Review of Case Studies on Successful Measures to Manage Land Use, Protect Land, and Mitigate Land Degradation

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Abstract

Land degradation is a major concern on matters relating to sustainable agricultural development and long-term food productivity in Africa. Not withstanding other factors, land degradation in most African countries has been driven by disparities in land distribution. This has led to a concentration of people on limited portions of land and the need to address their development needs and issues of food security. The degradation of soil has been further exacerbated by the subsequent increase in population on marginal lands. Agriculture continues to play an important role in sustaining the livelihoods of most African communities. It is often affected by climatic variations, which contributes to land degradation. Some efforts have been undertaken to reverse the process of land degradation and to promote sustainable land practices. These efforts vary at different communities depending on the nature and cause of degradation. It is a joint effort of governments, communities, research institutions, academia and non-governmental organizations. This paper reviews case studies on successful measures to manage land use, protect land, and mitigate land degradation in selected African countries.

Introduction

Land degradation occurs mostly because of land management practices or human development that is not sustainable over a period of time. Long-term food productivity is threatened by soil degradation, which is severe enough to reduce yields on approximately 16 percent of agricultural land, especially croplands and pastures in Africa. About 46 percent of the African continent is threatened by the processes of land degradation (World Meteorological Organization [WMO], 2005). Many countries in Africa experience severe climatic perturbations, resulting in droughts of varying intensities, which are often characterized by severe spatial and temporal fluctuations in rainfall with high variability. This affects issues relating to food security, crop production, and general agricultural economics. Land degradation is partly a result of the interrelationship between an increase in population and a decline in agricultural productivity.

Several projects have been undertaken at varying scales in Africa to address the problem of land degradation in a quest for sustainable agricultural development. These projects range from capacity building, farmer-extension participatory approach and researcher managed trials, promotion of sustainable land management practices, and the use of climate information and geo-information technology in informing sustainable agricultural development. This paper

provides a review of successful case studies to manage land use, protect land, and mitigate land degradation focusing on South Africa, Namibia, Morocco, and Uganda.

South African Case Studies

Measures to Protect Land, Manage Land Use and Mitigate Land Degradation

Sustained agricultural production and sustainable rural livelihoods are underpinned by an ecosystems approach comprising the integrated management of the land, water, and biological resources. In South Africa, with diversity in both natural resources and management, best practice technologies per ecosystem are at the core of sustainability. Implementation of sustainable agricultural development projects is in line with several international agreements including the World Summit on Sustainable Development (WSSD).

LandCare Programme and Water Harvesting Techniques

The Natural Resource Management Programme is largely encompassed in the country's LandCare Programme initiated in 1989 and the consequent LandCare Policy. The LandCare Programme is a community-based and government-supported programme to promote sustainable land management practices and to stop and reverse land degradation. More than 300 rural development projects have been implemented and these multidisciplinary projects follow an integrated ecosystems approach. The success of LandCare projects are attributed to the adoption of best management technologies utilized in on-site experimentation and demonstrations. South Africa's LandCare programme was designed in recognition that land degradation and water shortages are serious environmental threats, affecting each and every person through the economy, the environment, and poverty.

Small-scale and homestead crop production are often practiced in areas marginal for crop production as a result of low, erratic, and unevenly distributed rainfall and soils with a low-rainfall use efficiency. This triggered research on the development of water harvesting technologies based on the ecotope concept, describing the quantitative soil water regimes of benchmark crop ecotopes. An ecotype is defined as the smallest ecologically distinct geographic feature in a land use classification system. Water harvesting technology projects, similar to LandCare projects, are based on on-site demonstrations to facilitate adoption. The in-field rainwater harvesting technique was designed to capitalize on limiting soil characteristics such as low water infiltration rate and crusting; to optimize selected soil characteristics such as high water storage capacity and high fertility status; to maximize rainfall use efficiency; and to bridge the dependency of small-scale and homestead farmers on mechanized agriculture (Morgenthal, et al., 2005a).

ARC - Sustainable Rural Livelihoods Programme

The purpose of the Agricultural Research Council (ARC) – Sustainable Rural Livelihoods Programme is to promote sustainable agricultural development, improve the quality of marginalized groups and rural communities, in order to alleviate poverty through enhanced production, creation of employment opportunities, and a more equitable distribution of resources. The programme provides technical support to ensure successful farmer settlement, enhance

agricultural productivity of the Resource Poor Agriculture sector in rural areas through the development of integrated farming systems and value-added skills development amongst related rural households. The programme also promotes natural resource management strategies for Resource Poor Agriculture (Small Scale Farmers) for addressing problems arising from the interaction between agriculture and the environment, with priority reference to communal areas.

Working for Wetlands Programme

The departments of Environmental Affairs and Tourism, Water Affairs and Forestry, and Agriculture, together with partners in provincial and local government and civil society, especially the Mondi Wetlands Project, have jointly launched the Working for Wetlands programme. The programme addresses the protection, rehabilitation, and sustainable use of wetlands. The programme also addresses commitments under several international agreements, especially the Ramsar Convention on Wetlands.

Working for Wetlands rehabilitation projects are intended to produce sustainable environmental outcomes, using implementation models that simultaneously contribute to the employment creation and skills transfer objectives of government's Expanded Public Works Programme. Funding for these activities is provided by the Department of Environmental Affairs and Tourism to the South African National Biodiversity Institute (SANBI), which hosts the programme. All rehabilitation interventions are undertaken within the context of improving the integrity and functioning of the ecosystem, and include measures that address both causes and effects of degradation. A guiding principle is to raise awareness and influence behaviour and practices impacting on wetlands, rather than focusing exclusively on engineering solutions.

South Africa's Involvement in International Initiatives for Mitigating Land Degradation

World Overview of Conservation Approaches and Technologies (WOCAT)

South Africa, under the auspices of the Department of Agriculture, participates in WOCAT. WOCAT was launched in 1992 and was accepted, in 1996, as a global programme by the International Soil Conservation Organisation. WOCAT uses a standardized framework for the evaluation of soil and water conservation. Data is collected by means of questionnaires. The South African WOCAT database is maintained by Agricultural Research Council – Institute for Soil, Climate, and Water (ARC-ISCW), South Africa's project leader. The objective of WOCAT is to contribute to the sustainable use of soil and water through the collection, analysis, and presentation of world-wide soil and water conservation technologies/approaches and to promote improved decision making and land management. The system enables an evaluation of the strengths and weaknesses of any particular technology under given circumstances on the basis of a set of indicators. Such an assessment may be made of a technology in its present environment or may be used to assess its applicability in another area. By 2003, the WOCAT database contained some 300 technologies and 120 approaches from more than 35 countries. Sub-Saharan African countries account for two-thirds of these, with more than 75 technologies related to water harvesting and soil water conservation. The WOCAT database is accessible at www.wocat.net.

Food and Agriculture Organization (FAO) of the United Nations Land Degradation in Dryland Assessment (LADA)

South Africa is one of six pilot countries to participate in the global LADA project. The LADA project will upscale and contribute to the objectives of United Nations Conventions such as the Convention on Biological Diversity (CBD), Convention for Combating Desertification (UNCCD), and Framework Convention on Climate Change (UNFCCC); and global initiatives such as Agenda 21 supported by World Summit on Sustainable Development. LADA is aimed at reviewing and synthesizing data and information of relevance to the development and assessment of drylands and at developing, testing and revising integrated land degradation assessment approaches and methods. The Soil and Terrain Digital Database (SOTER) developed and maintained for South Africa by ARC-ISCW, will form an important component of LADA.

Applications of Geo-information and Remote Sensing in Natural Resource Monitoring

Coarse Resolution Satellite Imagery Database

The Agricultural Research Council – Institute for Soil, Climate and Water (ARC-ISCW) houses a fully processed 1-kilometer spatial resolution National Oceanic and Atmospheric Administration – Advanced Very High Resolution Radiometer (NOAA-AVHRR) dataset spanning 18 years (from 1985 to 2004). The database consists of daily raw channels (5 bands) and angle images, Normalized Difference Vegetation Index (NDVI), Land Surface Temperature (LST), and Active Fire data. Initiatives are also undergoing to extend the ARC-ISCW's database through alternative sources of course resolution data from Spot-4 VEGETATION and processed data from the Moderate Resolution Imaging Spectroradiometer (MODIS). The SPOT VEGETATION satellite data stretch from 1998 to date and the MODIS data from 2000 to date. The MODIS data is obtained from the Land Processes Distributed Active Archive Center (LP DAAC), located at the U.S. Geological Survey's EROS Data Center http://LPDAAC.usgs.gov and SPOT VEGETATION is provided with courtesy of the VEGETATION Programme and the VGT4AFRICA project, produced by Flemish Institute of Technology (VITO).

The institute also hosts an Agrometeorology Databank, which archives South Africa's climate data, ranging from 1900 to date. The data is used for various applications in assessment and monitoring of natural resources.

Figure 1 demonstrates the use of long-term climate data (rainfall) in calibrating and validating satellite derived observations for natural resource monitoring. Shifts in the 500 mm isohyet were complemented by shifts in the cumulative NDVI. The line graph for rainfall indicated a strong cyclic activity in the experimental region. The long-term trend graph confirms high variability in the study region. Both the NDVI and rainfall maps indicated areas with high variability in the central parts of South Africa.

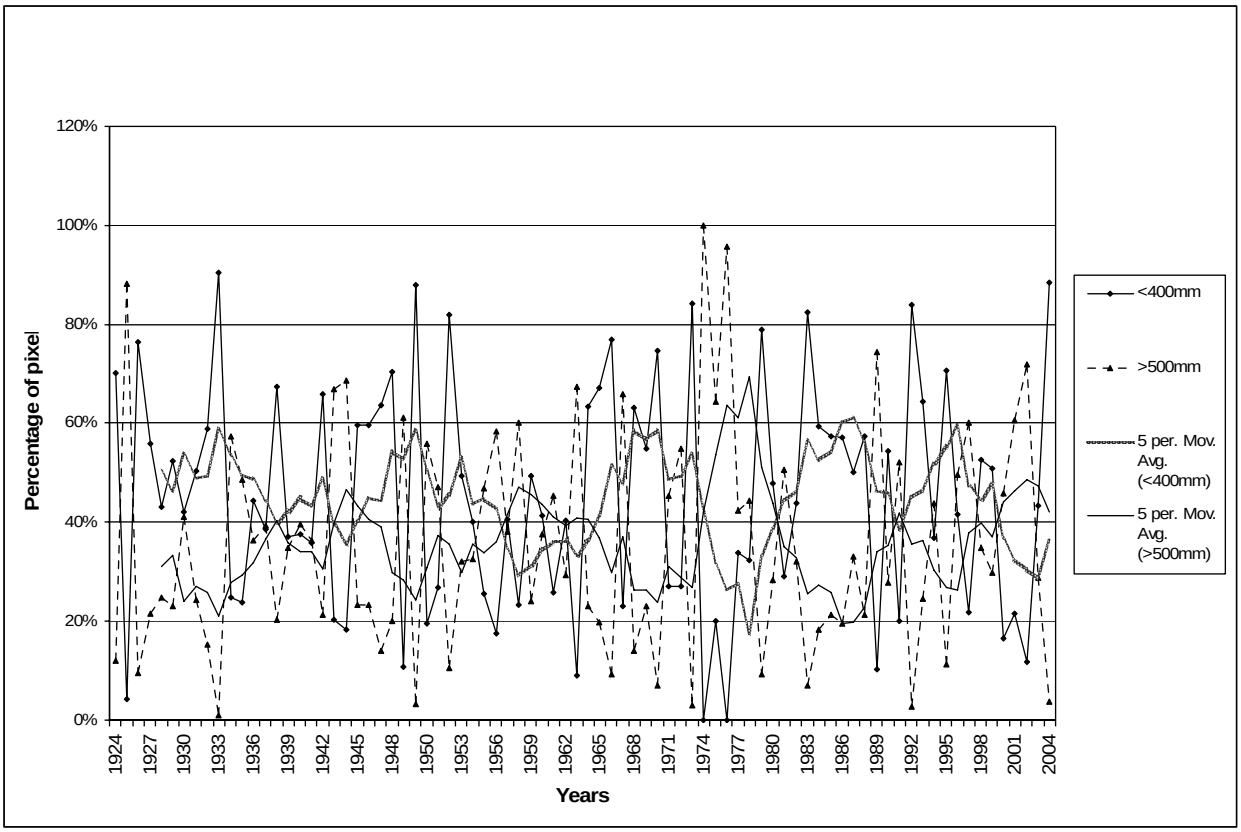

Figure 1. Pixels of 500 millimeter (mm) isohyet experimental region (maize crop area) that received less than 400mm and greater than 500mm rainfall (1924-2000).

Early Warning Project on Drought and Its Impact on Food Production

The ARC - ISCW developed an early warning and decision support system for food security, funded by the South African Department of Agriculture. The system is referred to as *Umlindi* (meaning the watchman) and provides information to decision makers on the current drought condition, fire risk, and vegetation conditions based on the interpreted satellite data and climate data. The *Umlindi* system proved to be useful in predicting the production of maize crops against the predicted extent of drought (Petja, 2002). The information is provided to the National Crop Estimates Committee and the National Agrometeorological Committee (South Africa) in the form of monthly reports/ advisories, newsletters and the Website (www.agis.agric.za/). Previously NDVI data calculated from NOAA (AVHRR) data was used to monitor drought occurrences but during the past 3 years SPOT VEGETATION is increasingly being used to monitor and predict drought conditions. Results obtained include trend analyses from long-term datasets, cumulative and maximum composites over a growing season, and difference maps between different periods to flag drought occurrences.

National Vegetation Cover and Grazing Capacity

To ensure sustainable use of natural resources and to prevent degradation and desertification of rangelands, the Conservation of Agricultural Resource Act (Act 43 of 1983) was promulgated. The act requires the implementation of a grazing capacity map to give guidance to farmers on the

potential stocking rate of their rangeland based on the grazing capacity of their veld (grassland). Such a map was developed based on expert opinion and provided a grazing capacity value in hectares per livestock unit for homogenous regions in South Africa. The 1993 national grazing capacity map related well to coarse resolution satellite data and a study to investigate the potential update of the current grazing capacity map using long-term NOAA AVHRR data was conducted at ARC-ISCW (Morgenthal et al., 2005b) in collaboration with the Department of Agriculture. The use of coarse resolution satellite data enables the Department of Agriculture to give timely information on the current grazing capacity of a district and to monitor the effect of drought on the condition of rangelands at a national scale.

Namibian Case Study

Land Degradation at the Uukwaluudhi Community

Imbamba (2002) undertook an extensive study of land degradation in Northern Namibia. He focused on the major causes of degradation and mitigation strategies. Like in most of the former colonies, land in Namibia was inequitably distributed according to race. The White people owned freehold title to 60 percent of agricultural land, which they could sell and purchase or borrow money on from lending institutions, using it as collateral. About 40 percent (about 33.4 million hectares) of the land held by the Blacks could not be sold or purchased freely because it belonged to the community. The land held by the Blacks (homelands and reserves) was located in areas with poor climatic and soil conditions as well as inadequate water resources. Uukwaluudhi is situated in the Ovambo region, northern Namibia and constitutes approximately 44 percent of the national population. The population of the Uukwaluudhi community was 34,448 in 1990, and the population growth rate was estimated to be 3.8 - 4.2 percent.

The Uukwaluudhi community is composed of semi-sedentarized farmers who raise some crops but move their livestock about in search of fodder and water. The Ovambo region is semi-arid with variable rainfall, which decreases from about 500-mm per annum in the east to about 300-mm in the west. The Uukwaluudhi region, which stretches from the Cuvelai flood plains to Kunene, experiences great variability in rainfall as well as the east-west rainfall gradient. The rainy season extends from October to April with the highest amount falling between December and March. Because of the high average evaporation rates, it is estimated that a considerable amount of rainfall (80 percent) evaporates shortly after precipitation.

In common with other former tribal homelands in Namibia, the environmental and socioeconomic impacts of land degradation in Ovamboland are distinctly striking because most of the inhabitants depend on land resources for their survival. Owing to the high degree of dependence on natural resources for human needs, the majority of the Uukwaluudhi people have become highly vulnerable to environmental changes, particularly those related to the depletion of land resources. Like many other rural communities, the Uukwaluudhi people are insecure and vulnerable to environmental related diseases, food insecurity, economic losses, and civil strife.

Causes of Land Degradation and Mitigation Strategies

According to Imbamba (2002), land degradation in the Ovambo region has been on the increase due to a variety of factors such as climatic variability, drought, soil erosion,

overstocking/overgrazing, deforestation, and woodland degradation. The intensification of the above environmental changes has, in turn, impacted negatively on the livelihoods of the local Uukwaluudhi community, resulting in a decline in agricultural production, scarcity of fuel wood, the disintegration of common property management, and increased food insecurity, as well as a decline in the quality of life. In addition, the changes in the environment have deepened poverty as well as contributed to the migration of the local communities to marginal areas. Local and national initiatives have been put in place to halt and reverse the environmental changes. In order to accelerate land conservation in Ovamboland, local communities (especially women) began to be empowered to participate fully in making and implementing decisions on the sustainable management of land resources.

In Namibia, one of the mitigation strategies has been the development of land policies in order to address equitable land distribution and sustainable land management. Community participation in forest management and land tenure reforms has been promoted and has gained momentum. Forest management authorities have also been established.

Namibia became the first African country to formulate a National Action Programme to combat desertification (NAPCOD). The country ratified the UNCCD on May 16, 1997. The objective of Namibia's Programme was "to combat the processes of desertification by promoting the sustainable and equitable use of natural resources suited to Namibia's variable environment for the benefit of all citizens both present and future." The programme addressed the political, socio-economic as well as biophysical aspects related to land degradation.

Morocco Case Study

Livestock-Based Livelihood Systems and Associated Environmental Changes

Most communities in the eastern Region of Morocco depend largely on livestock for sustenance of livelihoods. However, their activities are often affected and limited by environmental conditions. Salem (2002) reported on livestock based- livelihood systems in Morocco and their coping strategies that promote environmental protection. The communities in this area originally adopted a tribal structure to govern access to and control over natural resources. Each tribe had its well-established territorial boundaries that were respected by others. Access was limited to such boundaries by clans of the same tribe. Ancestral rights to rangeland use were an integral part of the traditional institutions that governed access to grazing grounds. Each tribe had its chief, who sat on the local council made of chiefs of all the tribes. Strict rules existed with respect to timing, zoning, and duration of grazing. These rules governed the complex user rights to pasture shared by a number of families and many generations.

Seasonal migration patterns of the population followed the ecological features and the climatic changes of the area. The northern high plateau (Dahara) in the Oujda province is less arid than the southern pre-Saharan environment (Sahara) in the Figuig province. The two landscapes are separated by a small mountain chain rising to 1,800 meters. The amount of rainfall decreases from 450 mm in the Dahara to 150 mm in the Sahara. Vegetation cover varies between the two regions accordingly. In the Dahara, perennial grass and woody shrubs grow with abundance. In the Sahara, a greater diversity of shrubs and succulents replace perennial grasses. In low-lying

landscapes, land maintains soil moisture and provides a hospitable environment for medicinal herbs, wild mushrooms, and large ground truffles.

For centuries until the late 1960s, inhabitants of the eastern Region maintained a nomadic lifestyle. During wintertime, tribes of the Dahara area moved their herds to lower elevations and the warmer climate in the Sahara. Along the way, men herded their sheep and goats to shrubs and grass. Women collected medicinal herbs, fuel wood, mushrooms, and truffles to trade in the local market or souk. Reverse migration from the Sahara to the Dahara would take place during spring. Herders used to carry their tents on camels and herd their sheep and goats over distances of about 250 kilometers (km) to take advantage of available resources in their two ecologically diverse zones. However, Salem (2002) further reports that most of the communities have permanently settled over the last 4 decades.

Coping Strategies

The 1980s witnessed consecutive years of drought, which exacerbated land degradation due to overgrazing. Rangeland degradation also adversely affected the health status of livestock. Given that livestock raising was the principal source of income for the population, their economic vulnerability became more pronounced through the poor nutritional status of the animals, and caused loss of subsistence and income, especially in the dry season. The small herders had extremely limited mobility and could not afford to move their herds by trucks to less degraded grazing grounds. They were obliged to herd their flocks near the water points that were often overgrazed.

A project was designed and implemented to reduce vulnerability of the local communities in the eastern Region (Salem, 2002). The project utilized a mixture of old and new institutions to establish an operational common property management (CPM) regime as a way of reversing environmental degradation and reducing human vulnerability. The project's overall objective was to raise the income and living conditions of some 9,000 families, while improving and sustaining productivity of some 750,000 hectares (ha) of grazing land. A related objective was the formation of "ethnolineal" cooperatives based on traditional tribal structures and territorial boundaries. These more representative and diverse cooperatives of herders were established to help organize them into groups to facilitate recognition of and compliance with the designed regime of CPM. The project intervened in six areas: i) pasture improvement; ii) livestock development (animal health, genetic improvement); iii) extension, training, research, iv) credit for small herders, v) women's activities, and vi) institutional strengthening. Total project cost was $45.22 million (U.S.), of which $14 million was a loan from IFAD, $6.43 million from the African Development Bank, $18.22 million from the African Development Fund, and $6.57 million from the government of Morocco (IFAD, 2000, cited by Salem, 2002).

Uganda

Land Degradation in Uganda

A pilot study by Olson and Berry (2003) was undertaken in Uganda to examine the extent and impact of land degradation. They found that a large percentage of land in Uganda is arable with

much of the land not yet under cultivation. Approximately 75 percent of the country's land is relatively fertile and receives sufficient rainfall for rainfed cropping and pasture. Only around 30 percent of the arable land is currently under cultivation. The agricultural population is relatively concentrated in eastern, southern and western Uganda; and zones within those areas have high population densities. In several regions, important signs of soil degradation trends are apparent including decline in yields and a switch to crops that demand fewer nutrients. Food production has not kept up with the country's population growth increase despite an expansion of area under crops. According to Olson and Berry (2003), per capita food production hit a low in 1980, and even with recent increases, it has not reached the levels of the 1970s.

The expansion of area under cultivation has been primarily due to short- and medium-distance migration and conversion of wetlands, grasslands, and forests to crops. These came along with some environmental problems. It is critical to reduce the trend of land degradation in areas already under cultivation, and to ensure sustainable land management practices in order to prevent degradation in the areas that will be placed under cultivation in the near future. Uganda's comparative advantage in climate and soils means that it has the potential to become an important producer of agricultural products if sustainable systems of production are implemented.

Mitigation Strategies

Olson and Berry (2003) identified regional and international institutions in Uganda having interest in mitigating land degradation. The mitigation emphasizes that the most promising and profitable technological option for improving soil productivity is through using a combination of organic and inorganic fertilizers, with erosion control measures where necessary. Sources for organic materials include manure, coffee husks, and other crop residues. Improved management of existing organic sources, such as methods integrating manure and composting, may significantly increase soil organic matter and reduce nutrient loss. Other sources of organic materials include legume cover crops, useful especially where population densities are intermediate and fallow is still practiced. They can also produce high-quality fodder as well as green manure and other soil enhancing properties. A rotation with *mucuna* (velvet bean) earned higher returns than with fertilizer for some areas in eastern Uganda. In addition, ground cover has been found to be critical to reduce erosion and fertility losses associated with erosion.

The soils of Uganda are generally deficient in phosphorus, and increasing this mineral through biomass transfer or applying rock phosphate improves productivity. Some biomass, such as *Tithonia (T.) diversifolia*, has been found to be of very high quality, and it increases phosphorus and soil productivity after being transferred directly onto fields or incorporated into compost. Combining *T. diversifolia* with rock phosphate has produced the highest yields, though *T. diversifolia* use alone was most profitable. Phosphorus rock is available in Tororo near Sukulu rock and Mbale near Busumbu rock. Use of the rock in nearby areas, especially when combined with nitrogen-fixating legumes, has also shown promising results.

Analyses of the costs and benefits of various technologies to farmers, especially in land- or labor-constrained regions, are important for technology development. In eastern Uganda, it was found that investment in some technologies was only profitable after the soil had been depleted

of nutrients, but that for maize they were profitable only in areas of higher rainfall and better soils. Farmers in areas where *T. diversifolia* was tested then adapted to their own technology requirements, the higher labor costs, in particular, would probably need to be met by returns from high-value crops. As market integration improves, the economics of investing in these technologies is constantly changing. Improving the farmer-researcher-extension linkages through participatory research is critical. The variability between farmers and households that affect resource constraints and influence adoption of technologies, including wealth and gender, also need to be considered.

Semi-arid areas have received much less attention by researchers and have additional research needs including water harvesting, storage and use methods, and improved integration of crop and livestock production. The processing and marketing of commodities produced in semi-arid areas, and infrastructure development, would also benefit from additional research.

Conclusion

This review of activities aimed at protecting land, managing land use, and mitigating land degradation shows that most African countries are committed to addressing the threats caused by environmental degradation to the agricultural sector and food security. The commitment is jointly shared by both the national, provincial, and local governments; together with the research institutions, parastatals, non-governmental organizations, and universities. The mitigation strategies promoted at countries aims at ensuring long-term sustainability of agricultural development. There should be a coordinated effort to share experiences learned from successful case studies with most of the African countries and the rest of the world.

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Relevant Web Sites

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WOCAT: www.wocat.net.
Working for Wetlands Programme: www.nbi.ac.za/research/wetlandprog.htm.
Department of Agriculture: www.nda.agric.za.