume most of the groundwater. They consume even more when groundwater recharge is increased through runoff control. This is because water availability, not evaporative demand, sets the limit to the amount of water used by the vegetation.

Table 3. The water balance of Romwe catchment[1] under present management, calculated for three successive years at the return to a wetter period (hydrological year 1 July to 30 June)

	Runoff (mm)	Recharge (mm)	Change in ground water storage (mm)	Ground water recession (mm)	Human abstraction (mm)	Balance (actual evaporation + change in soil moisture + other losses) (mm)
1994/95 Rainfall = 738 mm						
Red clay soil	9	51	-19	70	1	677
Grey duplex soil	48	0	-19	19	0	690
Woodland hills	0	na2	Na	Na	0	738
Total catchment	4	38	-34	72	1	695
1995/96 Rainfall = 990 mm						
Red clay soil	46	308	+58	250	1	635
Grey duplex soil	203	138	+46	92	0	649
Woodland hills	81	Na	Na	Na	0	873
Total catchment	93	262	+100	162	1	634
1996/97 Rainfall = 937 mm						
Red clay soil	64	281	+50	231	1	591
Grey duplex soil	335	50	+24	26	0	552
Woodland hills	98	Na	Na	Na	0	839
Total catchment	84	296	+62	234	1	556

[1] Maximum values of recharge are shown, calculated as rainfall minus Penman potential evaporation and run-off measured during the annual periods of ground water rise, and assuming no lateral flow or contribution to soil moisture storage. Average values of S_y of 0.034, 0.022 and 0.045 for pyroxene and leucocratic gneisses (red clay and grey duplex) and whole catchment, respectively were inferred from these maximum values of recharge and corresponding ground water rise measured across a network of piezometers. Change in ground water storage is annual change in ground water level multiplied by specific yield. Recession is the difference between recharge and change in ground water storage

[2] na = not available (because of the elevation and geological structure of the hills, their groundwater store is likely to be minimal)

Table 4. Cumulative volumes of water (Ml) over 25 years under three management scenarios

Romwe-type catchment 1973-1998	Recharge	Aquifer storage	Evapo-transpiration	Saturation-excess runoff
Present land use: trees, dryland crops and grass, no runoff control	2311	-122	2131	302
Trees, dryland crops and grass, enhanced recharge through runoff control	3238	-112	3135	215
No trees on aquifer, only dryland crops and grass, no runoff control	2861	11	2539	311

The results of surface-water modelling for the Mutangi micro-catchment were considered in conjunction with a variety of interventions, particularly those aimed at enhancing the regulatory services of reducing runoff and enhancing groundwater recharge. The results show that open-water evaporation from a reservoir completely overshadows the decreases in inflow to it due to reducing runoff by improved in-field water harvesting, and so is the driving force determining water levels in the dam. Open-water evaporation

is therefore a major non-productive loss. Since the study catchments are small headwater micro-catchments, damming water in catchment reservoirs does not have much downstream effect because the volume of runoff captured by such reservoirs constitutes a relatively small proportion (31%) of total runoff. In assessing the trade-off between management of groundwater and surface water the model results show a potentially significant trade-off. Harvesting all runoff to enhance groundwater recharge increases drainage (potential recharge), as well as baseflow and evapotranspiration, but significantly reduces runoff (Table 5).

Table 5. The effect of harvesting all runoff to enhance groundwater

Av. over 25 years	Evapotranspiration (mm)	Drainage (mm)	Dam storage (per cent full)	Runoff (mm)	Baseflow (mm)
No re-infiltration	507	70	37	21.0	0.7
Full re-infiltration	523	92	11	5.4	4.8

5. A glimpse on cultural services

Although there are dams and boreholes in both catchments ephemeral “private’ wells remain the major and more easily accessible source of domestic water for the majority of the people within both catchments. Although these wells are owned by individual households, over time, complementary cultural services have evolved in which lateral bonds and relationships mediate access to these important resources across the inter-familial, community and other social divides (Fig 2). The wells are shared with relatives, neighbours, church colleagues and friends, so that eventually everyone in the village has access to almost any well within reach – provided they use the resource within accepted norms of civility designed at ensuring sustainable provisioning. In Mutangi people from villages lacking adequate land and grazing resources often share these with neighbouring villages (Nemarundwe and Kozanayi, 2002. Conflicts in accessing and using resources, as well as those over the extent of jurisdictions, were also evident, however. In some instances people take active steps to organise themselves for collective actions and outcomes, but such organisation often entails high transaction costs. But people often devise and implement 'soft' and flexible arrangements that provide a hedge against high transaction costs.

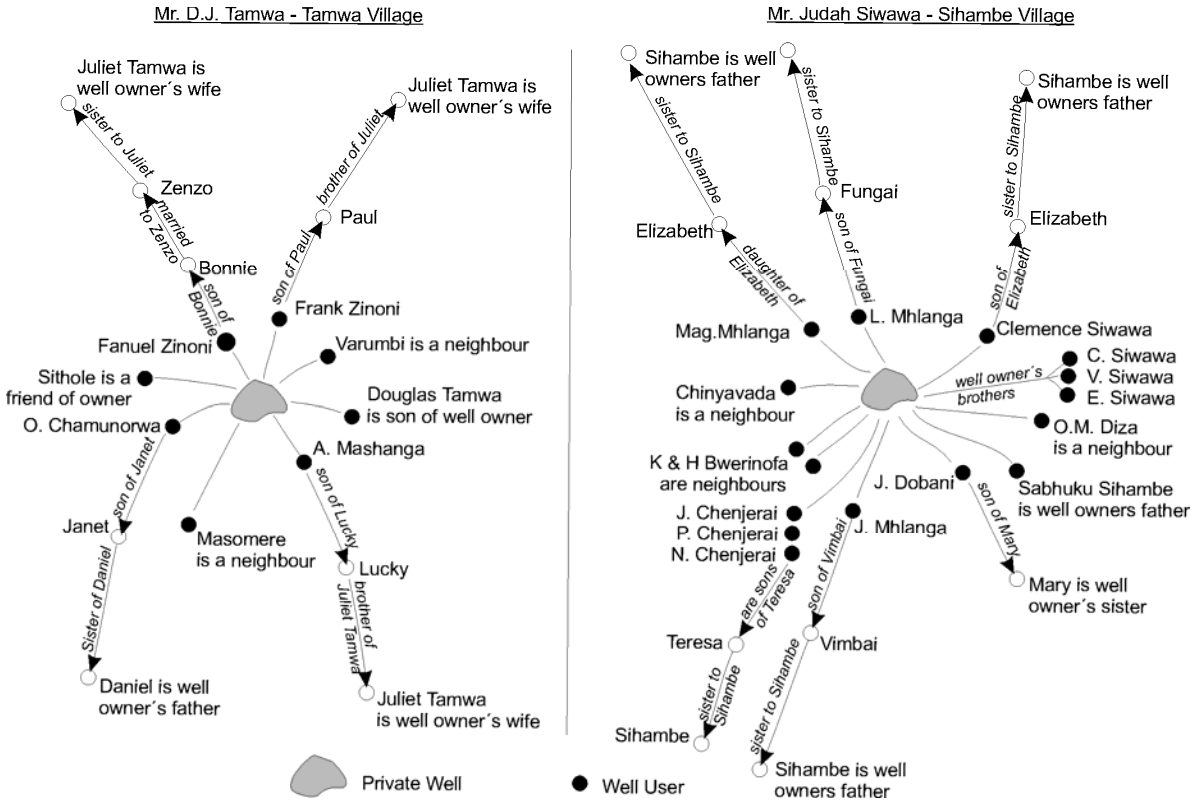

Figure 2. Rights to use water the private wells of Mr Tamwa and Mr Siwawa in Romwe, showing how social networks allow access to supposedly private resources.

6. Adaptive and opportunistic management strategies

Despite their limitations, the simplified conceptual models used in the hydrological component of these studies provide valuable insights in the way a complex system works and the implications of management over space and time, especially the role of evapotranspiration, the mechanisms of well failure, the brevity of management benefits, and the limited downstream effects of this management. The findings justified expanding the use of water to compete with various natural water losses (evaporation from surface water; evapotranspiration from groundwater), while cautioning on need for adaptiveness in matching abstraction rates to temporal fluctuations and spatial variation (e.g. local conditions at well sites). Related cost-benefit analyses for the mainly groundwater Romwe catchment suggested that the best way to implement the opportunistic strategy would be to develop and upgrade wells at prime groundwater locations into community wells to cushion people during times of stress, but augmenting these with ephemeral 'private' wells that make greater use of water when it is available. In the mainly surface water Mutangi catchment the optimum strategy would be to upgrade the underused dam, maintaining the outflow statistics but competing more vigorously with evaporation loss. Whilst the complexity of linkages between ecosystem services is beginning to emerge a lot of work still has to be done on how these impinge on poverty, with the challenge appearing to be that no site will be exactly the same as the other in terms of causality and direction of the linkages. The common denominator for the semi-arid sites, however, is that natural recession, particularly through evaporation and evapotranspiration, is the major pathway of water loss for surface and ground water, respectively.

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CASE STUDY NO. 2

Ecosystem services and human well-being: a case study of two local communities in Gorongosa National Park, Mozambique

Mapaure, I., Lynam, T. & Cunliffe, R.

1. Approach used

Research was conducted to determine the importance of environmental services to local communities in Muaredzi and Nhanchururu, Gorongosa National Park (GNP) in Mozambique (Lynam *et al*., 2003). The importance of landscape functions to local communities was conceived as a ratio of the benefits they derive from it and the costs of accessing or using those benefits. To test this hypothesis, Bayesian Belief Network models were constructed. Community resource use assessment teams (CRUATs) elected by the local communities worked with the scientific team to collect data using participatory approaches. The landscape was mapped into locally identified units and listed the services that emanated from each unit. Using the scores allocated to basic needs, an index of the gross importance of a landscape unit was estimated. The cost was estimated as a function of the distance from the village to the landscape unit and any institutional or physical barriers that increased the labour costs of procuring or using the resources. The final estimate of landscape importance was then created as a spatial map of the benefit:cost model. From a vegetation survey of each site, vegetation types and an index of biodiversity importance for each type were derived. The conservation importance of each vegetation type was determined as a function of its relative spatial extent, species diversity, and the presence of species of conservation interest. For each site, the two models (surfaces) were overlaid in order to identify locations of high importance to both conservation groups and the local community. Such areas would require careful management attention because of potential conflict.

2. Basic needs from the natural environment

Livelihood systems at both sites are dominated by natural resources-based production, with very few external inputs (Table 1). Food is derived from local agricultural production based on a tree fallow system of nutrient replenishment, from forest products, from wild foods, and from purchased commodities. The latter contribute only about 20% of the total food input, although this increases in drought or flood years. Most household basic needs are also directly derived from natural resources. Local communities obtain cash through the sale of grain, livestock, and natural products. Non-agricultural food products become very much more important in drought and flood years, when the situation becomes acute.

Table 1. Final set of services that were identified by the Muaredzi CRUAT and overall list of natural resources used in Nhanchururu. Importance scores reflect the relative importance of each resource to an average household achieving an adequate standard of living. All scores are relative to the least important resources. ([1]RIW = Relative Importance Weight, [2]RIWS = Standardized RIW, [3]RIWC = Cumulative Standardized RIW).

MUAREDZI				**NHANCHURURU**			
RESOURCES	**RIW[1]**	**RIWS[2]**	**RIWC[3]**	**RESOURCES**	**RIW[1]**	**RIWS[2]**	**RIWC[3]**
Water	20	0.163	0.163	Land for housing and fields	35	0.093	0.093
Agriculture	20	0.163	0.325	Water	30	0.080	0.172
Construction materials	16	0.130	0.455	Firewood	26	0.069	0.241
Firewood	15	0.122	0.577	Wood for handles	25	0.066	0.308
Fish	13	0.106	0.683	Livestock	19	0.050	0.358
Grinding sticks/stones	10	0.081	0.764	Reeds for mats	18	0.048	0.406
Clay products	8	0.065	0.829	Grinding sticks and bowls	17	0.045	0.451
Palm leaf products	6	0.049	0.878	Timber	17	0.045	0.496
Palm wine	5	0.041	0.919	Poles for construction	16	0.042	0.538
Honey	4	0.033	0.951	Bamboo for construction	16	0.042	0.581
Medicine	3	0.024	0.976	Rope for construction	16	0.042	0.623

Wild foods	2	0.016	0.992	Grass for thatching	16	0.042	0.666
Wild fruits	1	0.008	1.000	Cultivated fruits	16	0.042	0.708
				Clay for pots	15	0.040	0.748
				Traditional medicines	14	0.037	0.785
				Grinding stones	12	0.032	0.817
				Reeds fro construction	11	0.029	0.846
				Foods from the wild	10	0.027	0.873
				Mud for cultivation	9	0.024	0.897
				Honey	8	0.021	0.918
				Fish and other aquatic animals	7	0.019	0.936
				Wild fruits	6	0.016	0.952
				Sand	5	0.013	0.966
				Type of wild honey	4	0.011	0.976
				Slippery clay for cultivation	3	0.008	0.984
				Type of wild honey	2	0.005	0.989
				Type of wild honey	1	0.003	0.992
				Type of wild honey	1	0.003	0.995
				Wildlife	1	0.003	0.997
				Aquatic plants for food	1	0.003	1.000
Total	123				377		

3. Importance of landscape units to local communities

Most products used at both sites were obtained from the local landscape. Goods that contributed most to the importance of landscape units were water, land for agriculture and housing, construction materials, firewood, general household and craft materials, and various wild foods. For both sites, the cost factors (constraints) identified as inhibiting access to natural resources were dominated by a lack of tools, inputs or equipment, and official regulations (Table 2).

Table 2. List of factors limiting access to natural resources in Muaredzi and Nhanchururu. Importance scores reflect the relative importance of each factor as regards its contribution toward limiting access to natural resources by an average household. All scores are relative to the least important factor. ([1]RIW = Relative Importance Weight, [2]RIWS = Standardized RIW, [3]RIWC = Cumulative Standardized RIW).

MUAREDZI				**NHANCHURURU**			
LIMITING FACTOR	**RIW[1]**	**RIWS[2]**	**RIWC[3]**	**LIMITING FACTOR**	**RIW[1]**	**RIWS[2]**	**RIWC[3]**
Lack of tools or equipment	11	0.204	0.204	Droughts	22	0.182	0.182
Restrictions due to official regulations	10	0.185	0.389	Lack of agricultural implements	20	0.165	0.347
Lack of canoe makers	8	0.148	0.537	Lack of seeds	11	0.091	0.438
Occurrence of witchcraft	6	0.111	0.648	Lack of tractors	10	0.083	0.521
Destruction by wild animals	6	0.111	0.759	Poor soil fertility	9	0.074	0.595
Occurrence of droughts	5	0.093	0.852	Lack of wells	9	0.074	0.669
Distance to access resources	4	0.074	0.926	Lack of household implements	7	0.058	0.727

Occurrence of floods	3	0.056	0.981	Uncontrolled burning	6	0.050	0.777
Weakness or laziness	1	0.019	1.000	Difficulty of carrying	6	0.050	0.826
				Government regulations	5	0.041	0.868
				Distance	4	0.033	0.901
				Lack of oxen	4	0.033	0.934
				Lack of ploughs	3	0.025	0.959
				Traditional regulations	2	0.017	0.975
				Dangers (wild animals)	2	0.017	0.992
				Need to water vegetable gardens	1	0.008	1.000
Total	54				121		

Spatial model predictions of landscape unit values were reasonably well correlated (r = 0.538) with actual values developed by CRUAT for Muaredzi (Fig. 1a). However, the relationship was somewhat weak (r = 0.300) for Nhanchururu (Fig. 1b), largely due to noise in the data from various enumerators.

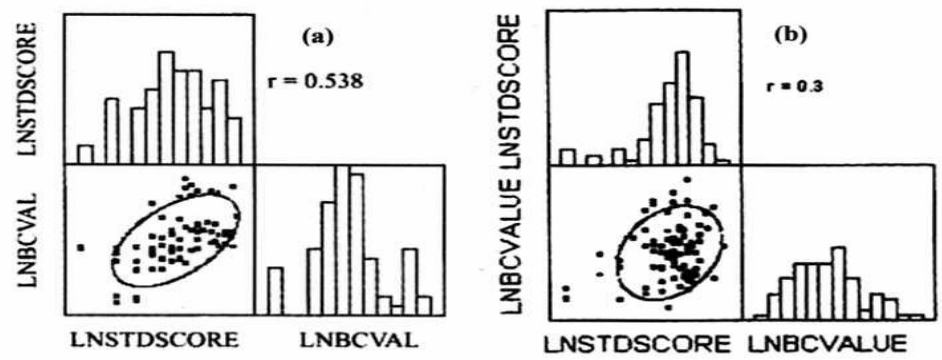

Figure 1. Correlation between the natural log of the model-predicted landscape unit value (LNBCVAL/UE) and the local community value (LNSTDSCORE) for (a) Muaredzi and (b) Nhanchururu . Histograms show the distributions of values for each variable.

4. Potential conflicts between conservation and livelihood systems uses

Both sites included a range of vegetation types, from open grassland areas through various savanna woodlands to thickets and forests. Thirteen vegetation types were identified for Muaredzi and seven for Nhanchururu, with 231 and 246 plant species, respectively. For both sites, it was the thicket and forest communities that were identified as being of greatest biodiversity conservation importance. These formations also had the highest local livelihood importance scores. These landscape units are likely to be under greatest threat from village-level consumptive use and, thus, are where the greatest conflict is likely to occur in terms of meeting both conservation and livelihoods needs. One possible solution for the Park management is to identify key areas of both high conservation and high local resource importance, and then regulate their use through zoning and co-management structures. Institutions could be developed to provide sustainable multiple-use opportunities to those communities with a high dependency and capacity to manage these resource units. Park management needs to develop and maintain functional relationships with these communities, with low levels of conflict and high levels of cooperation.

5. Trends in ecosystem services and their drivers

From the data collected, a number of ecosystem drivers and their trends can be identified in the two sites (Table 3). It should be noted, however, that ecosystem drivers interact across spatial and temporal scales, with varying magnitudes and directions of change; and that benefits and costs of declining ecosystem services within a community are not necessarily evenly distributed.

Table 3. Key ecosystem drivers and their potential consequences in Muaredzi and Nhanchururu, Mozambique.

KEY LOCAL-SCALE ECOSYSTEM DRIVERS AND TRENDS	CONSEQUENCES FOR PROVISION OF SERVICES
Increase in human populations and expansion of households (population pressure)	Reduction in wilderness areas due to extensification (Muaredzi) and intensification (Nhanchururu) of agricultural crop fields. Leads to decline in range of services from natural ecosystems (natural capital). Land degradation and soil erosion (seen in Nhanchururu) will be exacerbated leading to reduced land productivity. May necessitate changes in agricultural production technologies and more purchased inputs. Greater demands for the resources that the Park seeks to conserve, hence intensified conflict between Park management and the people will be inevitable.
Build-up of livestock populations (especially in Nhanchururu)	More supply of meat, milk, and other animal products, substituting some goods derived from natural ecosystems. Changes in ecosystem structure, composition and functioning, with possible land degradation, depending on stocking rates.
Increase in commercial timber extraction/deforestation (especially in Nhanchururu)	Short-term monetary gains at the expense of long-term provision of goods services from the wild as forests and woodlands are fragmented and/or degraded (changes in ecosystem function and structure).
More frequent floods and droughts than before (Climate change)	Increases in food inputs from purchased commodities due to scarcity and reduced land productivity.
More extensive and uncontrolled wild fires (especially in Muaredzi)	Changes in ecosystem function and structure impacting on provision of services (magnitude and direction of change depend on the fire regime).
Increase in wild animal populations in the park	Increased human-wildlife conflict, especially with large herbivores (e.g. elephants), predators (e.g. lions) and pest species (e.g. baboons).
Changing human values, beliefs and norms.	Leads to changes in the way people view their environment; how they manage their landscapes, etc.; may be beneficial or detrimental, depending on the nature of change. e.g. increased trade between villagers in Nhanchururu and Villa Gorongosa (urban) is leading to more importation of supplements into villages.

6. Gaps identified and lessons learnt

- The approach used in this research was shown to be effective and capable of using spatial data and/or site sampling to identify the importance of landscape units to local communities as well as the factors underpinning their importance.
- Landscapes are important for the bundles of ecosystem services that local communities derive from each location in the landscape.
- The preference-weighted sum of stocks of resources on a given site was a good predictor of the importance scores local people assigned to that location.
- Strictly enforced regulations, such as those prevalent in some areas of GNP and for some resources, did act to exclude users and thus greatly reduce the importance scores assigned to the given location.
- It was not clear whether techniques used enabled the CRUAT to separate costs of procuring benefits from its overall importance assignment (e.g. do people mentally calculate a net importance estimate for each location or do they develop a gross estimate and then evaluate the costs?)
- Development of the conservation importance scores was challenging because it was difficult to identify whose perceptions were of consequence. Derivation of importance scores for rarity or endemism was also difficult.
- The method was weakened because of failure to develop and use a cross-comparative reference point or importance object. There was no absolute zero or reference point to establish the relative importance scores assigned to goods, services, or landscape units across the sites. Thus, there is

limited ability to compare the effects of such things as tenure on the importance of landscape across the two sites.

7. Acknowledgements

This work was funded by the Centre for International Forestry Research (CIFOR).

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CASE STUDY NO. 3

Drivers of social-ecological change at Mt Coke

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Mt Coke (27° 28' E, 33° 00' S) is situated in the Eastern Cape province of South Africa, and was formerly part of the Ciskei Homeland under Apartheid. The area was re-incorporated into South Africa in 1992, and under the new dispensation falls within the Amatola District Council. With an altitude of 488m, Mt Coke has an annual average rainfall of approximately 500 mm per annum (S.E +/- 50mm).

1. Ecosystems and their services

A large proportion of Mt Coke is vegetated by Valley Thicket. When undisturbed, this vegetation type consists of extremely dense, semi-succulent thorny scrub forest interspersed with grassland areas. Valley Thicket has a very slow recovery rate after disturbance, and in many instances has retreated to river valleys.

People at Mt Coke rely on a variety of both on-farm and off-farm activities to secure their livelihoods. Woodlands, rangelands, natural streams and arable fields constitute the key natural resources on which people rely on a daily basis, from which building materials, fuel wood, food, grazing for livestock, medicines and drinking water are extracted. People do not appear to become less reliant on ecosystem services as they become wealthier. Figure 1 presents the results of a participatory wealth-ranking exercise, and helps to illustrate this point. Community members used the reliance on ecosystem services as an indicator of wealth. The wealthiest members of the community have the most livestock and therefore rely more on rangelands, while the poorer categories rely more on woodlands for building materials and fuel wood.

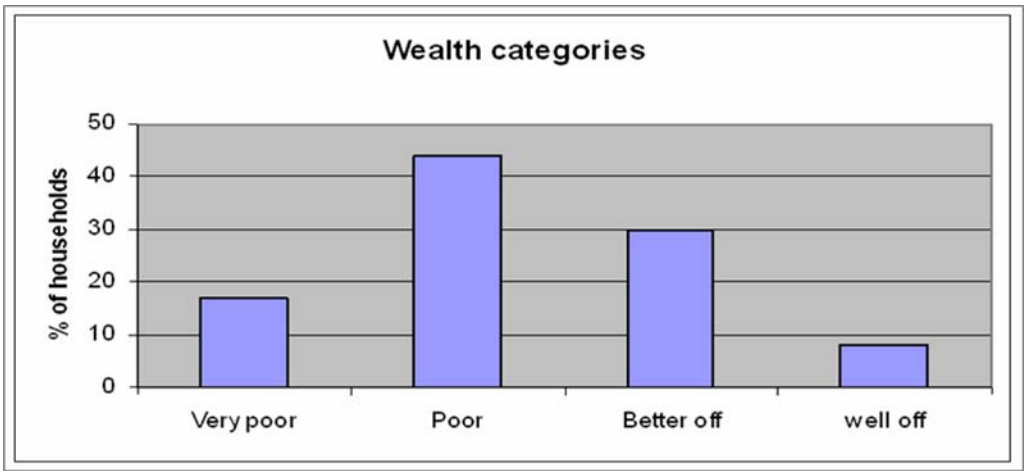

Figure 1: Results of a wealth ranking exercise at Mt Coke. [Categories – 1) *Very poor*: No income, depend on natural resources for fuel wood, building materials, and medicinal plants, food 2) *Poor*: Disability grant, depend on fuel wood and building materials, 3) *Better off*: A pension and one person working. Have more than three head of cattle, 4) *Well off*: More than two family members working. Up to forty cows, large fields, tractors

2. Ecosystem dynamics and trends

Land use trends
Land use preferences have changed dramatically at Mt Coke over the past few decades. Currently, grazing land is by far the dominant land use. According to official 1988 estimates cropping accounted for up to 80 % of the land use in Mt Coke. Today, local estimates place cropping at only 10.3 % of land use. A key symptom of this land use change has been the increasing flexibility of land use boundaries. Indeed, the total land use area has more than doubled since 1958 when the original boundaries were first assigned by the state - from 2925ha in 1958 to 5315ha in 2004.

Consequences
Land use change at Mt Coke is leading to landscape change. Woodland health (defined by community members as the ability of the woodland to continue providing services such as fuel wood, building materials and wildlife) is perceived to have declined. However, while woodland health has declined, the woodlands themselves have expanded, due in large to the invasion of opportunistic species such as *Acacia karroo*. *Acacia karroo* is an indigenous species that is useful, although not generally the preferred, fuel wood species. Analysis of orthographic photographs from 1979 and 1998 confirmed the perception of a growth in woodlands, which has taken place largely on abandoned fields. Therefore, bush encroachment appears to be a consequence, at least in part, of the process of land use change and field abandonment discussed above.

3. What is causing change?

The drivers of change at Mt Coke have been multiple, and their relationships with social and ecological trends at the local level are often complex.

3.1. Direct Drivers
The direct drivers of change are related to local level management practices, all of which are nested within broader scale changes. Key changes in management practices have included: a) changes in the level of cooperation between farmers; b) a shift toward home gardening rather than arable field cultivation, and c) changes in resource use patterns.

The extent of arable field cultivation is closely related to the ability of community members to co-operate with one another (Figure 2). Those who do not own cattle for animal traction, or cannot afford tractors of their own, are unable to cultivate fields without assistance from others. In 1990, political upheavals in the area caused by a coup against the president, lead to a great deal of distrust between families and therefore declining cultivation. Home gardening has increased dramatically in importance over the same time period. 94 % of households cultivate home gardens, and women ranked gardening as the most important daily activity. Similar ranking exercises performed for the 1990's indicated that collecting water and fuel wood were the most important daily activities. Currently, there is more time available for gardening since reticulated water and electricity arrived in 2000, and it has become more important since field cultivation has declined. Although fuel wood collection is no longer an important daily activity for women, 81 % of households still have fuelwood piles and *amagoqo* at their homesteads. However, of those who had fuel wood piles, 98 % claimed that these fuelwood piles would have been larger in the past. The most important reasons for this change have included; the recent access to electricity and other alternative fuels such as paraffin and a change in cultural values, which has decreased the importance of the *igogo* for women.

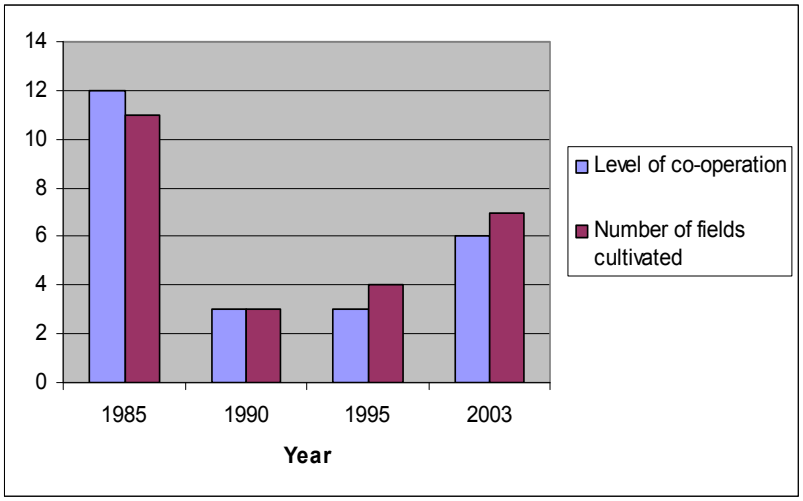

Figure 2. Results of participatory trend line exercises, indicating that the number of fields cultivated is related to the level of co-operation (social capital) between farmers.

3.2. Indirect Drivers
The indirect causes of land use change are related to state lead intervention into rural agriculture in the former Ciskei, nested within broader political ideologies and aspirations, as well as to various economic

and climatic changes taking place at the same time at the local, provincial and national level. These drivers, along with the direct drivers discussed above, are summarised in Table 1 and Figure 5.

Betterment Planning (1960 – 1975 at Mt Coke), and later the Ciskei Co-operatives Programme (1980's at Mt Coke) both represent direct state intervention into natural resource management. Both programmes sought to formalise farming practices, promote scientific farming methods and subsidise equipment and marketing of produce.

More indirect state interventions came in the form of the military coup in 1990, and basic service provision in the past decade – both have had indirect and often unintended impacts on local land use practices at Mt Coke. The coup lead to a collapse of government support for agriculture and resulted in a decline in the policing of transgressions of former rules regarding land use boundaries, access to common pool resources, and livestock numbers. These boundaries therefore became increasingly flexible, the impact that this has had on land use boundaries and characteristics has been discussed above. Basic service provision from 2000 onward has had indirect consequences in the form of declining reliance on streams and fuel wood. The provision of these services was in line with the national level Reconstruction and Development Plan (RDP) and the Water Services Act (108 of 1997), and was therefore linked to broader national imperatives.

Table 1. Direct and indirect drivers of change at Mt Coke

Period	Direct drivers	Indirect Drivers
1960-1990	Agricultural intensification, tight state control	Betterment planning, Ciskei Co-operatives Programme
1990 - 2000	Field abandonment, lack of co-operation between farmers, local rules collapse	Political unrest, dissolution of state extension services
2000 - present	Emphasis on home gardens, reliance on woodlands and natural streams declining, reliance on cattle increasing	Basic service provision, increased involvement in the formal economy.

Community members claim that rainfall has become far more difficult to predict in recent years, making cultivation risky. National rainfall data indicates that rainfall throughout South Africa declined steadily between 1980 and the 1990's, while temperatures increased steadily at the same time (Hoffman and Ashwell, 2001). In addition, a dry spell experienced between 1991 and 1995 is considered the driest sequence of years during the twentieth century in South Africa (Thought to be linked to an El Niño event).

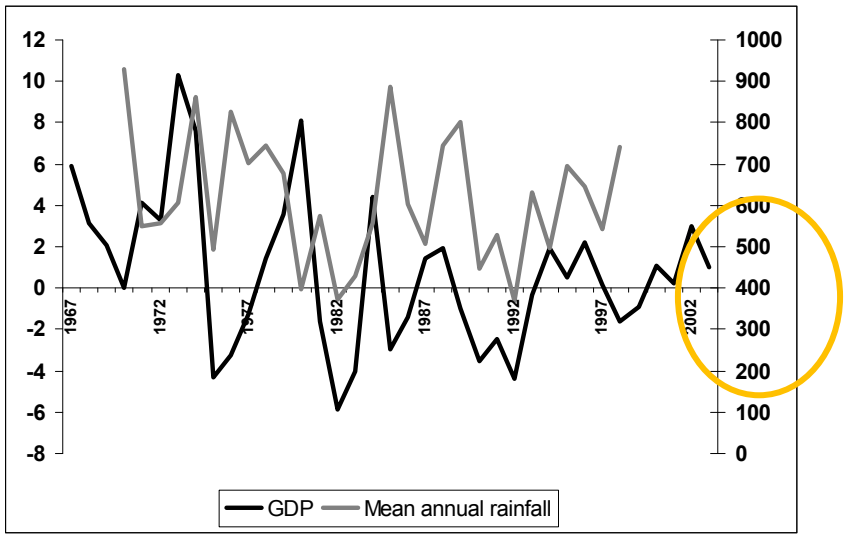

Figure 3: National GDP figures overlaid with rainfall data from Mt Coke. Note that the early 1990's were also a period of political upheaval in the Ciskei, and the period when large scale field abandonment took place.

Economic trends have also played their part (Figure 3). Between the 1960's and early 1990's the South African economy experienced relatively low growth rates, which, between 1989 and 1993, culminated in the worst recession since the 1930's (Rwelamira and Kleynhans, 1996). Rural-urban migration had been common place at Mt Coke since 1948. By the time that state extension services failed in the 1990's following the military coup, migration was no longer as viable an option as it had been previously due in large to the general economic downturn (Rwelamira and Kleynhans, 1996). Previously, according to local respondents, income from migratory work had allowed community members to purchase pesticides and fertilisers, and to hire tractors for the high input agriculture pushed by the state at the time. In the absence of this option, arable field cultivation became increasingly unattractive and a high risk activity.

Figures 2 and 3 should be considered alongside one another. The early 1990's were not only a period of low rainfall and economic hardship, but also of political upheaval and distrust within the community. Community members themselves relate the decline in cultivation to the early 1990 period, and the ecological consequences of this trend have already been discussed.

4. Responses and adaptations

Local people responded to the changes described above by employing a number of short-term coping strategies, and more long-term adaptive responses.

Short term coping strategies included technological adaptation (e.g. investing in rainwater tanks during drought); shifting preferences to faster growing and more abundant species (e.g. *Acacia karoo)*; drawing on social networks (e.g. sharing food during 1982 and 1992 droughts); and turning a blind eye to rule breaking (e.g. during the 1990 political crisis).

Long term adaptive responses have included: investing in diversity (e.g. multiple sources of income, food and livestock); ensuring flexibility (e.g. in resource boundaries, preferences, the role of women in food production); internalising ecosystem change (e.g. slow growing species like sneezewood not even mentioned in preferences), keeping options open (e.g. maintaining and letting go of taboos).

5. Take home message

People and ecosystems become more vulnerable when multiple drivers overlap. It is therefore essential to consider poverty reduction strategies within the broader political, economic and biophysical context in which they take place. An historical perspective is vital in order to better understand the interaction among drivers at different spatial and temporal scales.

CASE STUDY NO. 4

The complexity of a socio-ecological landscape in providing ecosystem services

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1. Key Ecosystem Services

Local people in the Kat River valley are highly dependent on their natural environment for a variety of other ecosystem services. A number of informants defined the degree of health or degradation of the environment in terms of its ability to meet their basic needs. Local people also described positive feelings when discussing their relationship with the natural environment. Examples included their love, appreciation and care of the environment. These feelings are primarily a consequence of the local people's high dependence on their natural environment to meet their basic needs. When the environment becomes degraded, and therefore no longer suplies an adequate number of resources, people's attitude and feelings towards the environment become negative. An integral aspect of the way local people relate to and value their local environment is therefore based on their dependence on it for survival.

In Cathcartvale, for example, a wide variety of plant species are utilized for fuel wood (21), medicinal plants (40), building materials (9), cultural species (7), edible plants (>6), grazing and forage (>47) and species of an economic value (2). This indicates the extensive use of the environment as a whole where species are harvested in, for example, mountainous grasslands, low lying acacia thicket and secondary forests. It also reflects the different practical benefits of species within one resource type. For example, some fuel wood species provide a lot of heat, other species are good for starting the fire, while some last a long time. The local landscape, therefore, supplies a wide variety of resources to local people. Table 1 has ranked these resources in order of importance to the villagers in Cathcartvale, with reasons.

Table 1. Resources of most value to villagers in Cathcartvale

Rank	Resource	Reason
1	Mountain water	Water is crucial to one's survival, and this water is healthy, unlike the river water.
2	Cultural species	Traditions are essential to the life of a Xhosa person and these species are needed when performing them.
3	Fuel wood	Used for many purposes, such as cooking, heating and traditions.
4	Livestock	Acts as a safety net; important for traditions; and supplies meat and milk.
5	Medicinal plants	Medicinal plants are used to treat many illnesses and play a role when performing traditions.
6	Building materials	Used for building homes, kraals and fences
7	River water	Acts as a safety net for when the mountain water dries up. Also useful for irrigation; washing in and provides drinking water for livestock.
8	Agricultural crops	Used as food; they are fresh and good for health; and will provide a constant supply of food.
9	*Imifino* (wild spinach)	Are healthy (full of vitamins); act as an alternative to meat; and are important when in poverty.
10	Honey	Treats asthma; useful when hungry in the bush; and has many vitamins.
11	Wild fruits	They act as a food supplement; have lots of vitamins; and are important in times of poverty.

The majority of local people expressed an aversion to leaving their rural lifestyle and moving to the city. One of the most common reasons was because the local environment meets their basic needs and they therefore do not need to spend money on a variety of services, including burial sites, physical health (medicinal plants), food (fish, wild fruits and herbs, livestock, agricultural crops), fuel (wood, dung), and accommodation (land, building materials). Ecosystem services also counteract poverty in another way as a variety of resources are sold locally. This includes medicinal plants, fuel wood and building materials while crafts are made to sell from the local reeds and 'bamboo'.

2. Cultural Services

The local AmaXhosa of the Kat River still retain many elements of their traditional worldview and eco-cosmologies, which has many characteristics of the Animist belief system. Great emphasis is placed on the spiritual aspect of reality. Misfortune and blessing are believed to have their source in the spiritual realm and the focus is therefore on controlling the spiritual realm by appeasing the ancestors. This worldview has had fundamental affects on people's relationship with their local landscape and how they value and manage it. Certain features in the landscape, including sacred pools, graveyards, caves, forests and the kraal, are important in connecting people to the ancestors and People of the River, and each therefore play a role in maintaining Xhosa culture and identity. These sites are where they can access their ancestors, as they are regarded as places of high spiritual intensity. They are also the portals where diviners can cross to the spirit world. Specific plants are critical for the successful performance of a ritual, while specific animals act as links and communicators between the spiritual and natural realm. These sites and species obtain very high significance in the lives of the amaXhosa. Some species, such as *Olea europaea* subsp. *Africana,* are integral to the amaXhosa belief system and can therefore be classified as cultural keystone species (Garibaldi and Turner 2004). These are species that are important to people's livelihoods and are thus encoded in rituals, traditions, ceremonies and songs. They become part of the cultural foundation of a group of people. Garibaldi and Turner (2004) believe that if these keystone species did not exist in a particular area, the society they support would be very different. A loss of these keystone species can thus affect the identity of a group of people. Informants from the Kat Valley gave vivid quotes of the effect that localised extinction of these cultural species would have on their culture. For example, one informant stated that this, "s*imply means the destruction of Xhosa people if these things are taken away from us".*

Informants gave three common reasons for the importance of sacred pools. Firstly, *amagqirha* (spiritual healers) receive their training at sacred pools and will occasionally be "*taken under the water*" to be directly taught by the ancestors. Secondly, sacred pools are important for the performance of rituals, especially those connected to the training of *amagqirha*. Thirdly, rituals are also performed to counteract illness experienced by an individual. Informants thus equated their life and health to the performance of these traditions.

These cultural services are, however, most evident when sacred pools are healthy because the ancestors then reside in the area and are at their most powerful. A healthy sacred pool is regarded as one that is big; has deep, dark water; is aesthetically pleasing and has a number of plants associated with the People of the River growing on its banks and hanging over the water. The common perception is that if these pools become environmentally damaged, or disturbed by the presence of too many people who are not entitled to go there, then the water spirits will move to another location that is more suitable. Once these pools have been abandoned, they have no spiritual power that the local people can access. Droughts or other extreme climatic conditions are also believed to result. This would have a devastating impact on the local community's health and environment. Thus when asked, "What would happen if sacred pools became degraded or disappeared?" informants gave the following responses: "*we would get sick*", "*we would be in danger*", "*we could become blind*", and "*we can't be alive*". The following quote sums up the importance of sacred pools for individual and community health. When asked if "the ancestors would be better able to help if the river was more natural?" the informant replied that *"if it was natural, we'd be stronger. Your physical health would be better as well, and the unity in the village would be stronger".*

Informants described how sacred pools played an important practical role during times of drought as they never dried up, and therefore provided an invaluable water source for both people and livestock. This is because they are typically the deep pools of water, but also because they are surrounded by dense trees, which may protect the water from evaporation. There is a widely held belief that the roots of *Salix capensis*, a tree associated with sacred pools and which is only harvested for ritual purposes, clean the water by filtering the leaves and sediment. If this is true, this could play an important role during drought, when the water is typically murkier.

When asked "*which species are most important to Xhosa people*", and "*which species does one find in a healthy environment*", the response was often those which are important to their ritual traditions, as indicated by the following quote: *"The most important species are ones for traditions: umnquma (Olea europaea* subsp. *africana), umdubi (Combretum* sp*) and umNgcunube (Salix capensis). These are most important to the life of a Xhosa person.*

When asked what would happen if these species were to be destroyed the responses were always negative. Comments included that the ancestors would be angry, the people wouldn't enjoy life, the

villagers would suffer because they wouldn't be able to perform their rituals and culture, and ultimately that their nation would die, as indicated by the following quote: *"Simply means the destruction of Xhosa people if these things are taken away from us".* The local people, therefore, see a direct relationship between the loss of these cultural services provided by the local landscape and cultural poverty.

3. Trends and Drivers in Ecosystem Services

There are a number of important drivers of change in these ecosystem services. In Cathcartvale a change in land ownership occurred in the mid 1980s from white and coloured to black ownership. There has consequently been a change in land use, both in terms of reducing the intensity of anthropogenic disturbance and type. This has affected the provision of ecosystem services both positively and negatively. The majority of people stated that there has been an increase in either vegetation cover or species richness. However, the general feeling towards this increase is negative and informants reminisced about the past. During this time the land was intensely managed in comparison to the present. It was consequently more open as there were less trees and more grass. It was thus easier to access resources, and livestock were easily seen. One-hundred percent of the informants interviewed saw the present increase in vegetation as negative. Respondents gave the following four main reasons: a dense forest is dangerous; we are unable to harvest resources in a dense forest (especially fuel wood and building materials); we are afraid of dense forests; and it increases livestock death. This indicates that utilitarian value does not depend on how many resources a landscape contains, but rather how accessible they are.

A change in cultural values, which is directly affected by the condition of the environment, is another important driver of change. In Cathcartvale there were at least 17 sacred pools; many of these are still treated with awe and respect and they retain their ecosystem and cultural services. This compares to the research findings at Ntlini and Fairburn, located further down the river and nearer to urban influences. Sacred pools were no longer revered and respected by the wider community and people began to harvest the valuable resources that grew near them and threw rubbish into the pool. A positive feedback resulted because, when sacred pools were harvested, they were no longer as dense, and were harvested further by the wider population. This compares to the past where "*when you looked at it you were afraid to go near it* [the sacred pool]*".* In Ntlini it was mentioned that the whole river used to be a sacred area, but as a result of degradation there are now very few sacred pools. Similar attitudes apply to harvesting of cultural species such as *Olea europaea* subsp. *africana.*

There is a close relationship between environmental degradation and resource value which was evidenced in Ntlini, a village located in a relatively degraded environment. Firstly, people are demotivated to harvest in an unattractive environment. Thirdly, people no longer spend recreational time in the bush which limits their capacity to accumulate ecological knowledge and monitor the environment's condition and there is consequently a loss of ecological knowledge. Local people also explained that the ancestors leave a degraded environment. Consequently the environment no longer acts as a medium connecting the Xhosa to the spiritual world. All of the above lead to a loss of knowledge, appreciation and value of the environment and it no longer supplies the vast array of ecosystem services. Consequently local people are less inclined to adhere to traditional and environmental rules, and poor harvesting practices are reinforced. As one informant expressed: "*As the environment is degrading people do not care more and more. They just say whatever is happening is none of my business".* The consequence is that ecosystem services are no longer as critical to local people's livelihoods as they are forced to find alternatives in this resource poor environment.

This study demonstrates the complexity of a socio-ecological landscape and the dependency local people have on ecosystem services for a livelihood and buffer against poverty

CASE STUDY NO. 5

PANRUSA (Poverty, Policies and Natural Resource Use, Southern Africa)

D.S.G. Thomas, D. Sporton & C. Twyman

PANRUSA (1998-2001) was a DFID project aimed to inform policy makers and implementers of the impacts of natural resource related policies on poverty and sustainable natural resource use in drylands, identifying best experiences and practices from adjacent countries with comparable natural environments. The project particularly focused on rangeland management. A series of reports and briefing notes provided extremely useful background in-depth case study information for this report. The outputs identify components of existing local, national and international policies that most enable and most disable positive sustainable dryland use and poverty elimination. Countries included Botswana, Namibia and South Africa.

Materials can be downloaded from http://www.shef.ac.uk/panrusa

CASE STUDY NO. 6

OKAVANGO – Botswana

Local Ecological Knowledge and the Basarwa in the Okavango Delta: The Case of Xaxaba, Ngamiland District

Masego Madzwamuse and Christo Fabricius

This chapter in the book edited by Fabricius, C. and Koch, E. (2004) (see below) uses a socio-ecological systems approach to understand the livelihood dynamics and natural resource dependency of the nomadic Basarwa (Bushmen) people in the Ngamiland District of Botswana. The case study focuses on the remote settlement of Xaxaba in the north-west corner of Botswana. The history of the Basarwa, their traditional lifestyle, the impacts of land use policies on their culture, mobility and flexibility, the adaptations they have made, their cultural values and traditions, their dependency on tourism, welfare, and natural products and the sustainability of their livelihoods are all considered. This case study provided much material that is referred to in this report.

The full reference is: Madzwamuse, M. & Fabricius, C. 2004. Local knowledge and Basarwa in the Okavango Delta. In: Fabricius, C., Kock, E., Magome, H. & Turner, S. (eds.). *Rights, Resources and Rural Development: Community Based Natural Resource Management in Southern Africa.* Earthscan, London. pp. 160-173.

CASE STUDY NO. 7

The Real Jewels of the Kalahari
Drylands Ecosystem Goods and Services in Kgalagadi South District, Botswana

Masego Madzwamuse, Brigitte Schuster and Bertha Nherera
Contributions from: Nathaniel Tlhalerwa, Kgosietsile Velempini and Jon Barnes
Edited by Carol Kerven
2007

Summary extracted from IUCN Report. IUCN, Pretoria

The study sought to identify the contribution of drylands ecosystem goods and services to poverty reduction, livelihood security and the national economy, illustrated by a case study of two dryland communities in the Kgalagadi District of Botswana. The aim of the study was to obtain a better understanding of how the economic contribution of drylands could influence national and international decision making. The study sought to answer the following questions:

- What are the ecosystem goods and services found in the study sites?
- Which of these services are key to the livelihood strategies of the local communities?
- What is the social and economic value of these ecosystem services?
- What are the implications of the case study findings to local and national development planning?

This valuation helps us answer practical questions of environmental policy such as: how much do our ecosystems contribute to our economic activities at national level? Does a given conservation investment justify its costs? How are costs and benefits of ecosystems distributed?

Botswana is an arid to semi-arid landlocked country that borders South Africa, Zimbabwe and Zambia. Over 80% of Botswana is drylands and three quarters of the total land area is covered by the Kalahari sands. The mean annual rainfall ranges from over 650mm in the northeast to less than 250mm in the southwest, but rainfall is highly erratic and the country is subject to periodic droughts. Roughly half of Botswana's population lives in the rural areas, using mixed agro-pastoral farming practices. Botswana's natural resources comprise range and arable land, woodlands, a large wildlife population and a variety of mineral deposits. Botswana produces over 30% of the world's diamonds by value.

Kgalagadi District is located in the southwestern corner of Botswana and constitutes about 10.5% of the country's total area. The district has an average annual rainfall of 150mm in the south to 250mm in the north; the terrain is flat, with occasional low rocky hills, plains or pans and sand dunes. There is no surface water except in seasonal shallow pans and fossil valleys.

The study methodology combined reviews of existing literature, household questionnaire surveys, focus group discussions and interviews with key informants. At the conclusion of field work, a seminar was organised to bring together experts on valuation from the region, local communities in Kgalagadi District and from another desert district, NGOs and Government economic development planners, in order to review the results of this study and to share experiences and lessons.

A combination of tools was used in the Kgalagadi study to assess the economic value of ecosystem goods and services:

- Market prices were used to derive direct use values.
- Benefits transfer methodology was used to assess indirect use values. This method involved the modification of land use economics studies conducted in Namibia or elsewhere in Botswana. These models were re-run with adjustments for a lower carrying capacity and slightly different plant species mixes, to get results that could be transferred to the Kgalagadi study area.
- Models for veld products use and fuel wood harvesting were based on empirical data from semi-arid northern Botswana and Namibia, adjusted to fit with the lower production conditions in the study area.

Both private and economic values were measured in this study. Private values quantified the turnovers, net profits and returns to investment realised by households or enterprises, as expressed in transactions in money or in kind. Economic values, on the other hand, represented the estimated amounts that

activities added to the national income. These estimates consisted of outputs less the costs of production, leaving the returns to internal factors of production, i.e., the capital, labour and entrepreneurship.

To measure total economic impact, the multiplier effect of an activity on the broader economy was considered. At the national level, the social accounting matrix (SAM) model for Botswana was used to derive the income or value added multipliers for different activities. The SAM is an input-output model of the whole economy, expanded to include income and expenditures at household level.

Dryland ecosystems in Kgalagadi South sub district provide a wide range of goods and services that are pertinent for local peoples' lives such as fuel wood, construction material, grazing for livestock, medicines, veld foods (vegetables and fruits) and scenic landscape with high tourism potential. Contemporary livelihood strategies combine Government drought relief projects, social welfare programmes, livestock rearing and collection of veld products (especially by female-headed households). Plant resources contribute to the livelihoods of the local communities on a seasonal basis and also in times of good rains. In droughts, wildlife and livestock become even more important because there is diminished plant nutrition and availability. Access to wildlife resources is now at a collective community level through a quota allocation. The community auctions this quota to private safari operators and uses only part of it for subsistence.

The following results were established in comparing the economic values of key resources:

Private direct use values were measured at a household level in order to ascertain the value of costs and benefits from the preference of the individuals affected. The net annual private profit for households was highest from livestock production at a mean USD 1,124 per household, followed by the utilisation of natural plants at a mean USD 270 per household. The community as whole realised a net private value of USD 3,590 from community –based natural resource management (CBNRM) and as a result of joint ventures with the community private sector realised an annual private net profit of USD 8,735. Private resources were more highly valued by local residents because they were controlled at a household level as opposed to CBNRM and tourism which accrued to a collective community fund.

Economic direct use values were estimated for Kgalagadi South ecosystems. These values estimated changes at national level in terms of incremental additions to national income. The total direct annual contribution made by the Kgalagadi case study ecosystem to the gross national income in 2006 was estimated at USD 191,260 (Pula 1.2 million). Of this amount, the biggest contribution came from the various plant uses (Pula 577,800), and the livestock production activities (Pula 429,000) of households. When the effect of the income multiplier on the broader economy was added, the total impact of natural resource use in the study area on the national income was USD 335, 680 (Pula 2.1 million). The multiplier effect was greater for tourism than for household and community activities, because tourism had many more backward linkages into the wider national economy.

The asset value of the study area represents the present value of the expected future contribution of the dryland ecosystem in terms of economic rent. The asset value of the study area was USD 984,200 (Pula 6.2 million), with the highest contribution – about half the value – coming from plant utilisation (Pula 3.8 million), followed by private sector tourism (Pula 2. 3 million) and CBNRM trophy hunting (Pula 170,000). Although the main economic activity in Kgalagadi South sub district is livestock production, the valuation exercise revealed that livestock production contributed nothing to the asset value of the study area since it generated very minimal economic rent.

Among the **indirect use values or ecosystem regulating and supporting services** were carbon sequestration, protection from erosion, and value as a wildlife refuge. These values were roughly calculated using benefits transfer methods based on more detailed work that has been done elsewhere in semi-arid Botswana. The main indirect use value was the annual net change in carbon sequestration, at USD 111,300 (Pula 700,0000). Protection from wind erosion, measured as annual production losses averted, was valued at USD 68,400 (Pula 430,000). The value of the study area in protecting wildlife which disperses i.e. the wildlife refuge value, was estimated at Pula 15,000 per annum. The value for groundwater recharge was estimated to be negligible.

This study raised some fundamental issues and challenges for national economic and development planning. These included:

- Veldt product markets are not formalised and remain underdeveloped and invisible in formal land use and investment plans at national and district levels.

- Cultural values are not adequately rewarded; for example, no formal benefits are derived by local residents for local knowledge and innovations through patents and royalties from the use of herbal teas or medicinal plants.
- There is a general lack of economic diversification at the local level i.e. livestock production concentrates only on beef production and not on the development of other by-products and small stock farming.
- Failure to pay attention to gender roles means that village institutions generally support male-dominated livelihood strategies such as cattle farming and wildlife-based CBNRM, which has left the livelihood strategies of female- headed households underdeveloped and vulnerable to poverty.
- Sectoral approaches to development planning have reduced opportunities to address dryland degradation and diversify livelihood supporting initiatives. For example, agricultural policies fail to take into account other goods and services provided by dryland ecosystems.

In sum, decisions regarding management of dryland ecosystems are made on the basis of economic, social, cultural and political considerations, but are often mainly based on economic calculations comparing the costs and the benefits of any planned initiative. It is therefore important that comprehensive information is available on the total economic valuation of drylands. This will require the design of innovative conceptual frameworks for the inclusive valuation of local social and ecological systems. Holistic and multidisciplinary approaches will enable a more accurate valuation of dryland ecosystem goods and services. Finally, improving the sustainability of dry lands depends on appropriate market incentives, product development in order to strengthen the economic base, and the transfer to the local level of knowledge on the valuation of environmental goods and services.

CASE STUDY NO. 8

Ecosystem services and poverty in arid and semiarid sub- Saharan Africa
Paulshoek case study

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1. Social context

Paulshoek is located in Namaqualand, Northern Cape Province, South Africa about 50 km from a small agricultural town called Garies and about 90 south of the nearest large settlement called Springbok. Paulshoek is comprised of a village settlement of nearly 500 people and a village commons of 20,000 ha. It is one of 10 villages in the Leliefontein communal area which is itself one of 7 communal areas in Namaqualand. Recent census data indicate that there are 112 house holds and 495 people. Of these, 279 are adults over 15 yrs of age of which only 51 are formally employed and 216 are children under the age of 15. Individual monthly income is only received by 169 people. Pensions and state welfare provides about two thirds of the village income. Eighteen people received between R800-R3200/month, 151 people received <R800 per month and 326 received no income. The average expenditure is R520 per household per month. There are no banking facilities while a nurse at a mobile clinic visits the village twice a month and a doctor once a month. There is a primary school in the village (up to grade 7) in which there are 80 learners and 4 educators. The number of learners has dropped by 30% over the last 10 years. A comprehensive summary of the social context of Paulshoek and Namaqualand can be found in Rohde et al. (2003), Wyn-Jones et al. (2003) and Hoffman et al. (2007).

2. Environmental and agricultural context

Paulshoek is located within a semi-arid environment and receives an annual average rainfall of between 150-200 mm falling in winter months (Apr-Sep). The region falls within the succulent karoo biome (an internationally-acclaimed biodiversity 'hotspot') and is dominated by perennial leaf succulent and deciduous and evergreen shrubs about 0.5 to 1.0 m in height. Livestock production and to a rather limited extent, dryland farming comprise the most important agricultural activities in the village. The overall contribution of agricultural production to the village economy varies from about 4-10% depending primarily on seasonal rainfall (Rohde et al. 2003).

3. Key ecosystem services affecting the well-being of the poor, trends, drivers and interventions

3.1 Water

Every household has at least a yard stand pipe. These were only installed in 2003. Prior to this people had to collect poor quality water from dug wells, boreholes, fountains and rivers (Atkinson et al. 2002, Titus 2002). The main water supply comes from a borehole about 5 km from the village. An electric pump is used to transfer water to reservoir tanks above the village from where it is gravity-fed to individual households. This arrangement is augmented by a water harvesting system established in the 1980s which collects water from a large gneiss dome in the village and stores it in a separate reservoir. Most houses also have small-scale, roof water harvesting systems which feed into 500 litre tanks. There is also minor use of water from a freshwater spring. The enhanced provision of water arose primarily from a national government development programme within the Department of Water Affairs and Forestry. This was associated with a sanitation improvement programme. Smaller contributions have also come from an EU research-led development programme (gutters and roof brackets) and local NGOs (water tanks). The response to increased availability of water has been for people to consume more water. Average consumption is 3.5 to 4 Kl/ month. The first 2 Kl is free. People with vegetable gardens consume more water than those without gardens. Consumption is seasonal and increases in the spring and summer months. An increase in usage has resulted in large water bills largely because of poor record keeping on the part of the municipality as well as water leaks and high consumption. Most of the excessive bills remain unpaid.

3.2 Fuelwood

Prior to the installation of electricity in the village by the national government in 2003 inhabitants relied on a wide range of fuelwood species for most of their energy needs including for warmth, cooking, baking and heating water (Solomon 2000). An economic valuation of this usage is provided by James (2001). Electrification has resulted in a reduction in the frequency of fuelwood use (from daily in 1998 to weekly in 2005) (Price 2005). The average distance travelled (roundtrip) to collect fuelwood is down from 7.2 km in 1998 to 4.3 km in 2005. Time spent collecting was 2.7 trips per 5 days in 1998 and is now 0.9 trips in 5 days. The overall amount of fuelwood consumed is down from about 8.5 kg per day in 1998 to 1.7 kg per day in 2005. Wealthier households have benefited more from the electrification programme than poorer households which cannot afford the cost of electricity and still rely on fuelwood to some extent.

3.3 Natural rangeland plants

The rangelands provide food for domestic livestock which allows about 40% of households to keep at least some animals on the range. Livestock ownership is aligned along gender lines although not as strictly defined as in many other African cultures. Sales, slaughters, milk, skins and donations contribute significantly to household income and maintain social networking. Livestock also maintain cultural identity and provide status. They are important for reciprocity relations (e.g. church auction, milk sharing, sharing of animals, marriage gifts, "coming of age" gifts, etc.). Slaughtered animals are also a key part of marriage and death functions. Nearly 95% of the rangeland has been grazed over the last 10 years (Samuels et al. 2007) at stocking rates nearly double those recommended by the Department of Agriculture. This assessment excludes the 200-300, uncontrolled donkey population which grazes the commons (Vetter 1996). Such sustained heavy grazing has resulted in a transformed landscape particularly on the sandy lowland areas (Todd and Hoffman 1999, Todd 2000, Riginon and Hoffman 2003, Petersen et al. 2004, Simons 2006). This pattern is also widely consistent across the communal lands of Namaqualand (Todd and Hoffman 2000, Anderson and Hoffman 2007) and is not a recent phenomenon. There are important implications for the region's environment and biodiversity (Allsopp 1999, Joubert and Ryan 1999, Seymour and Dean 1999, Mayer 2004, Pufal 2005, Mayer et al 2006, Allsopp et al. 2007, Richardson et al. 2007). Vegetation has not changed a great deal over the last ten years as the impact of livestock happened decades earlier. Herds are kraaled at night at between 20-30 stock posts. Their spatial location is determined by water points and the presence or otherwise of cultivated lands (Samuels 2006). Some stock posts are moved regularly while others never move. Both environmental and social reasons are important determinants of the frequency and timing of stock post movement (Baker and Hoffman 2005). The most important influences on animal numbers within the livestock sector include the annual variation in rainfall (Hahn et al. 2005, Richardson et al. 2005, Richardson and Hahn 2007a, 2007), change in market prices which encourages or discourages farmers to sell and the drought relief initiatives (i.e. provision of fodder) from the National Department of Agriculture. The post-2004 land reform programme has also played an important role in the livestock production sector. This initiative enables larger farmers to take animals off the commonage to the new land reform farms. Wealthier individuals have benefited more from this intervention than poorer individuals (Rohde et al. 1999, Rohde et al 2002, Lebert and Rohde 2007). An animal tax proposed by the municipality will further influence the livestock industry.

3.4 Crops (cultivated lands)

This once-important activity is now only undertaken by a minority of households although there are still 29 allocated croplands (saaipersele) including fallow lands. Together they comprise <5% of the total commonage. There 25 registered farmers of which about 7 on average have cultivated over the last 10 years. The main reason for cropping today is to provide extra fodder for animals. Cropping provides seasonal and temporary employment (150-220 person days of labour in a good year) for those who plough, harvest, thresh and winnow the crop. The owners of the croplands themselves generally don't make a profit and only twice in the last 10 years has a profit been recorded. Cropping is strongly influenced by seasonal rainfall conditions. The decline in its importance was started in the 1950s as villagers moved from subsistence to more of a cash economy (Hoffman and Rohde 2007, Rohde and Hoffman 2008).

3.5 Household gardens

More than two thirds of the households in Paulshoek have food gardens which provide a range of fresh vegetables to augment largely processed food diets. Food gardens provide almost the only source of fresh vegetables in people's diets since distance to nearest town is >50 km. Parastatal intervention initiated and maintained the programme through seed provision, training, advice and tools. Availability of piped water from 2003 and initiation of garden project in 2003 enabled the project to take off. Associated garden development at stock posts has also occurred and sporadically at the school. Early entrepreneurship plans are being discussed around market garden development. Although nutritional

improvement has occurred, payment for water has not occurred. It is largely because of non-payment that food gardens are viable and well supported.

3.6 Wild plant foods
Occasional and opportunistic use of a few fruits, seed, stems and bulbs as well as honey occurs. However, wild food plants are not considered very tasty and are generally not abundant in the landscape except in some seasons and even then only in low abundance. Consumption has declined significantly when compared to the 1940s and 1950s and is negligible today. Limited inter-generational transfer of knowledge occurs which helps to maintain cultural diversity and distinctiveness.

3.7 Wild animal foods
This service is negligible for village inhabitants because modernisation has affected taste and cultural perceptions of wild animals and their uses. Environmental education has also changed attitudes amongst the youth. However, for herders and their dogs the consumption of wild animal foods is still relatively important. The consumption of a few hyrax (dassies), hares, porcupines and more rarely aardvark, steenbok and klipspringer occurs.

3.8 Building materials
A range of shrubs are used for cooking shelters as well as rocks, poles, reeds for matjieshuts (Evans 2001), sand from river banks for building (cement), bricks and clay for outside ovens. Poorer inhabitants benefit especially. Modernisation and availability of more durable plastic materials as well as electrification has resulted in a decrease in the use of building materials derived from rangeland resources.

3.9 Traditional medicines (medicinal plants)
About 75% of the villagers use 15 main species which are found locally while 3-4 specialist herbalists use considerably more species from local area and surrounding district (Goldberg 1998). Traditional plants are also used for veterinary medicines (Waliszewski et al. 2003). Although many people still use traditional cures for common ailments (e.g. flus, colds, high blood pressure, stomach bugs, diabetes, wart removal and skin ailments, dandruff etc.), improved medical services have become more accessible for the treatment of chronic ailments especially diabetes and high blood pressure. Western medicine and health service provision to the village and presence of local hospital at Garies and the availability of chronic medication on state health scheme (post 1994) has also affected this shift.

3.10 Research Tourism
A ten-year research programme has contributed significantly to the village economy. There was little or no tourism activity prior to 1996 when a cultural campsite was started. Guest houses were built in early 2000s and upgraded in 2005/6. Unfortunately there are no records of this contribution to the village economy. However, records kept from March - Dec 2007 shows 126 people have stayed in the guest house (273 bed nights). The income of R12,300 has been used to pay labour to cook and clean guest house. Three field assistants are on the payroll of the research institutions with many more ad hoc payments. Presence of research institutions and internationally and locally funded research projects (e.g. BIOTA, CI, SKEP) are key to attracting researchers to the site.

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