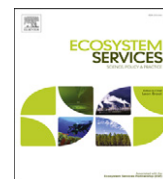




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An African account of ecosystem service provision: Use, threats and policy options for sustainable livelihoods

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ABSTRACT

Scientific work on ecosystem services has been growing globally as well as in Africa. Human dependence on provisioning ecosystem services in particular is mostly acknowledged in developing countries like those in Africa, where many people are poor and reliant on natural resources. The reliance of communities on natural resources in Africa varies from place to place as aridity, vegetation and socio-economic conditions change. In the humid and forested areas in the west and central parts of Africa, food and raw materials coupled with agriculture are important ecosystem services while in the dryer arid and semi-arid countries in southern and northern Africa, tourism, water and grazing are priorities. Overexploitation of resources coupled with large scale agriculture threatens both ecosystem services and livelihoods. The need to safeguard ecosystem services is urgent. There are some efforts to safeguard ecosystem services in Africa. However, realizing benefits to livelihoods still faces serious challenges due to climate change, recent land grabbing and urbanization. These challenges are compounded by the land tenure situation in Africa. Whilst policy goals have been established at both the international and national levels the implementation of such policies and likelihood of them leading to sustainable land management for delivery of ecosystem services remains a key challenge.

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1. Introduction

The Millennium Ecosystem Assessment (MA) highlighted both the importance of ecosystems to humans and the current state of degradation of many ecosystem services around the world. According to the MA, more than 60% of ecosystem services worldwide are being degraded or transformed (MA, 2005). The need to safeguard ecosystems and their services is urgent. Following the publication of the MA, scientific work on ecosystem services has been growing globally, and in Africa in particular (Layke, 2009). Research is necessary to account for their benefits to humans through monetary and non-monetary valuations; to identify priority areas for conservation action where the management of ecosystems will produce the greatest benefits for ecosystem services; and to evaluate the trends in degradation and declines in ecosystems and the associated effects on the ecosystem services they provide (MA, 2005; van Jaarsveld et al., 2005; Reyers et al., 2009; Egoh et al., 2011).

In Africa, where natural resources directly support the livelihoods of many poor people, numerous studies were carried out before the MA, focused on the sustainable use of natural resources (Naimir, 1990; Davies, 2002; Fabricius, 2004). Many African people depend on ecosystem services for the provisioning of wood for cooking, poles for fencing, wild animals for protein or water for drinking. Although ecosystem services are important in supporting livelihoods both in developed and developing countries, humans dependence on provisioning services is mostly acknowledged in developing countries like those in Africa where many people are poor and reliant on natural resources. In these countries, resources are also collected for sale to supplement household income. In west and central Africa, income from bush meat trade can be as high as \$1000 per year (see Davies, 2002). Despite being a resource-rich continent many African nations are still listed as the world's poorest, as measured by the gross domestic product (GDP) per capita, and many people live on less than \$1 per day and depend on ecosystem services for their survival (Chen and Ravallion, 2004). Research has highlighted the critical need for these natural resources to be managed sustainably (Western, 2003).

African ecosystems and the services they deliver face a number of threats. The economies of many African countries (e.g., Cameroon, Ethiopia, Malawi and Nigeria) are dominated by agricultural production and large areas of natural vegetation have been converted to this end. However, the imposition of Structural Adjustment Programs from the mid-1980s to the mid-1990s amounted to a drastic undermining of the most industrialized production through the removal of subsidies on improved inputs such as fertilizers, seeds and pesticides (Bryceson, 2002). This led to a decrease in large scale agriculture and a diversification of livelihoods into activities such as the small scale planting of fast growing crops (e.g., tomatoes) and crops planted year round (e.g., cocoa and coffee). People's dependence on natural areas also increased following the Structural Adjustment Programs. At present the conversion of land for the production of crops such as palms, cocoa, and coffee for exportation is increasing and foreign investors are leasing land for food production (Cotula et al., 2009). In some parts of Africa, large scale timber extraction still takes place, and this threatens both ecosystems and the livelihoods of

many communities. Policies that seek to curb degradation and promote the delivery of ecosystem services are urgently needed.

Africa has been identified as being one of the most potentially vulnerable regions to climate change, making the need for sustainable land use practices critical. The projected resultant changes are: increasing water scarcity, an increased diseases burden, collapsing agricultural yields, desert expansion and damaged coastal infrastructure (Brown et al., 2007). Many African governments' key priority is to improve the livelihoods of their citizens. This combined with climate change necessitates investing in nature and deriving benefits for society through ecosystem service provision. The growing momentum to safeguard ecosystem services around the world could be beneficial to Africans in a variety of ways, including through initiatives such as payments for ecosystem services (Pagiola et al., 2005).

In this paper we provide a descriptive review of ecosystem services and their varying importance to human wellbeing across Africa and we highlight the current research and themes that are emerging on this topic. We then briefly present novel approaches that have been trialed in Africa for conserving biodiversity and ecosystem services. Finally, we identify key threats to sustainable land use and service supply, and discuss policy initiatives and governance challenges that are specific to the African situation. We use examples from across Africa but highlight South Africa in particular as there has been an increase in research on ecosystem services following its inclusion in the MA. Throughout the paper, we use the MA ecosystem service framework in discussing different ecosystem services.

2. The importance of different ecosystem services in Africa

2.1. Diversity of service provision across Africa

The continent of Africa can be divided into six main regions: northern Africa (Morocco to Sudan), western Africa (Mauritania to Nigeria), central Africa (countries on the east of Cameroon to Democratic Republic of Congo (DRC)), eastern Africa (east of Burundi and Rwanda to Somalia), southern Africa (Tanzania to South Africa) and the Islands in the Indian Ocean (UNEP, 2006). Across these regions, the climate and vegetation is diverse. Central Africa and countries along the coast of western Africa are the most humid regions dominated by forests. Humidity decreases to the north and south (Fig. 1). Vegetation structure shifts in response to humidity from forest in the central parts of the continent to savanna and grasslands in the north and south.

The diverse climatic conditions and vegetation cover result in different ecosystem services delivered in different parts of the continent. The reliance of local people on natural resources varies significantly from place to place as aridity, vegetation, and socio-economic conditions change (Rebelo et al., 2010). In the humid and forested areas, found in the west and central parts of the continent, local communities rely mostly on food and raw materials such as non-timber forest products coupled with agriculture. For example, the hunting and trading of bush-meat in West Africa has developed into a large industry (Bowen-Jones et al., 2003). Timber extraction for export is also an important

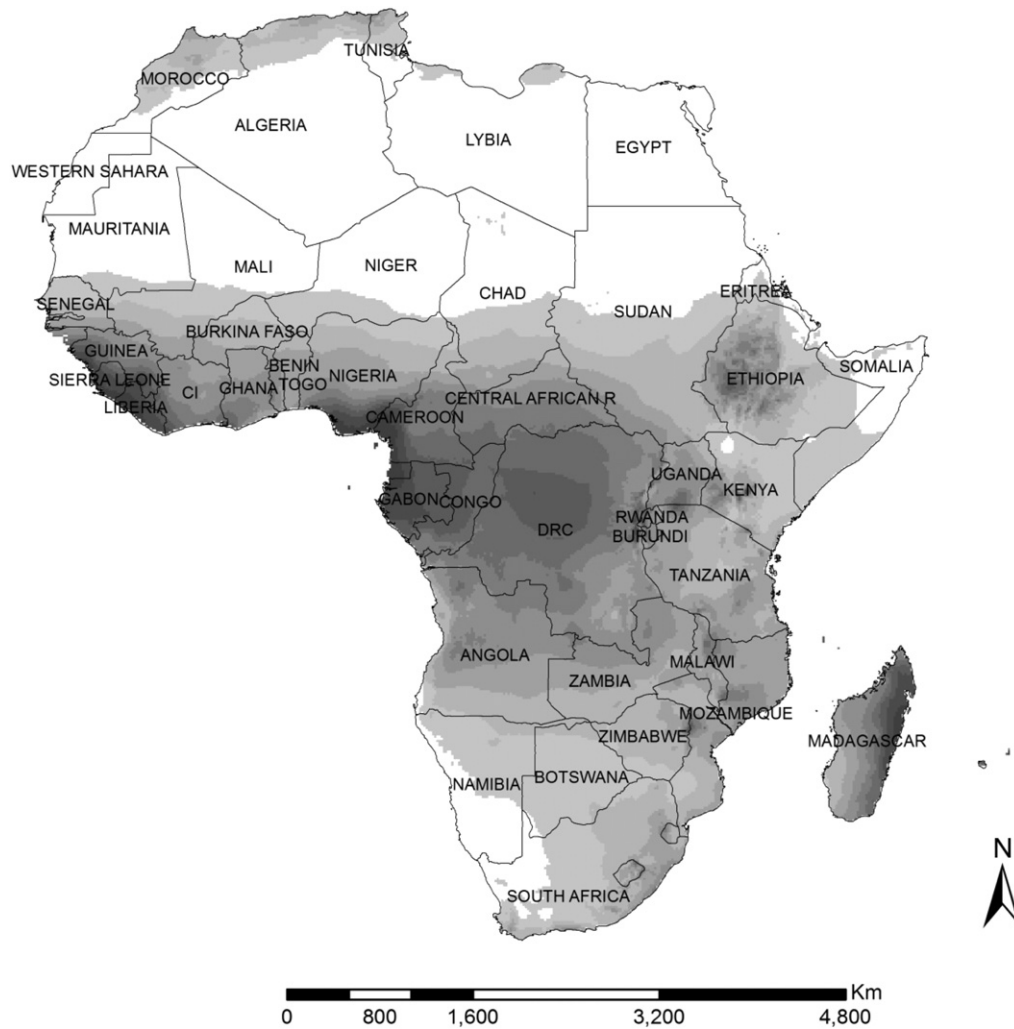


Fig. 1. Map of Africa showing aridity. The lightest areas are the most arid.

ecosystem service in these regions. Livelihoods are supported from a combination of these products as well as small to medium scale agriculture. In contrast, in the dryer arid and semi-arid countries in southern and northern Africa, tourism, water and grazing are important ecosystem services and have been included in assessments (Reyers et al., 2009; O'Farrell et al., 2011).

Terrestrial ecosystems are not the only ecosystems supporting livelihoods in Africa. In coastal countries like Ghana, Cameroon, Gabon, South Africa and Tanzania, livelihood strategies involve resource collection from both terrestrial and marine systems and locals tend to switch between the two systems depending on the availability of harvested resources. For example, Brashares et al. (2004) showed that years of poor fish supply caused by foreign fishing fleets in Ghana coincided with increase in community hunting in nature reserves and livestock consumption. In Tanzania, along the eastern coast of Zanzibar coastal communities have been engaged in farming and harvesting of seaweed (Msuya, 2011). In many parts of Africa whole communities are exclusively fishermen (e.g., in the Bakassi peninsular at the border between Cameroon and Nigeria).

2.2. The rural nature of Africa and its ecosystem service implications

Despite the diversity of environments found across the continent, more than half of African communities live in rural areas. For example, approximately 90% of Burundians, 88% of Ugandans

and 84% of Ethiopians live in the countryside (<http://www.nationmaster.com>). This large rural population means the majority of the people depend on various and varying ecosystem services used directly (wood/coal for fuel, water supply from natural streams for consumption) or indirectly. In rural communities where employment opportunities are limited many people collect natural resources for their own use or sell them to supplement household income (Yemiru et al., 2010). In many instances, the financial rewards are relatively small, but vital for poverty alleviation where there are no social support networks and facilities.

2.3. The importance of provisioning services

Provisioning services include the harvesting and collection of food and raw materials such as medicinal plants, fodder provision for livestock and water supply. Africans have a long history of using medicinal plants for curative purposes due to a lack of easily accessible hospitals and medical facilities. In many African countries, the sale of medicinal plants has become a significant source of income within some communities. For example, export of medicinal plants is a major foreign exchange earner in Cameroon, with annual earnings of 2.9 million dollars (FAO, 2002). Many plants are also collected for housing and fencing materials, as well as for craftwork such as baskets and bangles. In Namibia, the sale of baskets made from palms is an important income generating activity amongst women (see Box 1). Wild

Box 1

Case study: Importance of natural areas for local livelihoods in Salambala Conservancy, eastern Caprivi, Namibia. The eastern Caprivi can be defined as the “island” surrounded by the river Kwando, Linyanti, Chobe and Zambezi (Turpie et al., 1999). Twenty-three villages in the Salambala Conservancy were sampled. The provisioning service important to villagers includes grass, poles and reeds for thatching and fencing, hunting, grazing, wild fruits, wild foods, fish, medicinal plants and firewood. The selling of thatching grass is one of the three most important sources of cash income in the Caprivi region (Suich and Murphy, 2002). Palms are used for making baskets either for home use or for sale to both villagers and outsiders. Basket sale is the number one cash generating income for women in the study area contributing to about 37% of household income (Suich and Murphy, 2002). Medicinal plants are collected for use to cure diseases but not sold. There are only three clinics serving all 23 villages which makes the dependence on medicinal plants to cure diseases highly important. Ailments cured using medicinal plants include coughing diarrhea, child ailments and malaria.

Most resources are communally owned and are seen as a bundle rather than sectorally in the way government and other institutions often perceive them (Blackie, 1999). Usually there are a number of small villages in a village area (*silalo*), and villagers in an area are allowed to collect resources only within the boundaries of that area. Most people living in the same village are from one family and manage some of their resources together. For example, all the cattle are collectively herded. Most villages have access to both floodplain and forest in order to access both ecosystems for resource collection. In the wet season the cattle are grazed in the forest and in the floodplains in the dry season. (Source: Egoh (2002)).

fruits for personal use or for sales are also often collected. In countries, like Namibia, the collection of wild fruits and foods is especially important for school children and herders (Egoh, 2002). Shackleton et al. (2007) reported that forest products potentially contribute approximately 28% to the gross income of rural livelihoods in South Africa. Biomass, and in particular fuelwood, is estimated to account for 35% of energy consumption in developing countries and represents an important commercial commodity especially in peri-urban areas (EFTEC, 2005). Shyamsundar and Kramer (1996) estimate that the value of fuelwood is \$39 per household per year for communities surrounding the Mantadia National Park in Madagascar. The fuelwood collected from the forest amounts to almost 15% of the mean household annual income, estimated to be \$279.

One of the most important provisioning services in northern and southern Africa is fodder provision, particularly grass for livestock. This service and the resultant livestock produced are an important source of income to local people and also a source of protein to both locals and city dwellers. In western and central Africa, nomadic herders follow a transhumance lifestyle in association with pasture requirements. In these areas, bush meat provides an important source of income and protein (Bowen-Jones et al., 2003).

Surface and ground water supply are usually abundant in the humid areas of Africa because of high rainfall and therefore the challenges for water provision are infrastructural. In arid and semi-arid countries in the north and south of Africa, water is scarce. For example, South Africa is chronically water stressed and is already importing water from neighboring countries; water availability is predicted to be the single greatest and most urgent development constraint (Turpie et al., 2008). In arid and semi-arid areas water scarcity issues may be compounded by competing uses such as irrigation for agriculture.

2.4. The importance of supporting ecosystem services

African rural people depend on subsistence farming for their survival and cultivate crops such as maize, rice, and millet using minimal inputs. Using such practices, farmers rely heavily on ecosystem services relating to soil fertility, water supply and regulation, erosion prevention, and pest control. These same ecosystem services are of high value for the production of cash crops, such as coffee and cocoa. Soil fertility through the accumulation of soils and organic matter is arguably one of the most important supporting ecosystem services in Africa. The more fertile the soil the less inputs are required. The role of supporting services in protecting livelihoods is extremely important (e.g., providing the basis to support provisioning services, in protecting homes, providing clean water and moderating environmental risks), but their role in active poverty alleviation is sometimes much less clear than provisioning services (Brown et al., 2008). Abiotic resource extraction through mining, large scale agriculture and unsustainable use of natural resources now threatens not only soil services and other ecosystem functioning, but also biodiversity, and livelihoods (Fa et al., 2001; Davies, 2002; Bowen-Jones; et al., 2003; Ndoye and Tieguhong, 2004).

2.5. The importance of regulating ecosystem services

Regulating services that are of high value to Africa are mainly linked to agricultural production, including water regulation, disease and pest control, and pollination. As mentioned earlier, water is particularly important in arid and semi-arid parts of Africa found in the north and south of the continent. Cultivation practices are dependent on irrigation, therefore rainfall capture and storage are necessary. For example, more than 20% of South Africa is under irrigation which is the leading sector of water consumption in the country (Boutraa, 2010). In the Gauteng province alone, more than 94% of ground water is used in irrigated agriculture (Bohensky et al., 2004). In Egypt, between 68% and 98% of the country's agriculture is under irrigation (Boutraa, 2010). Agricultural production contributes substantially to household incomes (e.g., at least 27% of household income for both poor and rich in South Africa) making water regulation an important ecosystem services for poverty alleviation (Machethe et al., 2004). Water regulating services are also vital particularly in flood-prone regions (e.g., Mozambique and KwaZulu Natal province in South Africa). One of the worst recent flooding events in Africa was reported in Mozambique in 2000, resulting in an increase in infectious diseases following flooding incidences (Kondo et al., 2002). In eastern Africa, estimates suggest that more than 60 million people reside within 100 km of the coast, which equates to approximately one third of the region's total population (WRI, 2002). Such coast populations are highly vulnerable to flooding.

Pollination, though not studied in great detail in Africa, is an important ecosystem service that contributes to the livelihood of African people and requires conservation attention. Many crops cultivated in Africa are pollinator dependent (e.g., beans, cocoa, and coffee) but research on pollination is still in its infancy, with most of the studies having been carried out in South Africa (Rodger et al., 2004). The global trend of pollinator decline has also been observed in the Cape Floristic Region of South Africa. Many Africans also rely on specific ecological functions for pest control in place where insecticides, and substitutes for these chemical alternatives, have long been stopped by most governments as part of the Structural Adjustment Programs.

2.6. The importance of cultural services

Cultural ecosystem service provision includes tourism and leisure sites, natural heritage sites, the use of natural areas for

rituals and spiritual worship as well as the use of nature for education. Tourism is well developed and is an important source of income in northern, southern, and eastern parts of Africa as well as the oceanic Islands. The tourism industry is diverse and is aligned to the natural features of specific regions. For example, the primary motivation for tourists who go to Tunisia is the sea, sand, and sun (Marzouki et al., 2012). In contrast, tourists go to South Africa for the landscapes, high biodiversity, flowers and scenery (Turpie et al., 2003; O'Farrell et al., 2011). Income from tourism includes entry fees, the sale of handmade items such as crafts, baskets and mats, accommodation, food sales, or local transportation. Natural resource-based tourism is one of the greatest income generators in the Cape Floristic Region of South Africa, which is renowned for its beauty and floral diversity as well as other nature pursuits such as whale watching and angling, which contribute between 7% and 9% of the province's gross geographic product (Turpie et al., 2003). Although tourism is not as important in central and west Africa as the rest of Africa, many tourists visit these countries for game watching where locals benefit as tour guides.

Many African communities reserve a piece of land or section of river banks as a sacred place for worship and for communicating with their ancestors or for other traditional activities such as initiation. These sacred places that exist across Africa are believed to contribute significantly to the physical, mental and spiritual well-being of local people, and are also integral to their sense of cultural identity (Cocks et al., 2012). In Tanzania, more than 600 sacred groves exist in North Pare Mountains alone and comprise about 8% of the land. These small forests are the locations for sacrificial rituals to kin group ancestors and for initiation ceremonies (Sheridan, 2008). In addition to the landscapes and the forests, many plant and animal species are used for spiritual purposes (Egoth, 2002).

Despite many threats to biodiversity and ecosystem services coupled with associated vulnerability, Africa remains one of the most pristine continents (Western, 2003). For many years, Africa has served natural scientists, particularly ecologists and conservation biologists as an important study area to address many research questions. The use of nature for information and education is therefore an important cultural ecosystem service provided by the continent. Africa, with its large "pristine" savannas, forests, great lakes, and charismatic megafauna became very popular among field biologists in the late 1960s and 1970s (Western, op. cit.). Much research on conservation has been done in national parks around Africa. For example, the Serengeti National Park and Gombe Stream National Park in Tanzania, Luangwa Valley in Zambia, the Ituri Forest in the Democratic Republic of Congo (DRC), and Lake Malawi have drawn many researchers from Europe and America, dedicated to explaining everything from the origins of humankind to the behavior and ecology of large, free-roaming mammals, fish speciation, and the dynamics of "natural," unspoiled ecosystems (Western, op. cit.). Such research activities in Africa have some benefits to the African people, e.g., specific areas become known to the public at large and thereby increase tourism to such regions. However, ecosystem services of this nature still need proper recognition, which could be achieved through access and benefit sharing policies.

3. Ecosystem services research activities in Africa

3.1. The millennium ecosystem assessment experience

The MA included some study sites in Africa (e.g., Gauteng Province of South Africa, Zambezi Basin, and a regional site for Southern Africa). As part of these studies, van Jaarsveld et al. (2005) measured the condition and trends of ecosystem services

at multiple scales. The authors showed that over the period 1990 to 2000 freshwater resources appeared strained across the continent with large numbers of people not securing adequate supplies, especially of good quality water, which translated into high infant mortality patterns across the region. As a follow up study, Bohensky et al. (2006) used scenarios to explore four possible futures in a southern African river basin to understand future water provisioning services. These types of analysis are not only important for understanding the distribution of ecosystem services and the effects of its degradation on livelihoods, but also for understanding the causes of some of the challenges faced in Africa, such as high mortality and low life expectancy. The MA African studies provided an opportunity to experiment with innovative ways to assess ecosystem services, including the use of supply–demand surfaces, sources and sink areas, priority areas for service provision, service 'hotspots' and trade-off assessments (van Jaarsveld et al., 2005).

3.2. Mapping ecosystem services

The MA facilitated the grouping of research efforts around the concept of ecosystem services in Africa and the world. Since the MA, Africa has positioned itself as an important continent for research on ecosystem services with South Africa leading the way (see Costanza and Kubiszewski, 2012). A review of spatial indicators used for mapping ecosystem services around the world by Egoth et al. (2012) showed that approximately 20% of 67 studies were from Africa with most of African studies carried out in South Africa (Fig. 2). Case studies were carried out in Kenya, Namibia, South Africa, and Tanzania (Table 1). A review of first author's affiliation also confirmed that most of the authors of studies in Africa were based in South African institutions (8) with the rest in the UK (1) and USA (5). The availability of data and expertise that exist in South Africa has contributed to the work on ecosystem services in the country. The results of this review indicate that there is a need to build expertise to carry out the work on ecosystem services in other African countries. Data availability is also a potential limiting factor for mapping ecosystem services. Most of the studies in Africa were quantified using proxy methods. This could be partly due to the high costs of primary data collection, especially at national and continental levels.

The most frequently mapped ecosystem services in Africa were water and fodder provision, climate regulation, together with regulation of water flows, recreation, and tourism (van Jaarsveld et al., 2005; Bohensky et al., 2006; Egoth et al., 2008; Reyers et al., 2009; O'Farrell et al., 2011). Typically, mapping efforts have focused on the classical natural resources and agriculture related ecosystem services. Also the (potentially) new commodity services such as carbon sequestration/storage and tourism are intensively studied. Egoth et al. (2012) also found that despite their importance to the African community, so far no study has mapped the following: medicinal plants, ornamental resources, air quality, moderation of extreme events, waste treatment, pollination, lifecycle maintenance, nor inspiration for culture and design. Due to the ease of access and spatial and temporal coverage of satellite data, such sources play an important role in the monitoring of the earth's surface, especially in Africa where other data sources are poor (Brinkmann et al., 2012). Vegetation and land use maps are the most utilised data sources for mapping ecosystem services in Africa (Egoth et al., 2012).

3.3. Ecosystem services valuation and mainstreaming

Valuing ecosystem services is challenging as they are not often traded in the market. Despite the difficulty in valuing ecosystem services, there have been some valuation studies in Africa (e.g., Turpie et al., 1999; Naidoo and Adamowicz, 2005; Blignaut et al.,

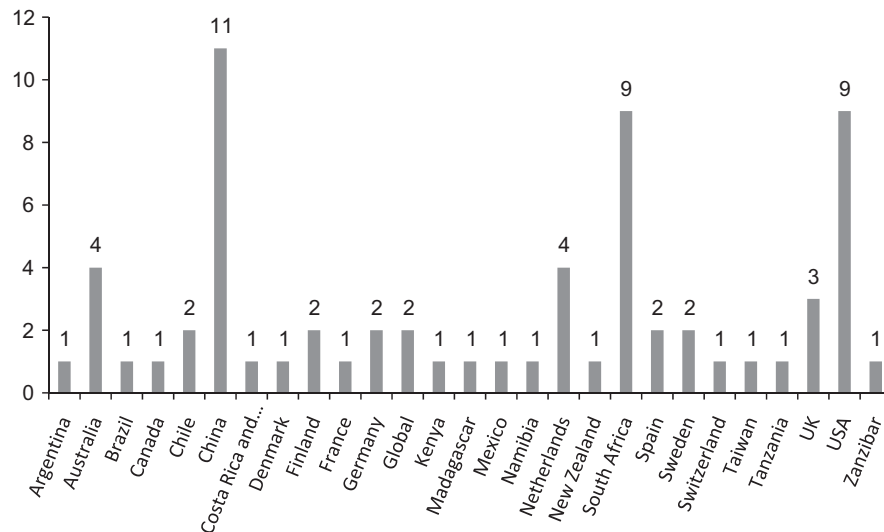


Fig. 2. Number of studies that have mapped ecosystem services per country (Egoh et al., 2012).

Table 1

Studies that have mapped ecosystem services in Africa and their main theme.

Source: Egoh et al., 2012.

Lead author	Year	Country of study	Extent of study area	Country of affiliation	Theme
van Jaarsveld Albert	2005	South Africa	Local	South Africa	Scenarios analysis
Egoh Benis	2008	South Africa	National	South Africa	Biophysical mapping and congruence
Van Wilgen Brian	2008	South Africa	National	South Africa	Effect of invasive species
Egoh Benis	2009	South Africa	National	South Africa	Congruence with biodiversity
Lange Glenn-Marie	2009	Zanzibar	National	USA	Economic valuation
Reyers Belinda	2009	South Africa	Local	South Africa	Biophysical mapping and trends
Swetnam Ruth D.	2009	Tanzania	Local	UK	Scenarios analysis
Chisholm Ryan A.	2010	South Africa	Local	USA	Trade off analysis
Egoh Benis	2010	South Africa	Local	South Africa	Congruence with biodiversity and Trade offs
Wendland Kelly J.	2010	Madagascar	National	USA	Economic valuation
Egoh Benis	2011	South Africa	Local	South Africa	Identifying priority areas for managing ecosystem services
Naidoo Robin	2011	Namibia	National	USA	Economic valuation
O'Farrell Patrick	2011	South Africa	Local	South Africa	Biophysical mapping and valuation
Simonit Silvio	2011	Kenya	Local	USA	Economic valuation

2008; O'Farrell et al., 2011). Along with the spatially explicit ecosystem service research in Africa, pragmatic approaches to ecosystem service valuation have been suggested by O'Farrell et al. (2011). The authors put the total annual values from grazing in the succulent karoo of South Africa at a range of \$19 to \$114 million, \$2 to \$20 million for tourism and \$300 to 3120 million for water. In another study, Naidoo and Adamowicz (2005) quantified the costs and benefits of avian biodiversity at a rainforest reserve in Uganda. They demonstrated that the economic benefits exceeded the cost of conservation and concluded that local biodiversity markets could play a positive role in tropical conservation strategies if the appropriate institutions for redistribution could be developed. In one of many examples given by Blignaut et al. (2008), investing in carbon sequestration in South Africa has the potential of creating about 240,000 jobs per year. These types of studies provide valuable information that could be used in the mainstreaming of ecosystem services into other sectors.

Important contributions to the mainstreaming of ecosystem services should come from African countries and the people themselves. Many examples exist in South Africa where conservation of natural resources is being mainstreamed into different sectors. Cowling et al. (2008) provide such a framework for mainstreaming of ecosystem services into local level ecosystem management. Restoration projects have been set up to improve

ecosystem services such as water supply and carbon storage, while benefiting local people. For the project "Working for Water" invasive alien plants are being removed to improve water supply while another project involves the planting of trees to store carbon (van Wilgen et al., 1998; Powell, 2009). Furthermore, Blignaut et al. (2008) and Rouget et al. (2010) used maps from Egoh et al. (2008) and combined them with a poverty index to identify areas where such restoration projects and other PES programs could be established to contribute to poverty alleviation. The grassland program in South Africa has also successfully involved civil society into nature conservation by engaging with the production sector (www.grasslands.org.za). Africans should be responsible for managing their ecosystem sustainably and harnessing the benefits to improve their livelihoods. Alternatively, exploitation of such natural resources may well be harnessed by other nations, potentially resulting in economic gain in other places while risking costs to the environment and local livelihoods. Recent entry of foreign investors into African countries leasing land for large scale agricultural development pose in many cases serious threat to biodiversity, ecosystem services, and livelihoods (Cotula et al., 2009).

International initiatives on ecosystem services in Africa are growing. These include "Valuing the Arc", The Natural Capital Project and other MA follow up research (e.g., PROECOSERV; www.proecoserv.org). Valuing the Arc was a five-year research and

policy program (2007 to 2011) with the aim to improve knowledge of the ecosystem services provided by the eastern Arc Mountains of Tanzania. This included their contribution to human welfare and to find solutions to managing the services in a sustainable manner (<http://www.valuingthearc.org/>). While most of the work and expertise on ecosystem services is concentrated in South Africa, it is important to develop capacity in other parts of the continent. It is hoped that the newly formed research centre for ecosystem services and livelihoods (IRT) at Pretoria University will play a key role in training students not only in South Africa but also from other African countries.

4. Efforts to conserve biodiversity and ecosystem services

The pressure on ecosystem service supply and biodiversity in general, coupled with the identification of several biodiversity hotspots in Africa (Africa holds about 40% of the world's biodiversity), has generated a spin-off of conservation activities in the continent, mainly the establishment and management of protected areas (Myers et al., 2000; Mittermeier et al., 2005). Scientific work has therefore focused on the ecological and social impact of extraction of natural resources and other human activities in protected areas (De Boer and Baquete, 1998; Campbell et al., 1999; Grundy et al., 2000). Within Africa, many areas have been identified as ideal candidates for protection of biodiversity due to the lack of development. The designation of strict protected areas in Africa has created much conflict with local communities with the need to find a balance between resource use and preservation of nature (De Boer and Baquete, 1998). As a response to these needs some protected areas allow for various kinds of access to local people living around them (Locke and Dearden, 2005; Dudley, 2008).

In countries where communities have ownership of land and legal rights to provisioning services, communities are opting to collaborate with conservation organizations in order to derive win-win outcomes through Community Based Natural Resource Management (CBNRM). This has become an attractive approach to land management around Africa (e.g., Kenya, Namibia, Mozambique, Tanzania, Zambia, Zimbabwe), and aims to improve the socio-economic situation for rural communities, and to maintain or improve the natural resource base through sustainable land use management (Emerton, 2001; De Kock, 2007). Zimbabwe's CAMPFIRE, developed in the mid-1970s, is both a rural development and a conservation programme and is considered the pioneer of CBNRM initiatives in southern Africa (see De Kock, 2007; Nelson and Agrawal, 2008). Since then, the number of conservancies has increased following the income this approach has generated for communities with high wildlife value and tourism potential (Jones and Murphree, 2004). By 2010, at least 50 CBNRM institutions were present in Namibia one of which is the Salambala conservancy (Box 1; Suich, 2010). Recent research in this conservancy suggests an increase in wildlife and tourism activities since the initiative began. According to interviews conducted by De Kock (2007) in the Salambala conservancy, 100% of the respondents said that the conservancy is generating benefits to local communities, and more than 90% want the conservancy to continue. The establishment of the conservancy has boosted tourism with positive effects on sale of local products such as baskets and mats.

These types of resource management initiatives are still ongoing especially in southern African countries. A recent development is the establishment of large trans-boundary protected areas in southern Africa (Peace parks). The establishment of large nature reserves is an important conservation strategy that could benefit ecosystem services. Target 11 of the Convention on

Biodiversity (CBD), is focused on the expansion of protected areas to 17% of terrestrial surface (CBD, 2010). At present most African countries have between 9% and 10% of terrestrial land listed under IUCN protected areas (Jenkins and Joppa, 2009). New biodiversity targets present an opportunity for African nations to set aside protected areas that benefit not only biodiversity but also ecosystem services and should be carefully planned to integrate the needs of local people. Wise et al. (2012) showed that for the expansion of protected areas in the Cape Floristic Region in South Africa contracts with landowners (offering compensation to landowners for foregone production and development opportunities) was more cost effective than the cost of land acquisition. High cost of land acquisition and the current land tenure situation in general in Africa, coupled with potential conflict with other land uses means that more innovative approaches should be employed when expanding protected areas. Large conservancies or trans-boundary protected areas which include villages could play a key role as conservation areas and migratory corridors, protecting biodiversity and benefiting many ecosystem services if they are under CBNRM programs. With the growing momentum on ecosystem services, such initiatives may become instrumental in safeguarding biodiversity and associated ecosystem services while benefiting local communities.

Most of the conservation initiatives discussed here have been geared toward biodiversity with ecosystem services often seen as a secondary benefit. In the past, some nature reserves have been set aside specifically with the aim of improving the delivery of ecosystem services. An example is the Drakensburg Maloti National Park in South Africa that was designated for water supply and is still protected by the South African Water Act 54 of 1956 as amended and the National Water Act 36 of 1998. In fact, many parks are used for recreational purposes around the world.

At present, ecosystem services are rarely included in prioritization procedures in their own right (Egoh et al., 2007). With the increased recognition of the importance of ecosystem services, it is time for conservation efforts to explicitly include ecosystem service priorities alongside biodiversity initiatives or revert to the setting aside of parks for ecosystem services where necessary.

5. Threats to livelihoods and ecosystem service provision

Safeguarding ecosystem services and realizing benefits to livelihoods faces serious challenges because of the threats of the effect of climate change, recent land grabbing in Africa, and current trends in urbanization in the continent.

5.1. Climate change

Africa is one of the most vulnerable continents in terms of climate change. Increases in global temperatures will result in a decrease in crop yields (of up to 30%) by the 2080s (Parry et al., 2004). Climate change will also result in the increase of some climate related diseases in African countries. Patz et al. (2005) estimated relative changes in a range of climate-sensitive health outcomes including: cardiovascular diseases, diarrhea, malaria, and malnutrition, for the years 2000 to 2030 and showed that the highest mortality rates would be in sub-Saharan Africa. Another study that assessed the vulnerability of national economies to the impact of climate change on fisheries identified countries in west and central Africa as most vulnerable (Allison et al., 2009). Most African countries depend on fish as a source of protein and income particularly in the coastal countries of west and central Africa (e.g., in Congo, 45% of animal protein is from fish). Negative

effects of climate change on fish production will have serious impacts on the livelihoods of locals in such countries.

5.2. Livelihood displacement by foreign powers

The recent food and energy crises around the world have led to a global land grab, or 'foreignisation of space' as described by Zoomers (2010). Many developed nations in an attempt to meet demands for energy and food in their national territories, are opting to lease land in developing countries in unused productive cropland. Africa is a primary target location for such initiatives with a total of about 2.4 million hectares of land from Ethiopia, Ghana, Madagascar, Mali and Sudan leased to foreign investors between 2004 and 2009 (Cotula et al., 2009). This land grabbing with similar leases is increasing in many more African countries such as Cameroon and the DRC. Large scale agricultural investments possess a serious threat to the safeguarding of biodiversity, ecosystem services and livelihoods in African countries. While African leaders see the entry of foreign investors as an opportunity for development which includes job creation and infrastructure development, many local communities are being ejected from land by their own governments. This land is then offered to foreign investors with inadequate or no compensation and with no options for resource collection or small scale farming often practiced by communities (Cotula et al., 2009).

5.3. Urbanisation

In terms of population, Africa is urbanizing faster than any other continent and the population is expected to more than double from 300 million in 2000 to 750 million in 2030 (UNFPA, 2007). This shift in land use is associated with sprawling settlement development and an associated loss of natural ecosystems. This has massive implications for the delivery of ecosystem services, biodiversity, and human well-being; particularly given the chronic poverty levels in Africa (UN-HABITAT, 2008). Future ecosystem service research needs to prioritize these emerging trends, understanding both the impacts and changes in services within urban areas and those beyond. Some initial research has started to explore the ecosystem service shifts with these rapidly urbanizing African cities. O'Farrell et al. (2012), examined the effect of urban growth on nine different ecosystem services, and found that all had decreased from their potential level. Provisioning services in particular were affected with reductions between 30% and 50% depending on the service. Their study highlights the significance of the loss of regulating services which, while less threatened than other services, are potentially more problematic when lost as these services cannot be transferred but must be delivered in situ. Provisioning services (e.g., the provision of food) can be outsourced to areas beyond the city boundaries, whereas this is not possible with most regulating services (such as flood mitigation and coastal zone protection).

6. Ecosystem service policies and governance

6.1. Policy initiatives to improve ecosystem service provision

Following the publication of MA, ecosystem services are being included more into environmental policies due to the acknowledgement of their contribution to the world's economy and human well-being. At the global level, the CBD has set new targets for 2020 which includes the management of biodiversity for the delivery of ecosystem services. Target 14 deals specifically with the need to safeguard ecosystem services for improvement of livelihoods and well-being and emphasizes the needs of

women, indigenous and local communities while Target 15 deals with climate regulation (CBD, 2010). More than 90% of African countries are signatories to the CBD, thus the African Union (AU) is working closely with the CBD on biodiversity conservation and has a biodiversity strategy for 2020. There is some commitment to the safeguarding of ecosystem services while reducing poverty in the continent. African environmental ministers, signatories to this convention, have recently identified the following priorities:

- Enhanced financial support, including through innovative ways of mobilizing financial resources (e.g., via payment for ecosystem services (PES)).
- The reduction of deforestation via reduced emissions from deforestation and degradation (REDD).
- The support of establishment of Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services (IPBES) and full contributions to such a platform including the creation of a pan-African committee.

A potentially important global policy instrument that may benefit Africa are PES schemes where individuals practicing sustainable land use are paid by those benefiting from such sustainable land use practices (Pagiola et al., 2005). REDD is a form of PES where countries that decrease their rate of deforestation are compensated (<http://www.un-redd.org/>). Although a relatively difficult concept to implement, PES schemes are becoming more and more popular amongst governments, businesses and scientists (Pagiola et al., 2005). The basic requirement for PES is to understand what ecosystem services are produced where, by whom and where the benefits are realized and by whom. The introduction of PES, especially through the REDD initiative could lead to a potential reduction in undesired land conversion while livelihoods are improved in Africa. Many challenges remain and include the valuation of ecosystem services. The international body charged with the economics of ecosystems (TEEB) is an important initiative that could help overcome this challenge (<http://www.teebweb.org>). TEEB is an international initiative that is yet to be endorsed by many African countries. However, TEEB is now being coordinated from UNEP offices and regional workshops are being held one of which was North African countries. TEEB related activities in Africa include the strengthening of protected area financing and management systems and the valuation of wetlands and forest in North Africa (an activity which has already been finalized) (UNEP/CBD, 2012).

Other international bodies are also emerging with the specific aim of generating scientifically sound information for decision making to safeguard specific or multiple ecosystem services. These include IPBES which was agreed to be formed by more than 90 countries around the world and charged with providing scientifically sound information to support decision making on biodiversity and ecosystem services (<http://www.ipbes.net/>). Most of these initiatives are driven by the UN and guide decision making implemented at the level of the member states including the majority of African countries (54 out of 56 African countries are members of the UN).

6.2. Implementation and governance challenges

Whilst policy goals have been established at both the international and national levels the implementation of such policies and the likelihood of them leading to sustainable land management for delivery of ecosystem services remains a key challenge. For example, the CBD requires each country to have a National Biodiversity Strategic Action Plan (NBSAP) including a national spatial biodiversity assessment. It is the responsibility of each

country to implement this policy action. At least 40 African countries have NBSAP and South Africa is one of the first countries to have a national biodiversity assessment (Driver et al., 2005). These national biodiversity assessments are carried out at the regional levels as well, while taking into consideration nationally identified priority areas. Outcomes from these processes should be implemented by national and local authorities at the level of land parcels. Land ownership and governance structures are extremely important in the implementation process. In South Africa conservation authorities have initiated a stewardship program with landowners to help them manage their land in a sustainable way. This is possible because South African land tenure is divided between government, private and communal land owners. Private landowner can voluntarily become part of the stewardship program. Outcomes from the national and provincial spatial biodiversity assessments are used in land use decision making when members of the public apply for land use permits. Aside from this site specific implementation, South Africa is on its way in expanding its protected areas with the aim of increasing the protection of currently under protected grassland biome. The grassland program in this country has included ecosystem services in its spatial biodiversity assessment and presents an opportunity for safeguarding them (Reyers et al., 2005). This program is working with landowners from the agricultural production and mining sectors in South Africa to set up PES schemes. According to King et al. (2005), at least 13 other PES initiatives had been established in South Africa by 2005. Successful implementation of PES or other sustainable land use initiatives depends highly on land ownership.

Most of the land in rural Africa is owned by the government with local communities only having user's right with no land title or registration. According to the World Bank between 2% and 10% of land is held under formal land tenure, mostly in urban areas (Deininger, 2003). According to Cotula et al. (2009), some of the biggest challenges to the implementation of REDD includes weak governance and insecure and unclear land tenure. Fenske (2011) found a link between land tenure and investment in fallow and tree planting in West Africa. Insecure land tenure can drive resource degradation because users may have little incentive to protect resources if they have no stake. Full right over land should encourage investment because land rights strengthen claims to the fruits of investment, increasing access to capital, allowing for gains from trade, and providing the cultivator with freedom to innovate (Fenske, 2011). Alternatively institutions need to be strengthened and aligned to community needs and ecosystem service management requirements.

Cotula (2012) reported that, in Francophonie Africa (e.g., Cameroon, Chad, Mali and Senegal) communities can enjoy user's right as long as they put the land into use (a process called *mise en valeur* requirement). In such countries, any un-used land belongs to the government. When land is in use, the government has the right to evict people from the land if they need it, with little compensation for loss of "improvement" (e.g., crops or building). Having access to resources but not ownership can lead to over-exploitation and degradation. An example is the collection of abalone on the east coast of Cape Town, South Africa. Data show that this fishery was managed sustainably for 50 years (Hauck and Sweijd, 1999). With socio-economic and political changes in the 1990s, resources were harvested illegally which resulted in the complete closure/collapse of the fishery (see Raemaekers et al., 2011). One factor highlighted for the collapse is the failure to accommodate many traditional fishermen in the legal fishing rights framework of the post-Apartheid fishery (Raemaekers et al., 2011). Appropriate incentives for fishing fleets and good governance have been demonstrated as necessary for successful fisheries management (Hilborn, 2007).

Land tenure is also a key factor if REDD is to lead to improved livelihoods. If the state is the primary owner of the land, revenues from such initiatives will go to the state. In such cases local communities may continue to manage land unsustainable if they do not benefit from such systems. Current land deals with foreign countries are government leases. In Ethiopia and Mali, all land agreements are of this nature. However, in some countries (e.g., Ghana) traditional authorities have retained control of land (Cotula et al., 2009).

7. Conclusion

Most African people live in rural areas and are highly dependent on ecosystem services for their survival either through the collection of natural resources for direct use, or benefiting indirectly through range of regulating ecosystem services. Unsustainable land use practices threaten biodiversity, ecosystem services, and local livelihoods. Key issues impacting on service delivery relate to the vulnerability of the African continent to climate change, rapid urbanization, and the occurrence of land grabbing by foreign nations for food and biofuel production. Unsustainable use of ecosystem services coupled with other challenges discussed in this paper will be exacerbated in the future if projected increases in population are realised (UNFPA, 2007). There are many national and international policies to conserve biodiversity and ensure the delivery of ecosystem services. However, implementing such policies is complicated by land tenure issues. While international PES programs such as REDD could benefit some African nations, local incentives are needed in most countries. Target 11 of the CBD provides an opportunity for countries to integrate the needs of local communities in the identification, expansion and management of protected areas. CBNRM initiatives already practiced in many African countries appear to offer potential for both safeguarding ecosystem services and improving livelihoods. Solutions to these issues will have to come from the African people. Africa has the expertise to build a strong research program on ecosystem services which could address these challenges. Here South Africa is ideally placed to lead this research whilst simultaneously building capacity in other African countries.

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