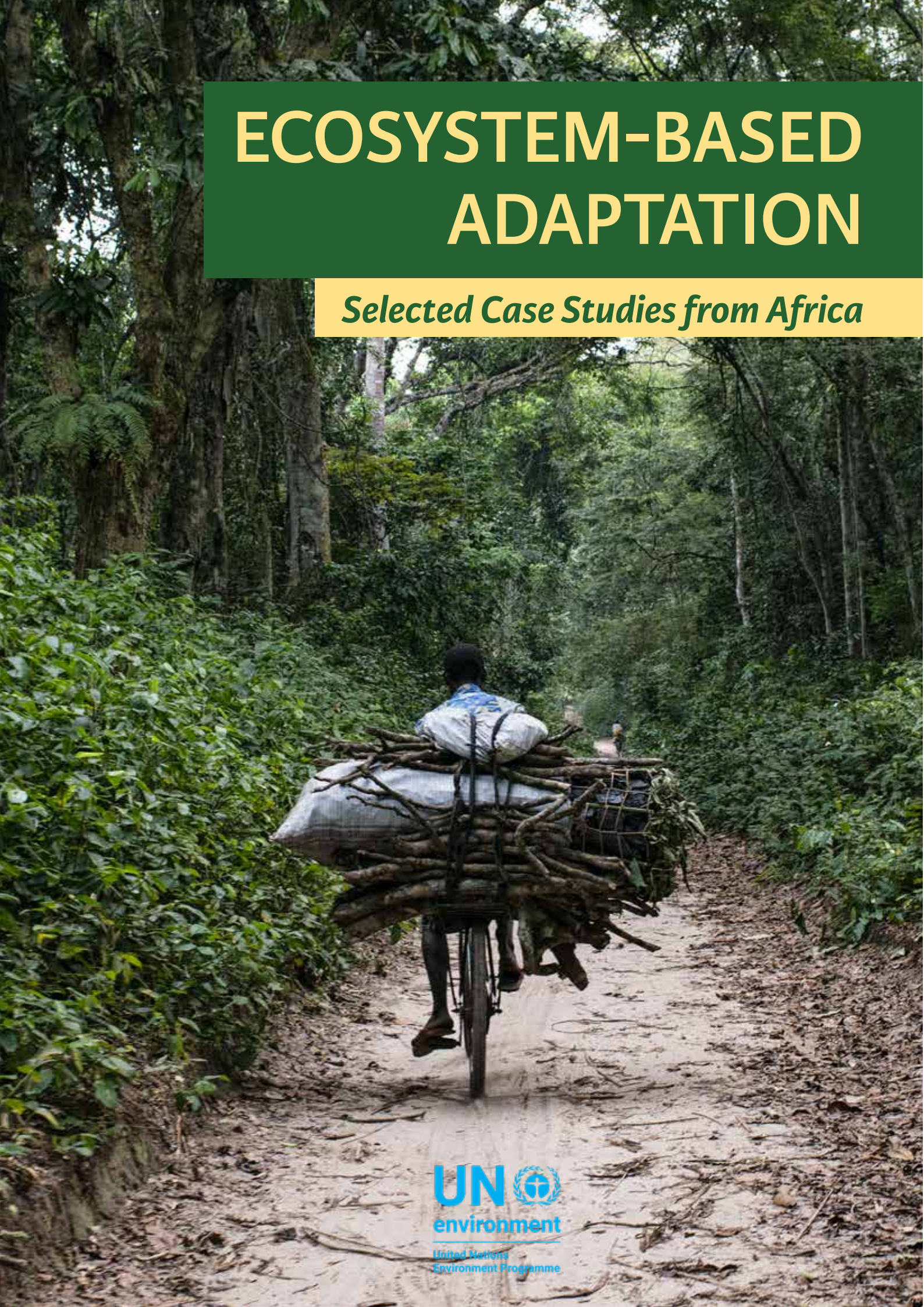
ECOSYSTEM-BASED ADAPTATION

Selected Case Studies from Africa



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Preface

Our growing population, people living longer and becoming more affluent is putting more demands and pressures on our limited natural resources as the demand for ecosystems services increases. Climate change can exacerbate the situation. Efforts to protect the environment can have a negative impact on people's livelihoods if it does not increase livelihood options from the ecosystem. So how do we maintain a healthy environment as climate changes and at the same time meet people's needs? Ecosystem-based Adaptation (EbA) may be an answer. While this problem exists world-wide, this report discusses five case studies related to vulnerable ecosystems and livelihood of people, in the application of EbA in Africa.

Fouta Djallon, Guinea: Valley bottom cropping was practised in the past by some indigenous communities, but has now been partly given up because of their difficulties in controlling water cycles, setting up and maintaining the necessary schemes and monitoring the quality of the cropping environment. The abandonment of a number of valley bottoms has increased pressure on the slopes and hillsides which suffer constant degradation as a result of bushfires, deforestation, soil impoverishment and mining activities which cause the silting and sanding up of watercourses. The drastic fall in crop yields, repeated water stress and moves by farmers to other activities posing a greater threat to the environment are some of the constraints faced by communities who now wish to develop these valley bottoms

Lake Faguibine, Mali: The ecosystem around Lake Faguibine has shifted from the livelihoods of a lake, fishing and livestock keeping to a livelihood that is forest-based as a new system to help combat climate change and its negative impact on the Faguibine community.

Mount Elgon, Uganda: Mount Elgon's ecosystem is vulnerable to the impacts of climate change largely because of the mountain's high population density. This puts pressure on the mountain ecosystem, particularly given the fact that the main source of livelihoods for Mount Elgon communities is agriculture and that hilly areas are being cleared for settlements and farming.

Southern Burkina Faso: The area faces major challenges in reaching a balance between preserving its natural resources and feeding its growing population. Southern Burkina Faso has experienced rapid population growth, mostly driven by immigration of farmers. Migrant people progressively convert forest land to cropland. If rural migration is not checked and lands not preserved, it will seriously degrade the environment

Xai-Xia, Mozambique: Constraints include loss of fertile land caused by flooding and salinization in the Limpopo river plain and high growth and concentration of population and refuges within the District's coastal area resulting in pressure and over-exploitation of natural resources.

Dr. Juliette Biao Koudenoukpo

Director and Regional Representative
UN Environment Programme – Africa Office

Chapter 1

Ecosystem-based Adaptation (EbA)

Introduction

What are ecosystems?

Ecosystems or ecological systems are made up of all living and non-living things interacting with each other in a particular area. For instance, plants and animals (biotic factors) interact in various ways with the environmental conditions such as weather, sun, soil, climate, atmosphere (abiotic factors) that support them. The biotic and abiotic factors in an ecosystem are usually dependent on each other. The absence of one may affect all other factors in that ecosystem.

Importance of ecosystems

Ecosystems provide four main functions: regulating (such as water purification, climate control, pest control), provisioning (including provision of food or water), supporting (such as nutrient cycles) and cultural (such recreational and spiritual) services (MEA, 2005). Their degradation, therefore, will undermine their ability to provide these services.

Why the concern?

Ecosystems may be disrupted by natural or human factors. Natural factors include floods, fires, volcanic eruptions or changing climate. Human activities also affect ecosystems with the main driving forces of environmental pressures related to population growth, demands for economic development, transport, agricultural and energy requirements among others. The resulting environmental degradation could be through overexploitation, pollution or mismanagement of the various ecosystems leading, for instance to pollution of air, soil and water, introduction of alien invasive species, deforestation and fragmentation or loss of habitat among others.

Pollution of an ecosystem may undermine the availability of clean water leading to negative impacts on human health, livelihoods and societies. Such changes may make communities more vulnerable to natural disasters such as climate change. For instance, the warming of certain regions attributed to climate change could lead to the extinction or migration of plant and animal species. In Africa, increasing temperatures have led to malaria-carrying mosquitoes extending their range into the higher altitudes leading to the spread of malaria into new regions (Rogers & Randolph, 2000). Future climate change is expected to continue to have various impacts due to other factors such as changes in land use, population density, and human behaviour.

What is ecosystem-based adaptation and how is it done?

The second Ad Hoc Technical Expert Group on Biodiversity and Climate Change of the Convention on Biological Diversity defined ecosystem-based approaches to climate change adaptation as the 'use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people adapt to the adverse effects of climate change' (Lo, 2016). It aims to help people recover quickly from climate change related disasters and allows them to withstand these impacts by reducing their vulnerability, through the sustainable use of the natural resources and restoring or improving the biodiversity and ecosystem services provided (Dourojeanni, et al., 2015).

Climate change is one of the greatest challenges of our time and healthy ecosystem services are able to provide benefits that help strengthen people's resilience to the impacts of climate change. So, a major component of this approach is the conservation, sustainable management and restoration of natural ecosystems. Where ecosystems are managed or improved, they are then able to provide the regulating, provisioning and other services that help people withstand the impacts of climate change. For instance, coastal habitats are able to provide natural flood defenses, well maintained wetlands provide water and other products during droughts and forests may be sources of products that sustain people and wildlife through all seasons. People are at the centre of all the various interventions.

The use of these ecosystem services thus becomes a part of an adaptation strategy protecting people from the effects of climate change while at the same time providing a variety of ecological benefits so central to human well-being, such as clean water and food. Adaptation strategies help communities plan better, lessen the negative impacts, even turn new conditions to their advantage.

What actions are needed?

Policy and decision-makers can choose from a wide range of interventions to use to help people and ecosystems adapt to climate change and reduce the risk of disaster. Some of the actions that can be utilized for effective ecosystem-based adaptation can be divided into three main areas: economic, social and environmental actions (Stefano, 2014). Systems involving natural resources management are proving popular because of their effectiveness and the multiple co-benefits they provide.

Policy interventions could target institutions, environmental governance, planning, capacity building, (Stefano, 2014). For instance, policies could include Intended Nationally Determined Contribution (INDC) to the UNFCCC, Climate Change Policies, National Development Plans, Poverty Reduction Strategy Papers, and other environment and natural resources conservation strategies and sectoral plans. These should go hand in hand with improvements in the enforcement of environmental laws and regulations. Communities and civil society organisations can be engaged to participate in environmental decision making and enforcement.

Actions that involve environment and natural resources management could be integrated water resources management, integrated coastal zones management, restoration of riverbanks and wetlands, sustainable fisheries interventions, reforestation and afforestation, conservation agriculture among others (UNDP, 2015).

Social interventions may include those that create opportunities for poverty eradication and social inclusion (UNDP, 2015). Such actions tend to lead to improvement, for instance, in access to clean water, food security, human resources capacity building, strong local institutions, new sources of livelihoods and economic opportunities.

The CGIAR Research Program on Climate Change, Agriculture and Food security (CCAFS), East Africa in collaboration with partners on the ground, took 16 farmers on a climate analogues journey. The journey was diverse and allowed farmers to see different agricultural approaches that will work for their future environment.

S.Kilungu /CCAFS

The Case Studies

This document uses several case studies from different parts of Africa to showcase the multitude of ways that ecosystem-based approaches can be applied and the benefits that can accrue. It considers Fouta Djallon Highlands in Guinea, Lake Faguibine in Mali, Mount Elgon National Park in Uganda, Southern Burkina Faso, and Xai-Xai coastal area in Southern Mozambique. All of the projects can be linked to the concept of ecosystem-based adaptation and all of them focus mainly on improving livelihoods.

In the Fouta Djallon highlands deforestation for logging and agriculture have changed the land cover from forest to grassland and led to soil erosion and siltation of water bodies with negative impacts on the hydrology of the watershed. The ecosystem-based approach employed to increase resilience was to encourage the conservation and rehabilitation of the watershed by encouraging sustainable land management practices such as agro-forestry to make better socio-economic and ecological use of these ecosystems. In Xai-Xai in Mozambique, sustainable use of the mangrove ecosystem was encouraged so as to increase food

security, enhance incomes and increase resilience to climate change. This was employed as a method of adapting to the impacts of floods and salinization.

Lake Faguibine has changed from an aquatic to a forest-based ecosystem due to climate change. There have been changes to the livelihoods of the people in the region as they have adapted to the changing ecosystem. High soil fertility has attracted a huge population to Mt. Elgon region in Uganda. There is thus pressure on the mountain ecosystem to support the growing population in terms of livelihoods and this is putting pressure on the forest resources as they are cleared to support settlements and agriculture.

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Chapter 2

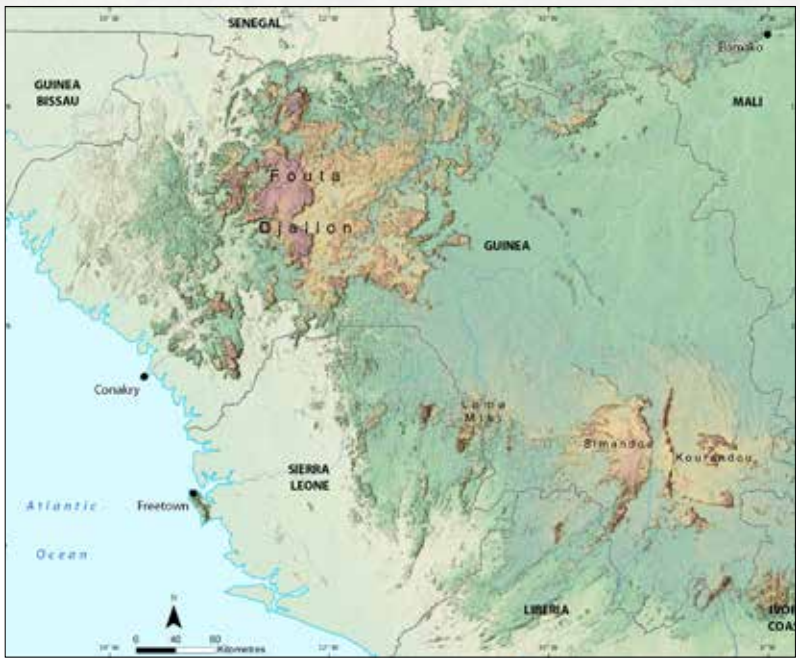
Ecosystem-based Adaptation — Fouta Djallon, Guinea Case Study

1. Introduction

The crescent-shaped Republic of Guinea has its western coast at the Atlantic Ocean. It is divided into four major geographical regions. Maritime Guinea (Lower Guinea) consisting of the coastal lowlands covering about 18 per cent of the country; Middle Guinea covering 20 per cent of the country and including the pastoral Fouta Djallon highlands; Upper Guinea the northern savanna covering 38 per cent of the country; and Forest Guinea in the southeast which is the rain-forest and mountainous region (source). About two-thirds of the country is mountainous.

The Fouta Djallon Highlands (FDH) are a series of high plateaus concentrated in the west-central part of Guinea and extending into Guinea-Bissau, Mali, Senegal, and Sierra Leone. This highland area is rich in biodiversity, has a variety of ecosystems and is also the source of a number of transboundary rivers that include the Rivers Gambia, Niger and Senegal. This has given Guinea the name 'water tower of West Africa' (USAID; USGS, n.d.). The four main ecosystem types are the Guinea-Sudanese Savanna, Dry Guinean Forest, mountain ecosystems, and river and freshwater ecosystems (GEF, 2005).

Figure 2.1 - Map of Fouta Djalon



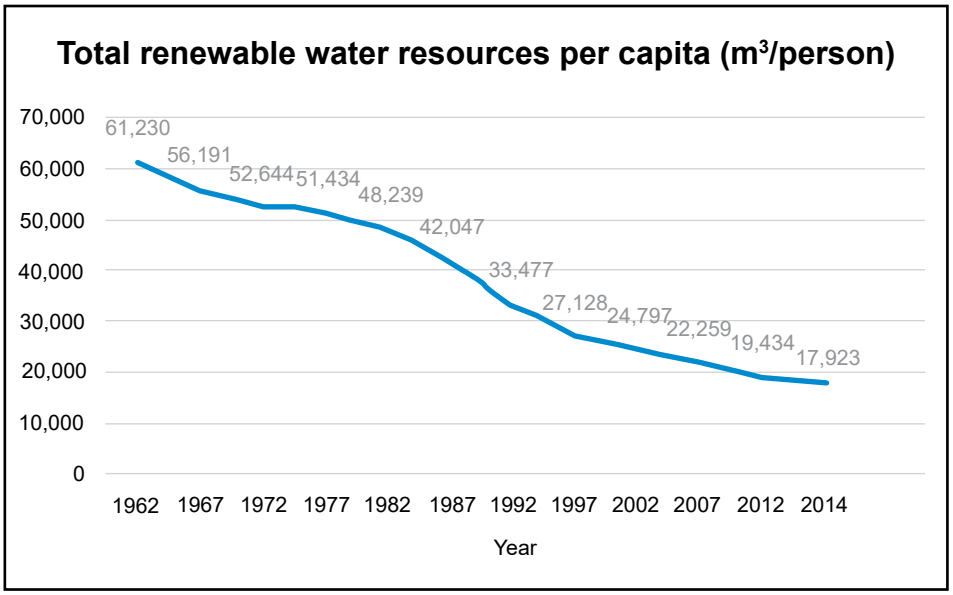
The series of high plateaus that make up the Fouta Djallon Highlands are concentrated in central Guinea and spread into Guinea-Bissau, Mali, Senegal and Sierra Leone.

2. What is the state of the environment?

Economy

The GDP of Guinea is only US $6.6 billion (USFCS and USDS, 2016). The country has abundant mineral

Figure 2.2 - Total renewable water resources per capita (m³/person)



FAO, 2018

resources and is home to half of global bauxite reserves, has four billion tons of iron-ore and potentially large deposits of oil, gold, diamond and uranium. In 2015, 85 per cent of exports were made up of minerals mainly gold and bauxite (USFCS and USDS, 2016). However, the mining industry has impacts on the environment and the overlap of mining areas with agricultural land has the potential for conflict with farmers in light of government plans to make the country an agricultural dynamo by 2025.

Climate

Precipitation is high ranging from 650 to 2,400 mm/year and averaging 1651 mm/year (FAO, 2018). Temperatures average 25°C to 28 °C from the south to the north respectively (FAO, 2005). The data from the last twenty years highlights declines in precipitation and the trend seems set to stay (CTCN, 2017). This situation has resulted in a high level of seasonable variability in the flow of streams and rivers and an increasing number of extreme climatic events.

Apart from rainfall deficits, the changes in river flow are also a direct result of mountain slopes degradation due to inappropriate land management practices and population pressure. This has been exacerbated by wind and water erosion and the changing hydrological regime of the rivers. Deforestation, loss of vegetation cover, soil erosion are some of the drivers of land degradation.

Water resources

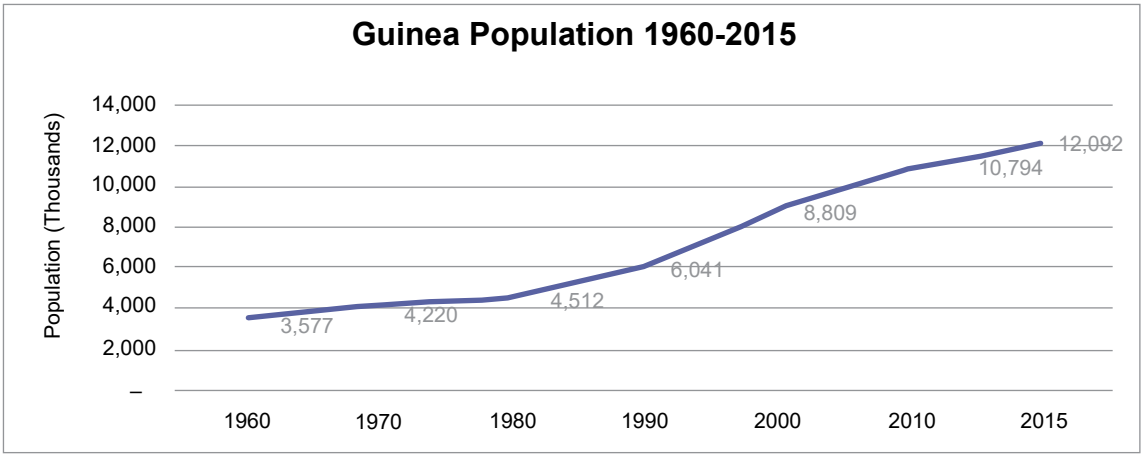
Guinea has a dense hydrographic network and the Fouta Djallon highlands are the source of several major transboundary rivers in the sub-region (CTCN, 2017). Guinea's total renewable water resources is 226 km³ per year, of which 226 km³/year surface water and ground water is 38 km³/year (FAO, 2018). National hydric potential is an estimated 13 billion m³ of underground water and 226 km³/year of renewable water (FAO, 2005). The water resources emanating from the Fouta Djallon highlands provide immense potential for hydropower, fishing, irrigated agriculture. For instance, currently only 6.22 per cent of the economically feasible hydropower potential is currently being generated by installed hydropower plants. The target by 2025 is to develop 25 per cent of the hydropower potential (AMCOW, 2018).

The country has 23 river watersheds, including 14 international watersheds. These complexes have been the site of different types of development varying according to region and project focus. At regional level, Guinea is a member of ECOWAS, the Gambia River Basin Organization (GRBO), the Senegal River Basin Development Organization (OMVS) and the African Union. Total renewable water resources per capita has been declining from a high of 61,230 to 17,923 m³/person between 1962 and 2014 (FAO, 2018).

Catchment degradation

Watershed and land degradation is compromising the capacity of the Fouta Djallon highlands to provide the provisioning, regulating and maintaining

Figure 2.3 - Guinea Population 1960-2015



World Bank, 2018

Figure 2.4 - Guinea: Population density 1970-2015

1970	1980	1990	2000	2010	2015
17.17308	18.36196	24.58528	35.8479	43.92874	49.20858

World Bank, 2018

ecosystem services that are critical to human wellbeing (Distefano, 2012). Degradation of the land has important negative impacts on the hydrology of the whole watershed affecting the downstream riparian countries of Benin, Gambia, Mauritania, Niger and Nigeria). The main drivers of land degradation include population pressure and land use change.

Population

The average population density in Guinea grew from 17 to 49 people per km^2 between 1970 and 2015 respectively, although it can reach a high of 120 people per km^2 in some areas. Total population in 2015 was 12.092 million growing at an annual rate of 2.4 per cent. Most (62.8 per cent) of the population is rural depending on the natural resources for food, livelihoods and wellbeing (World Bank, 2018).

The highland forests are a source of wood for domestic and commercial purposes. Non-timber forest products such as fruits, leaves, tubers, bushmeat and aromatic oils are also important for the rural communities. Pressure on these resources is increasing with the growing population caused by natural growth, internal migration from the north and refugees from the neighbouring countries of Côte d'Ivoire, Liberia and Sierra Leone (USAID; USGS, n.d.). Population pressure has also resulted in over-fishing; and poor mining practices have also accelerated environmental change.

Gray Tappan / USGS

The Fouta Djallon Highlands

Land use change

Land use has been changing over the years, with agriculture land use expanding from 1.3 to 4.7 per cent per annum between 1975-2000 and 2000-2013 respectively. The rate of agricultural expansion varies across the country, but the Fouta Djallon highlands have experienced the greatest pressure. A combination of steep slopes, slash and burn and shifting agricultural practices and unregulated forest logging for commercial purposes have exacerbated the situation leading to soil erosion and siltation of water courses affecting the hydrology of the watershed. For instance, excessive logging and agriculture have transformed the *Parinari excelsa* forest into grassland (Burgess, et al., 2004). Forest area as a percent of land area declined from 29.5 to 25.8 per cent between 1990 and 2015 respectively (World Bank, 2018). Between 1975 and 2013, this amounted to a decline of 33 per cent (USAID; USGS, n.d.). The impact has been particularly felt in those forests not protected by law.

Land fragmentation coupled with the traditional methods of shifting cultivation results in a very scattered land use. More people are preferring to cultivate the mountain slopes, abandoning valley bottoms. However, hillslope agriculture is difficult and has led to degradation as a result of deforestation, forest fires, mining activities and soil erosion resulting in the loss of top soil and soil nutrients which cause the siltation of watercourses. Soil nutrient loss has led to declines in crop yields and coupled with water stress forces farmers to shift even more (CTCN, 2017).

3. What has changed and what is the perception of the communities around?

Addressing water scarcity

Water scarcity is a growing problem. Streams are drying up and the situation is compounded by deforestation and growing population pressure as the farmers increasingly farm the hills slopes. In the remote villages, access to water during the dry season is challenging especially for domestic use and to support the rain-fed agriculture.

The ecosystem-based approach employed to increase resilience was to encourage the conservation and rehabilitation of the watershed by encouraging sustainable land management practices such as agro-forestry to make better socio-economic and ecological use of these ecosystems. For instance, since 1986 the Gueckédou agricultural project (PAG) in Forest Guinea has worked with subsistence farmers to achieve sustainable valley bottom development through good land approaches that include water management techniques including managing spring water, run-off water and rainwater (CTCN, 2017). In addition, the implementation of agro-forestry on the hills helps to maintain and protect the slopes by increasing infiltration rates and reducing soil erosion and soil nutrient loss. In addition, agroforestry can provide wood for timber and firewood for domestic use.

Improving agriculture yields

The provisioning function of ecosystems is critical in supporting human wellbeing and livelihoods. And therefore, the decline in agricultural yields which were being impacted by traditional farming systems such as slash-and-burn, mono-cropping, over-grazing, shortened fallow periods and the use of bushfires, was of concern (Juppi, 2017). The subsequent loss of soil fertility as a result of soil erosion; and poor access to good agricultural practices and inputs leads to progressive decline in crop yields.

Improved land management and agroforestry systems were employed around Soya-Pinsely and Madina Oula forests in Guinea. These practices included integrating indigenous and other high value trees on farms, improved market gardening, introduction of other crop varieties and soil fertility restoration using organic manure. Crop and income diversification, for instance fish farming, was also encouraged to tackle the problem of declining yields and food security especially during the dry seasons. Other practices included organic farming

with no slash and burn, reduction in shifting cultivation, employing the Taungya agroforestry system practiced with at least 100 trees/ha, live-fencing to help reduce pressure on forests for the yearly harvests to make fences. The use of indigenous tree species is important in encouraging local biodiversity protection.

These activities are estimated to have led to an average increase in yields of around 50 per cent (Serge, Balinga, Kalin, Tchoundjeu, & Sunderland, 2009).

4. How have the interventions influenced national policy if at all?

National level interventions

Policies in place to address some of these issues include development policies such as the Poverty Reduction Strategy Paper, the National Adaptation Plan of Action (NAPA), the Initial National Communication and the Intended Nationally Determined Contribution (INDC).

From 1993, the National Water and Forest Office of Guinea (Direction Nationale des Eaux et Forêts de la République de Guinée [DNEF]) adopted a co-management approach for all of Guinea's forest reserves. This decentralized approach involved management planning by both the local communities and the DNEF. The forest management plan allowed for the limited use of the forest resources and has proved successful in some of the forests such as the Balayan Souroumba Forest Reserve.

The Mining Code of 2011, includes provisions to combat corruption, protect the environment and review all existing contracts. There is also a Decree on the adoption of a directive to perform an environmental and social impact assessments on mining operations (2014). Other laws developed to protect the environment include the Environment Code, Pastoral Code, Water Code, Forestry Code, among others.

Regional Programme for the Integrated Development of the Fouta Djallon Highlands

The drought in the 1970s was a turning point for the management of the Fouta Djallon ecosystem. In 1981, the African Union (with support of UNEP, FAO, UNESCO and UNSO) established the Regional Programme for the Integrated Development of the FDH (RPID-FDH). Eight riparian countries were involved Gambia, Guinea, Guinea-Bissau, Mali, Mauritania, Niger, Senegal and Sierra Leone. The objective was to address desertification and drought and to promote sustainable management of the natural resources in the Fouta Djallon highlands. The aim was to improve human wellbeing and livelihoods and in doing so strengthen the resilience to climate change. Some of the activities include reforestation of the mountain slopes, reduction in forest fires, soil conservation approaches, among others.

5. What needs to be done?

Greater transboundary cooperation on natural resources management

In light of the increasing degradation, it is important that the countries that border the Fouta Djallon highlands area increase their cooperation on the management of the region and its resources. Desertification is hindering economic growth, destroying biodiversity and generally undermining human development. Conservation of water resources is thus a priority as the water resources support biodiversity and ecosystem wellbeing, domestic water supply, energy production, transportation and regional development. A coordinated framework employing Integrated Water Resources Management approach or other holistic water management approach is necessary (GEF, 2005).

For instance, there should be greater support for the Regional Program for the integrated Development of the Fouta Djallon Highlands which was tasked to ensure the protection and efficient use of the natural resources of the FDH with the aim of improving

the livelihoods and strengthening the resilience of the inhabitants of the highlands. Activities such as reforestation of upstream areas, reduction in the number of forest fires, irrigation in lowlands, soil conservation technology and the construction of cattle parks amongst others. In addition, support of income generation activities that can empower women financial such as vegetable production, training in rice and cereal processing is planned and should be actively implemented (ECOWAS, 2017).

Strengthen national institutions and policies

According to (Baldeh, 2013), some of the constraints to sustainable environment management of the Fouta Djalloh include financial resources, weak institutions and environmental governance. Policies in place to address some of these issues include development policies such as the Poverty Reduction Strategy Paper, the National Adaptation Plan of Action (NAPA), the Initial National Communication and the Intended Nationally Determined Contribution (INDC). According to (Serge, Balinga, Kalin, Tchoundjeu, & Sunderland, 2009), the estimated funding deficit for 2015-2030 is US $2 million, but adaptation is necessary to reduce the anticipated costs and damage of climate change.

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Chapter 3

Ecosystem-based Adaptation — Lake Faguibine Restoration, Mali Case Study

1. Introduction

The transboundary Niger River has its source in the Guinea Highlands located in southeastern Guinea. Its course follows a unique crescent shape and runs through Mali, Niger, along the Benin border and into Nigeria where it finally empties through the Gulf of Guinea into the Atlantic Ocean. The size of the Niger river means that it has a moderating effect on the semi-arid climate in the region. In Mali, the Niger river forms the Inner Niger Delta, a large flood plain made up of wetlands and lakes and rich in biodiversity. This is the third largest Ramsar site in the world covering an area of 4,119,500 ha (Ramsar, 2004).

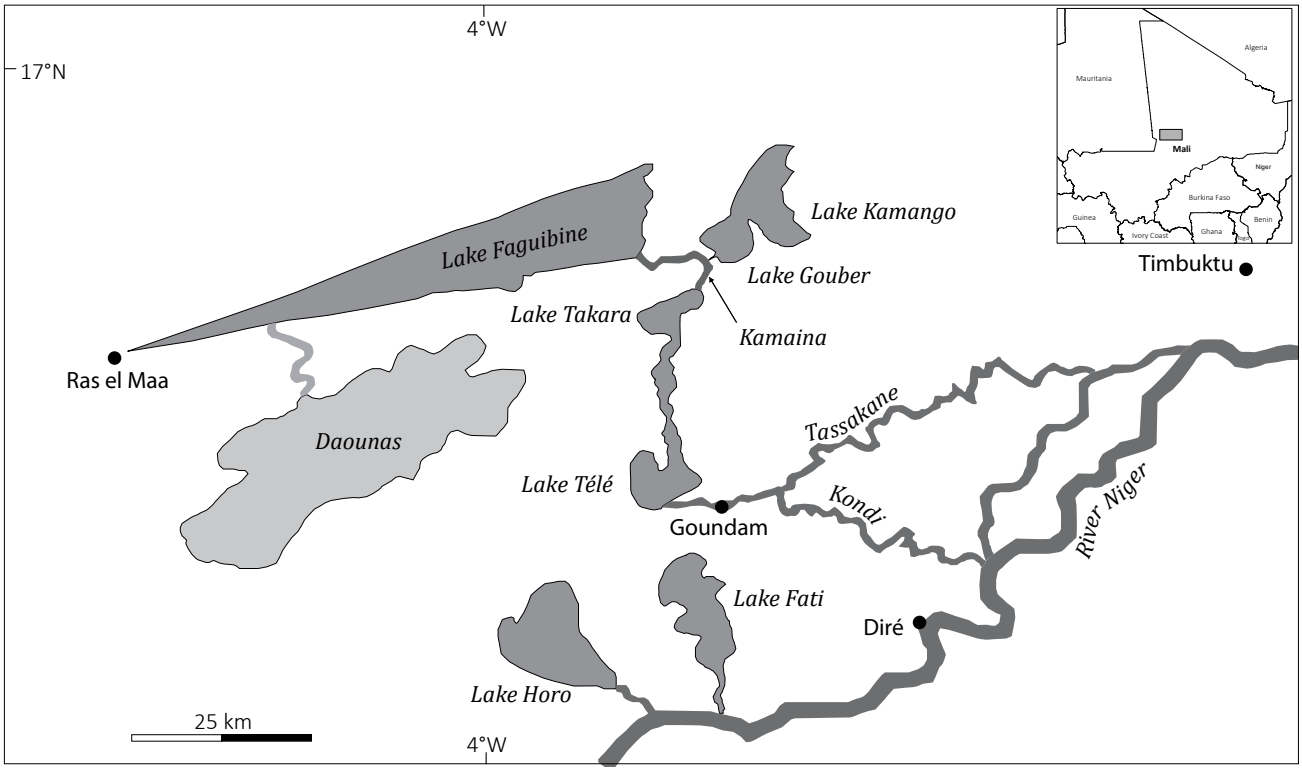
This case study is focused on Lake Faguibine, which at its fullest, is the largest lake in Mali with a surface area of 590 km^2 (Pérez, Fernández, & Gatti, 2010). Lake Faguibine, along with a series of smaller seasonal lakes (Kabara, Tanda, Fati, Horo and Télé) is located on the left bank of the Niger River (Figure 0.1). The hydrology of these lakes is primarily dependent on upstream precipitation and is characterized by large variations from year to year and even within seasons. Between March and May, water levels are low; it then floods from June to October and the waters gradually recede between November to February (Ajayi, Diakite, Konate, & Catacutan, 2012). These floods are critical for livelihoods support and ecosystem health.

Flooding starts in July when the Niger river rises about 4m in just under 3 months. When rains are high, the peak level may even surpass a height of 6m and this overflow finds its way into the Faguibine depression (Zwarts, Bjlsma, van der Kamp, & Wymenga, 2009). Periods of low rainfall imply reduced volumes of water reaching the smaller lakes. Indeed, the droughts during the 1970s and 1980s greatly affected water availability in the region (Andersen, Dione, Jarosewich-Holder, & Olivry, 2005). Lakes Gouber and Kamango have not flooded since the 1970s while Lake Daounas have not flooded since the late 19th century (Hamerlynck, Zeine, Mutua, Mukhwana, & Yena, 2016).

2. What is the state of the environment?

The Faguibine region is a huge fertile flood plain formed by the deposition of sediment brought by the regular floods of the Niger river. The geology and soils of the lakes district is made up of various Quaternary and recent deposits (Andersen, Dione, Jarosewich-Holder, & Olivry, 2005). The seasonal

Figure 3.1 - The Lake Faguibine system and linkages to the River Niger



(Hamerlynck, Zeine, Mutua, Mukhwana, & Yena, 2016)

lakes and rivers support an array of fishing, farming and pastoralist livelihoods. However, a combination of human population growth, unsustainable resource use and development, and desertification threatens the lake's ability to continue this support.

Population

The total population of Mali in 2015 was 17.5 million growing at an annual rate of 2.9 per cent. Of these, 10.5 million live in the rural areas (World Bank, 2018). The population in the Tombouktou Cercle was 497,813 in 2002 growing to 757,946 people in 2012 (AfDB, 2012). Most (95 per cent) of the population of Northern Mali is concentrated along 800 km of valley on both sides of the Niger River (OECD, 2015). The population in Mali can generally be classified as 'water users' as the country does not contribute any of the waters towards the Niger river.

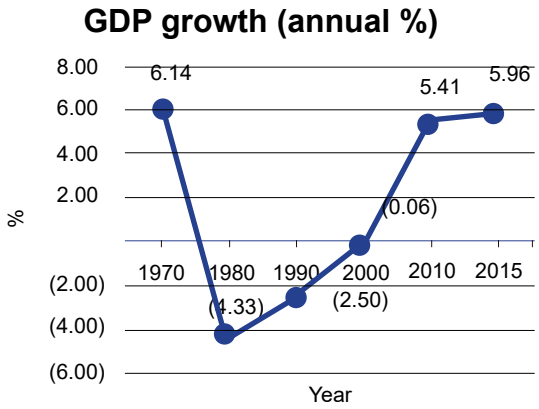
In 2015, adult literacy rate was only 33.1 per cent up from 31.1 per cent in 2010. Women have even less access to education with the adult female (15 years and above) literacy rate is 22.2 per cent (World Bank, 2018).

The people in the Lake Faguibine region are mainly Tuareg and Maure nomads along with the more sedentary Fulani and Songhai people. The Tuareg and Maure (Moors) are Berber nomads migrating between Mali and Mauritania. They are traditionally herders of goats and sheep, as well as providers of transport by camel and donkey. Some Fulani people some are cattle herders, while others are sedentary farmers. The Songhai are mostly subsistence farmers. Much of the migration is due to the harsh climatic conditions as well as insecurity.

Economic development

In 2015, Mali had a Gross Domestic Product (GDP) of about US $12.68 billion at 2010 prices or about US $726 per capita (World Bank, 2018). In 2011, the contribution of natural resources (agriculture, forestry, fishing and hunting) to GDP was 37 per cent increasing to 40.4 per cent in 2015 (AfDB, 2017). An economic evaluation in 2011 showed US$100 000

Figure 3.2 - GDP annual growth, percentage

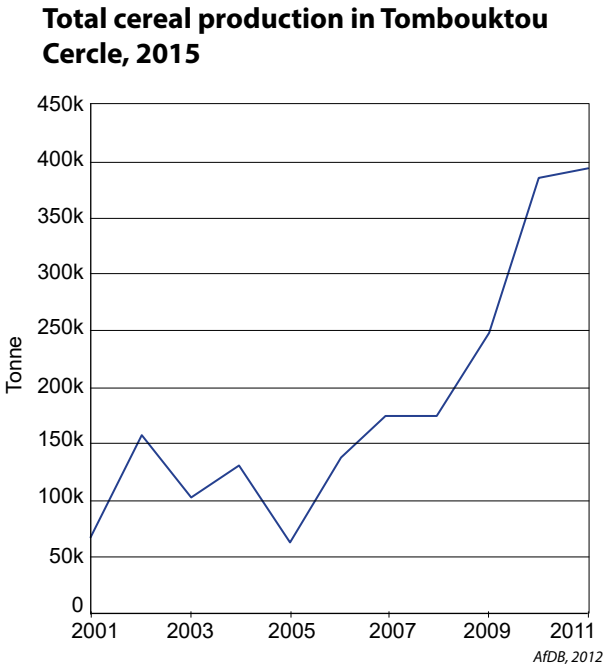


per year of net income per flooded km² in Lake Faguibine, allowing vulnerable people to practice recession agriculture, to fish and to graze livestock (Hamerlynck, Zeine, Mutua, Mukhwana, & Yena, 2016). Flood rise and recession agriculture is an important safety net for the people supporting an array of fishing, farming and pastoralist livelihoods. As the waters rise, a floating grass species known as Bourgou, flood plain rice and other crops provide habitat for aquatic birds and biodiversity and birds. As the waters go down and in the dry season, the crops are harvested and the flood plain vegetation becomes a source of pasture.

However, there are challenges. Most agriculture is rainfed and yields are low. A comparison of sorghum yields highlights this. In 2010 the sorghum yield in Mali was 1 ton/ha against 4.5 tons/ha in the USA; in 2016, the yields were 1 ton/ha in Mali against 5.5 ton/ha in the USA (FAO, 2018). The low yields are a function of changing climate (with a 30 per cent decline in rainfall since the 1980s), droughts, floods, locust invasions, inadequate agricultural extension support, poor access to inputs (land and fertilizer), credit facilities and market price volatility (FAO, 2013).

At the moment, most increases in yields are obtained due to expansion of land under crop. For instance, the area harvested with maize doubled between 2010 and 2016 from 0.5 million to 1.03 million ha between 2010 and 2016 respectively; but the yield only increased from 26,886 to 27,255 tons/ha over the same time period (FAO, 2018).

Figure 3.3 - Cereal production in Tombouktou

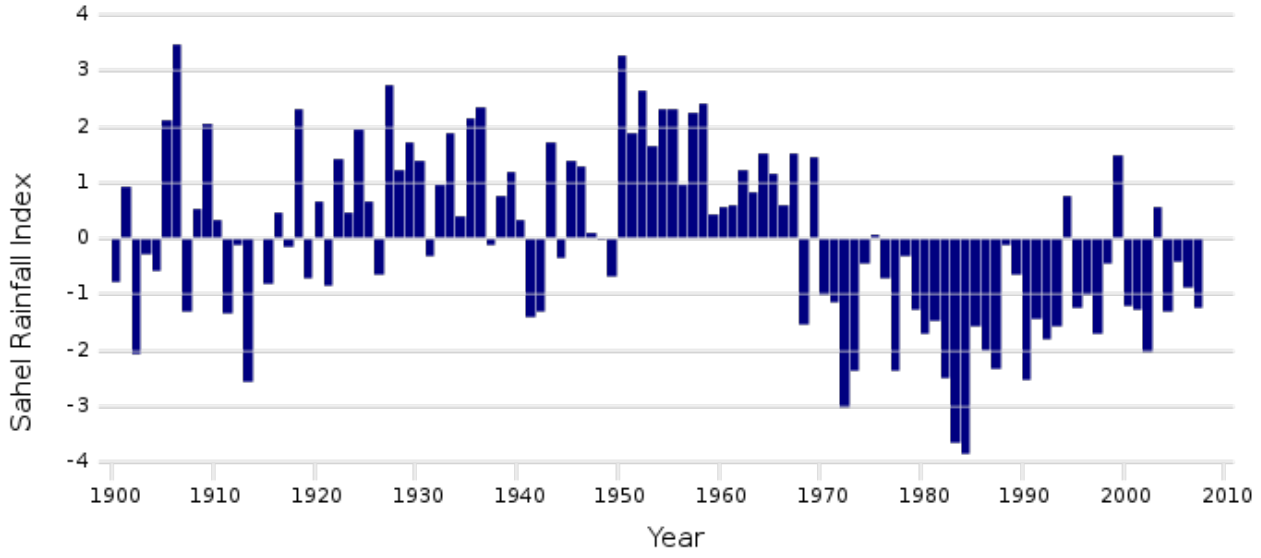


Climate

Climate change is a major pressure in this region and is thought to be behind the recurring droughts. The causes of the drought have been variously linked to climatic phenomena such as the periodic departures from expected sea surface temperatures (SSTs) that cause the El Niño Southern Oscillation (ENSO) phenomenon and the Inter Tropical Convergence Zone. However, it is also thought that the droughts may be due to the encroaching desertification. The depressed rainfall between 1970 and the 1990s led to a 25-35 km southward shift of the Sahelian, Sudanese and Guinean ecological zones with subsequent loss in animal and plant biodiversity (Boko, et al., 2007). Mali is also expected to lose between 30 and 40 per cent of its agricultural capacity because of this (Hummel, Doevenspeck, & Samimi , 2012).

The depressed rainfall in the upstream areas has contributed to the demise of Lake Faguibine as the overflows from the Niger river are insufficient to reach the lake. Predictions are that by the end of the 21st century, this region will receive 10-20 per cent less rainfall than between 1980 and 1990 (Boko, et al., 2007). Temperatures are also expected to increase affecting evaporation rates and reducing the surface area of the lake that will be flooded (Hamerlynck, Zeine, Mutua, Mukhwana, & Yena, 2016).The droughts during the 1970-80's led to

Figure 3.4 - Rainfall time series of the Sahel region



Benedikt.Seidl - Own work, based on JISAO data 2008

the drying of the lake. The canals that led water to the lake was blocked by sand and vegetation; and the lack of recharge caused the lake to dry up and had negative impacts on groundwater. By 2010, only 6 per cent of the 1974 surface area of the lake remained – about 35 km^2 (UNEP 2017) (Figure 3.6).

Water resources development

The growing population has ever expanding needs for water – for irrigation, domestic use and for energy supply. Climate change is adding to the pressures of adequate water supply. Water resources in the region are under pressure due to increased water abstraction for irrigation and due to the impact of climate change. Government response has been to expand the construction of reservoirs and dams for water storage and electricity generation. However, these have impacts on the hydrology of the river as the amount of water they use remains the same despite the amount of precipitation received. The size of Lake Faguibine is mainly dependent on overflows from the Niger. So, dams built along it are likely to have impacts on it. For instance, the Sélingué dam has already reduced the amount of water flooding the Inner Niger Delta. The system is further threatened by the building of the Fomi Dam in Guinea and by the planned expansion of cotton, rice and sugar plantation irrigation schemes upstream. There is also a risk of the return of a prolonged drought linked to the Atlantic multi-decadal oscillation index (Hamerlynck, Zeine, Mutua, Mukhwana, & Yena, 2016).

Canal near Goundam

maliactu.net

Conflict

Migratory movements are a part of every day life in this region. Pastoralists seasonally move with their cattle as an adaptation to the environmental conditions such as climate change and land degradation (Liehr, Drees, & Hummel, 2016). This helps reduce their vulnerability to economic, social and environmental risks while at the same time helping to diversify their incomes. Seasonal herders may at times come into conflict with farmers over water and pasture. Migration also occurs for economic reasons or because of political conflict.

There has been a civil conflict in Mali since 2012 and some of the impacts include poverty, issues of personal safety and access to natural resources. Many people seek safety in refugee camps or urban centres further limiting their access to natural resources, traditional lifestyles and livelihoods (Grünewald, Baché, Léon,, & Sokpoh, 2015).

3. What has changed and what is the perception of the communities around?

The demise of the lake, high soil fertility and the conflict that led to a reduction in livestock pressure and facilitated forest growth. The changes witnessed in the area include livelihood, ecosystem and social changes.

Ecosystem changes and livelihood changes

The aquatic ecosystem that was once Lake Faguibine has now been transformed into a forest ecosystem. Species such as Acacia and Prosopis are now common. Prosopis was originally introduced in the 1980s to protect against siltation but quickly overtook Acacia in colonizing the dry lake bed and covering it with high-density forests (Brockhaux & Djoudi, 2008). Ras El Ma on the western side of the lake has mostly Acacia while Tin Aicha in the northern part has mostly Prosopis. The rivers and flood plains of the lakes are covered with grasslands and perennial herbs (Brockhaux & Djoudi, 2008).

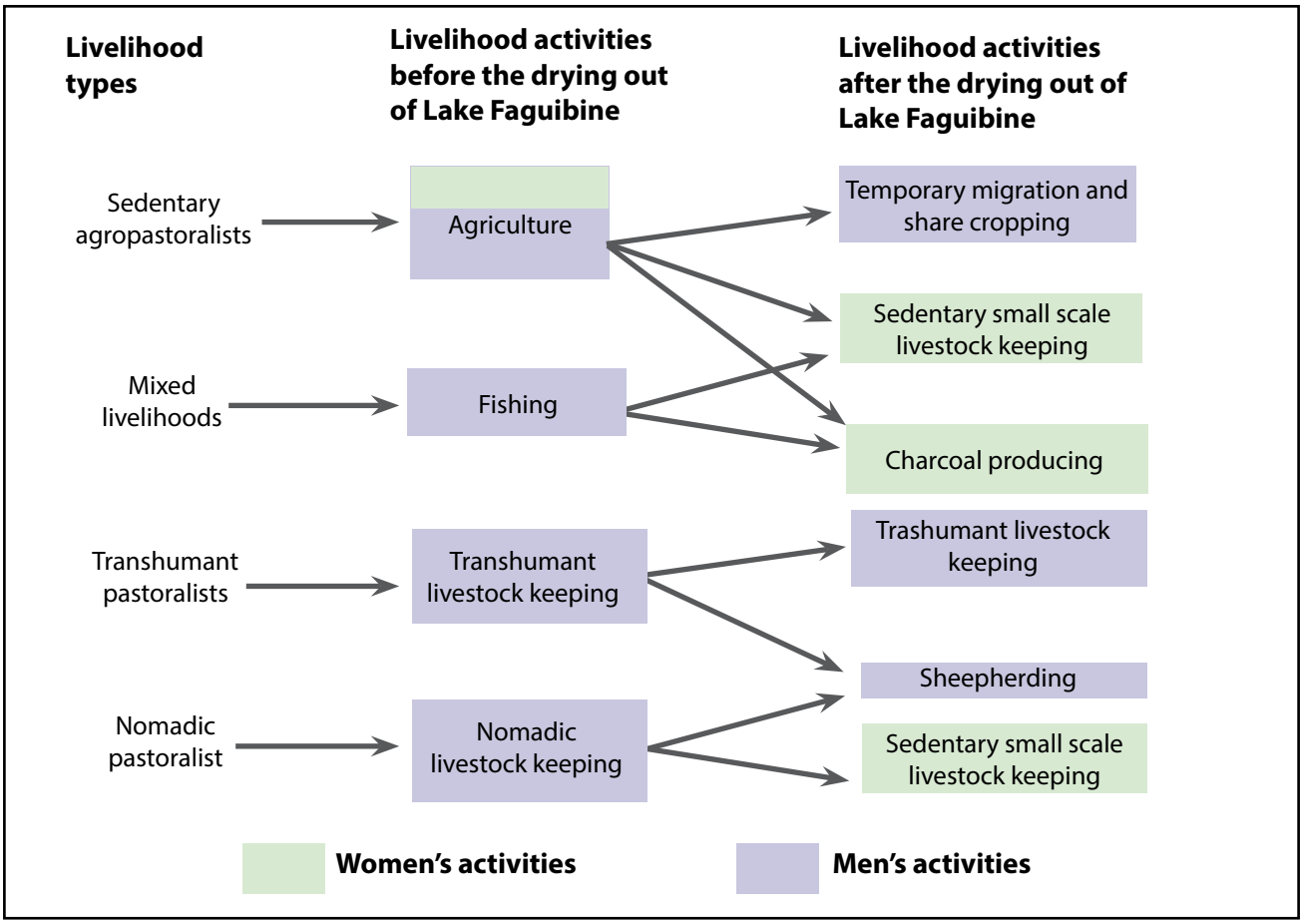
Previously, livelihood activities were centered around the lake and included agriculture, fishing and livestock-keeping. The local communities were involved in a variety of livelihood types such as sedentary agro-pastoralism, transhumance pastoralism, nomadic pastoralism and mixed livelihoods. However, livelihoods are now changing to adapt to the emerging forest ecosystem. Figure 3.5 (next page) shows some of these changes, including modifications in gender roles (Bedi, Bishop, Hawkins, Miller, & Pedrazaz, 2014).

The dependency on rainfed agriculture has negative impacts on the livelihoods base, food security and in many cases causes people to abandon their traditional livelihoods and move closer to the Niger river or towards the southeastern part of Lake Faguibine where they now access land under a share cropping arrangement based on a yearly rental agreement (Chenevix-Trench, Tessougué, & Woodhouse , Undated). In addition, there has been a gradual blurring between those whose livelihoods are based on agriculture and the pastoral communities driven by the years of drought. Key features of these livelihood changes can be seen in the growing diversity in herd size, an increase in the number of sedentary household's that own livestock and ownership concentration (Maiga, et al., 1995) (Crowley, 1991).

Migration is a common tactic used to support income diversification and is also a risk management strategy to the climate in the region. Pastoralists have developed mobility strategies through transhumance and nomadism. Transhumance involves seasonal movements over short distances while nomadism happens over long distances. Migration has not only supported livelihoods but has also been used to escape the impacts of conflict. Conflict in the 1990s led to the migration of much of the population with their livestock to neighbouring countries (Pérez, Fernández, & Gatti, 2010).

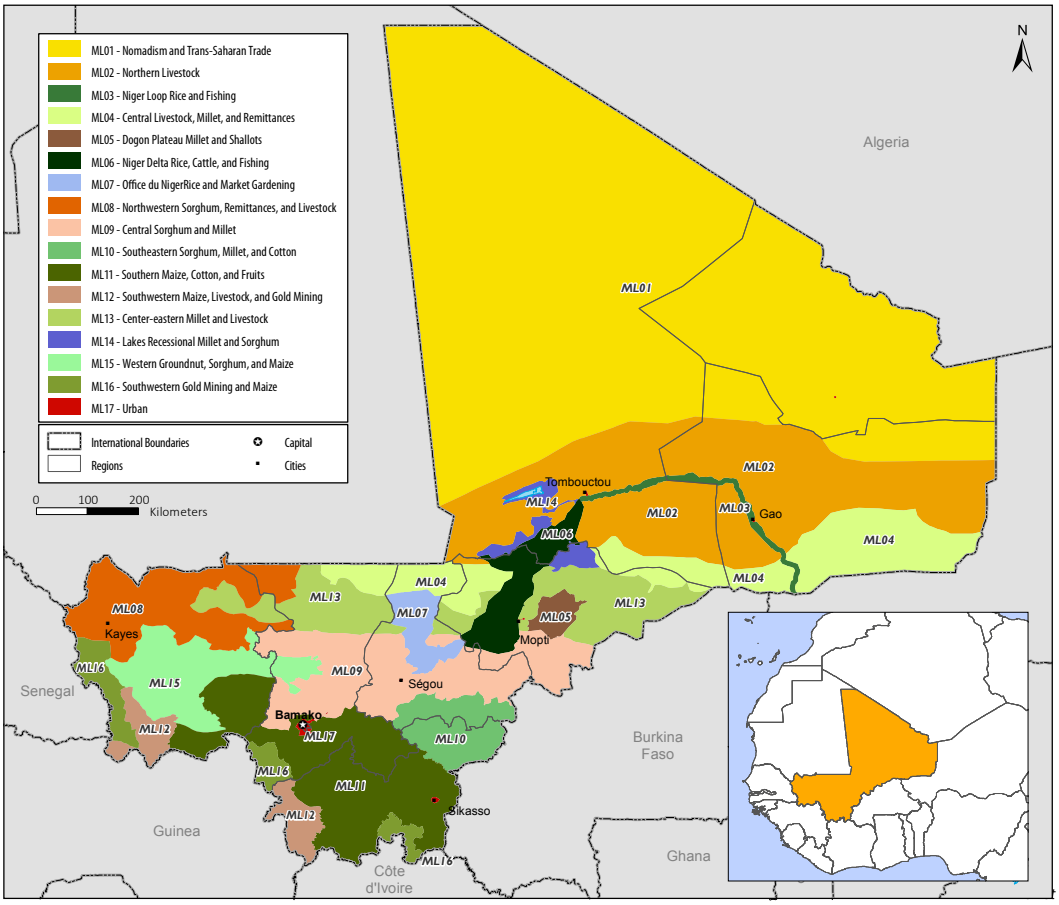
New livelihoods emerging based around the forest ecosystem including charcoal production, collection of firewood and non-timber forest products (Colfer, Basnett, & Elias, 2016). The forest is also a source of fodder for livestock. These are allowing the communities to adapt to the changing climate. However, some of the changes are of concern to the communities. For instance, the expansion of invasive Prosopis forest is of concern to as it may lead to loss of agricultural land through its rapid expansion and high tree density which makes it inaccessible for grazing.

Figure 3.5 - Shifting livelihoods and the resulting gendered repartition of livelihood activities before and after the drying out of Lake Faguibine.



Source: (Djoudi & Brockhaus, "Is Adaptation to Climate Change Gender Neutral?" Lessons from Communities Dependent on Livestock and Forests in Northern Mali, 2011)

Figure 3.6 - Mali livelihood zones, 2014



Prosopis juliflora

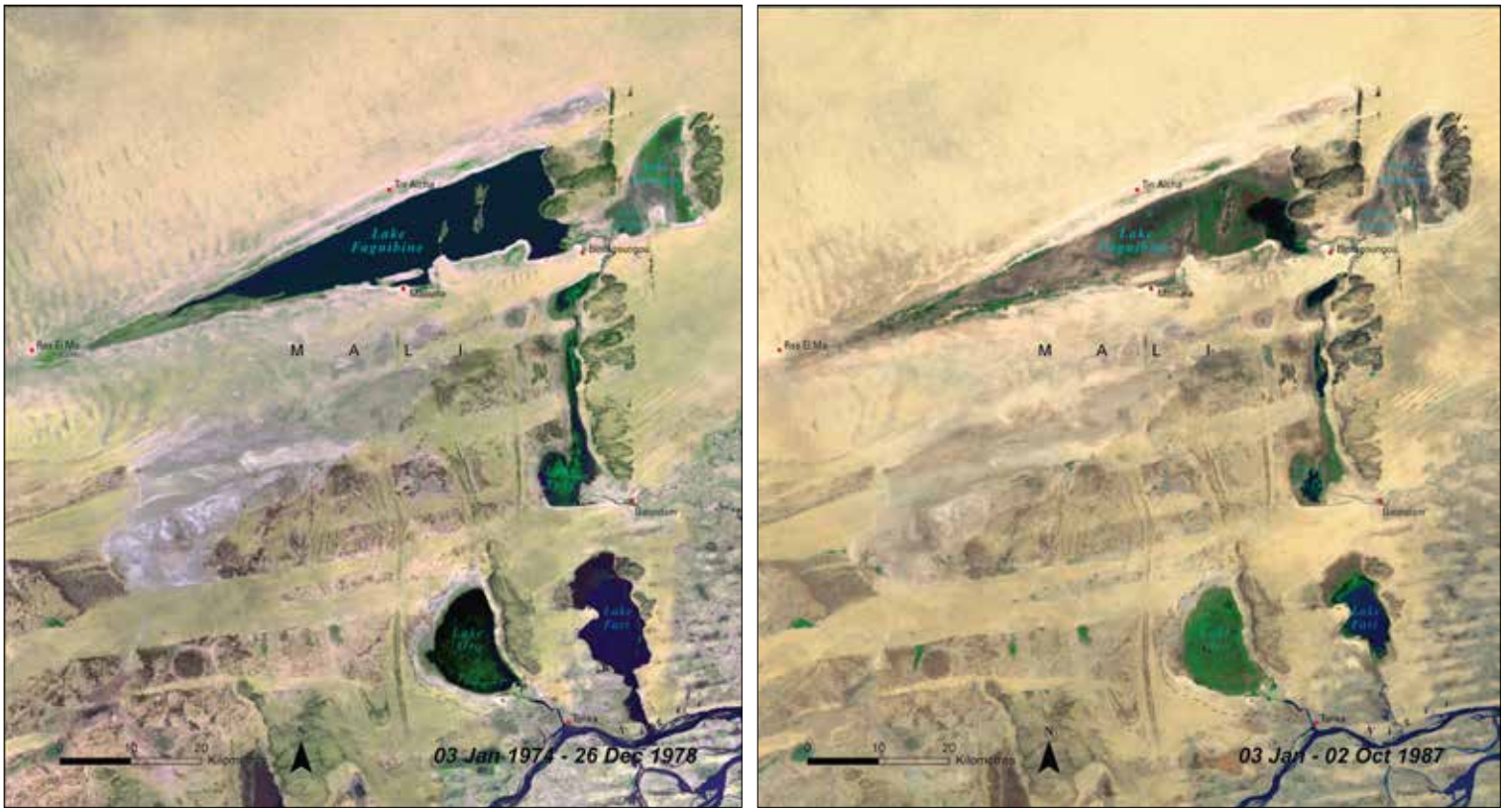
Philippe Birnbaum / West African Plants

Social changes and community perceptions

These changes have led to men migrating to seek economic opportunities. However, women in the Lake Faguibine area feel that migration of male members makes households more vulnerable (Padgham, et al., 2015). The migration has also left the women with increased workloads and having to take on roles that were originally only the preserve of men (Djoudi, Brockhaus , & Locatelli, 2013). These roles include charcoal production and the herding of small livestock such as goats and sheep (Brooks, Rohrbach, Chasi, & Cantrill, 2017).

The perceptions around these changes varies. Community members were keen on implementing sustainable forest management approaches as a means of adapting to the changes. At regional and district level, there was a preference for the engineering or infrastructure-based approaches that would result in refilling the lake. These perceptions were mirrored at the gender level with women, more optimistic about the opportunities brought by the ecosystem and social changes (Karttunen, Wolf, Garcia, & Meybeck, 2017) (Djoudi & Brockhaus, 2011). Men, on the other hand, favoured the engineering approaches feeling that they would then be able to return to their original livelihoods.

Figure 3.7 - The drying of Lake Faguibine, 1978-2013



Dark color is wetland. One can see significant difference in extent of water in the lake between 1990 and 2010 After rehabilitation efforts initiated in 2009, there seems to be no recovery as can be seen in the 2013 image (UNEP, 2017).

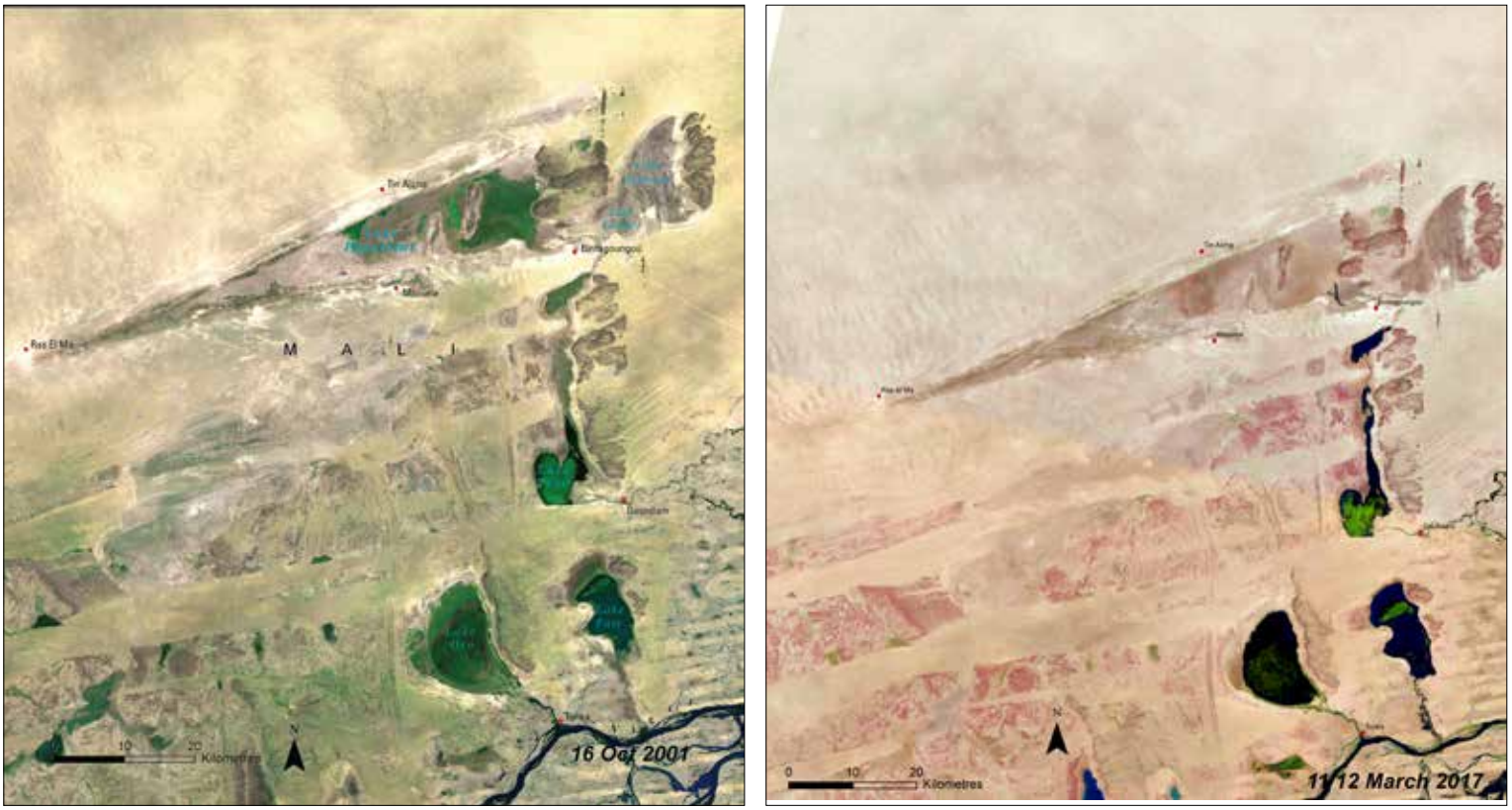
4. How have the interventions influenced national policy if at all?

National level policies and strategies

There are a number of policies that have incorporated ecosystem-based approaches to protect, conserve or restore the Lake Faguibine ecosystem against the threats of climate change, support resilient livelihoods, ensure food and water security and improve human and ecosystem wellbeing. Some of these include the National Adaptation Strategy, National Adaptation Programme of Action in 2007, National Policy on Climate Change in 2011, the National Climate Fund 2012 and integrating climate-related issues into policies at different governance levels within Mali. The National Climate Fund allows the government an element of financial freedom as it provides access to international finance thus allowing Mali to set and implement programmes that are relevant to national priorities (GIZ, 2017).

Improving early warning systems

There are many differing pathways adaptation can take. For instance, at the national level, there has been a push for infrastructure-based adaptation actions such as clearing the silted canals and refilling the lake. At the lower levels, the communities are more inclined to adopt ecosystem-based approaches more in line with the current land cover change. Whichever method is undertaken, an efficient data management system will be necessary. The use of hydrological measurements and satellite imagery to forecast floods will become increasingly important as the population grows and pressure on water resources increases. Accurate data will help to support agriculture and food security through the prediction of drought. The establishment of required institutions at the different levels will be necessary.



Source: (USAID; USGS, n.d.)

The Paris Agreement

Mali articulated the Intended National Determined Contributions (INDC) in 2015. There are ambitious plans to reduce greenhouse gas emissions in the agriculture, energy and forestry sectors by 29, 31 and 21 per cent respectively. Agriculture is an important sector with a net output (or value addition of GDP) of 42 per cent in 2015 (World Bank, 2018). Employment in this sector as a percentage of total population was 57.6 per cent in 2017 up from 44.8 in 2005 (World Bank, 2018). The Paris Agreement provides the opportunity for funding through the Green Climate Fund especially for the development of green energy options such as solar and wind energy.

5. What needs to be done?

The climate predictions indicate that the Faguibine region is likely to continue experiencing climate fluctuations (decreasing rainfall and increasing temperatures). The changes in climate has led to a reduction of the duration and extent of the flooded area. The annual flooding is important for the extra land that it brings into agricultural production. Reductions in flooding are also thought to be linked to the upstream damming of the Niger river for irrigation and hydropower. Lastly, the population in the area has grown and so is their needs for livelihoods and wellbeing.

Against this background, communities need to be supported and encouraged to adapt to the changing environment.

Address land tenure and land rights

With the transition from lake to forest ecosystems, there have been changes in livelihoods that have a bearing on land tenure systems. Pastoral systems are merging with more sedentary agricultural systems and bringing about social changes. For instance, entering into a sharecropping arrangement in a situation of vulnerability as occurred when

households were forced to migrate may weaken the negotiating power of the family. Furthermore, because the sharecropping occurred in a period of vulnerability the increased demand may also push up the rental prices pricing out many vulnerable people and thus entrenching poverty.

Sharecropping arrangements are perceived as being more in favour of the land owner other than the rental arrangement as the land holder provides land to assist an outsider in becoming established and eventually joining the community and establishing secure property rights. These issues need to be addressed within the communities and at the local and national government levels.

Management of the new forest resources

Sustainable forest management needs to be a priority. Otherwise, various pressures may undermine the sustainable use of forest resources and therefore drive vulnerability in the former lake area. It is therefore important for the government and development partners to consider the new roles and services provided by the forest ecosystem. Interactions between the different groups, including gender issues, need to be reflected in the planning and implementation processes to reduce competition. The Forestry law of 1995 has promoted a more decentralized approach to forest management facilitating improved environmental management by local institutions.

(Brockhaus, Djoudi, & Locatelli, 2013) further recommend the following:

- Increasing awareness on the various adaptation strategies ad different levels, social groups and genders
- Improve on knowledge exchange to encourage sustainability while enhancing adaptation. For instance, establishing forest extension services and forest use systems for the new Prosopis forest
- Set up institutional arrangements to improve land and forest use rights
- Improve the legal framework for adaptation by empowering local authorities and communities to plan and implement their strategies.
- Implement multi-level and participatory research into community and household vulnerability to inform adaptation planning. This should include social, environmental, economic, gender and political factors at various levels (Karttunen, Wolf, Garcia, & Meybeck, 2017).

Involve the private sector

In 2016, the Malian government made some efforts to improve linkages between the private sector, specifically national banks, and the government. National banks were engaged to underscore that profits can be made while promoting low-emission economic development. This is a strategy that could be encouraged. It will require greater awareness building as some in the private sector think they will be at a disadvantage financially if they collaborate on climate change solutions. The private sector can be key in supporting the implementation of ecosystem-based approaches from the very beginning.

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Chapter 4

Ecosystem-based Adaptation — Mount Elgon, Uganda Case Study

1. Introduction

Mount Elgon is an extinct volcanic mountain covering an area of 4,000 km^2, located on the border with Kenya in the eastern part of Uganda. Wagagai, its highest peak rises to a high of 4,321 metres above sea level (UWA, 2018). It is ecologically important, acting as a water tower and host of important biodiversity for both Uganda and Kenya and is thus protected under various instruments. In 1938 it was gazetted as a Forest Reserve and upgraded to National Park status in 1993. The Mount Elgon National Park covers an area of 1,121 km^2 (UWA, 2018) It was also listed as a UNESCO-MAB Biosphere Reserve in 2005 and is an IUCN Category II Conservation Area (EAC, UNEP, and GRID-Arendal, 2016).

Mount Elgon is valued for its regulating, provisioning, supporting and cultural ecosystem services. It has considerable plant and animal diversity, ranging from grasslands, forests and riverine ecosystems. It hosts several rare species of Afromontane flora and is important on the tourist trail of East Africa. It provides food and fodder for the mountain people; and has cultural significance for the local Bagisu people (EAC, UNEP, and GRID-Arendal, 2016) (UWA, 2018). Climate change and pressure from the growing population has led to encroachment and deforestation with serious impacts on the ecosystem services. The upshot has been frequent landslides, siltation and increased flooding around Lake Kyoga in central Uganda. This case study highlights some of the ecosystem-based adaptation strategies to address these challenges and reverse the environmental degradation.

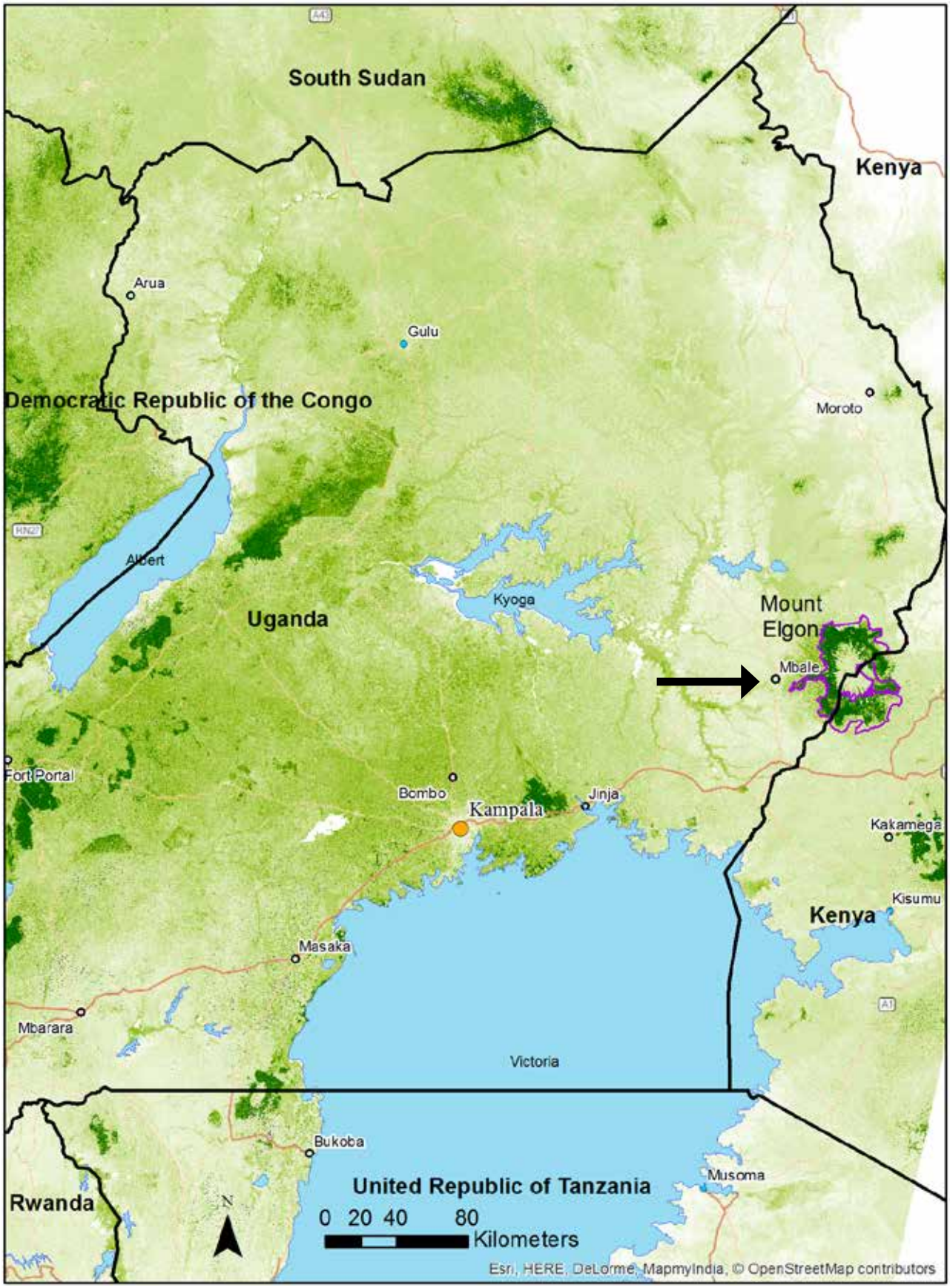
2. What is the state of the environment?

Population

Fertile soils and high rainfall (1500-2000 mm) have resulted in high population growth in the Mt Elgon area. Population demands for land for agriculture, settlements and other products like timber or charcoal in urban areas is a major driver for ecosystem change. Poverty, population pressure, land shortages and land fragmentation in the valley areas are the primary causes of vulnerability forcing people into the fragile high risk steep slopes. This, coupled with poor knowledge on disaster preparedness and cultural beliefs affects peoples coping mechanisms (Osuret, et al., 2016).

Average population density in the Mount Elgon region is 271 people per km^2 (UNDP, 2015a). However, there are local differences with population density ranging from a low of 118.2 people/km^2 in Kween district to a high of 1,026 people/km^2

Figure 4.1 - Location of Mount Elgo



Source: (Townshend, J., Global Forest Cover Change (GFCC) Tree Cover Multi-Year Global 30 m V003. 2016, distributed by NASA EOSDIS Land Processes DAAC, https://doi.org/10.5067/MEaSUREs/GFCC/GFCC30TC.003)

in Mbale district, almost 6 times the national population density which is in the country 173 people/km^2 (UBOS, 2014) (City population, 2018). Agriculture is the mainstay of 80 per cent of people in Uganda and in this region, it is mostly rain-fed and at subsistence level. Popular crops grown include bananas, coffee, vegetables, fruit, sugarcane; and yams and paddy rice in the valley

Table 4.1 - Key population indicators of the districts around Mt. Elgon National Park (1991-2017)

	Year of Population Census				Estimate density (p/km²)	Population growth rate (2014-2017)
District	**1991**	**2002**	**2014**	**2017**		
Bukwo	30,692	48,592	89,356	102,400	195.1	4.91
Bulambuli	64,576	97,273	174,513	199,100	305.5	4.74
Bududa	79,218	123,103	210,123	237,000	945.0	4.31
Kapchorwa	48,667	74,268	105,186	113,500	320.1	2.71
Kween	37,343	67,171	93,667	100,600	118.2	2.54
Manafwa	-	115,451	149,544	157,900	672.2	1.93
Mbale	216,849	324,674	473,239	532,100	1,026.0	3.02
Sironko	147,729	185,819	242,421	256,400	574.8	1.99

City population, 2018

wetlands. The forests on the mountain slopes are also important providing non-timber products such as bamboo shoots, fruit, honey and medicinal plants. Livestock keeping, petty trade, wage labor and small businesses for their livelihoods are also popular livelihood activities. Mbale and Tororo towns, also rely on the mountain for their municipal water supply.

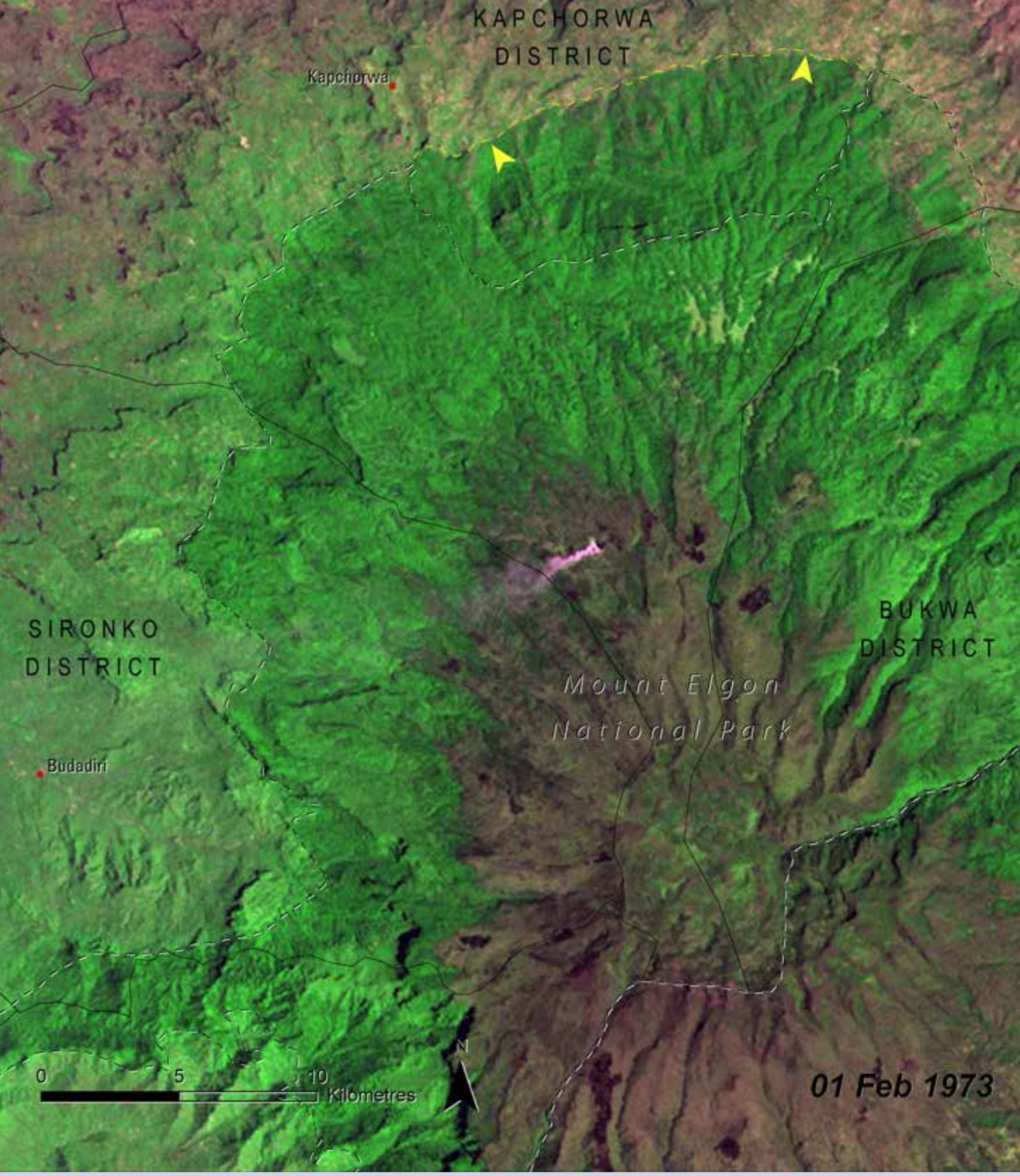
Key issues constraining agricultural production include land shortages, declining soil fertility, lack of access to inputs such as fertilizers and good farming technologies (Vedeld, et al., 2016).

Climate change

Pressures from the high population density makes the Mount Elgon's ecosystem vulnerable to the impacts of climate change. Subsistence agriculture is the source of livelihood for over 80 per cent of the mountain people and this has resulted in many

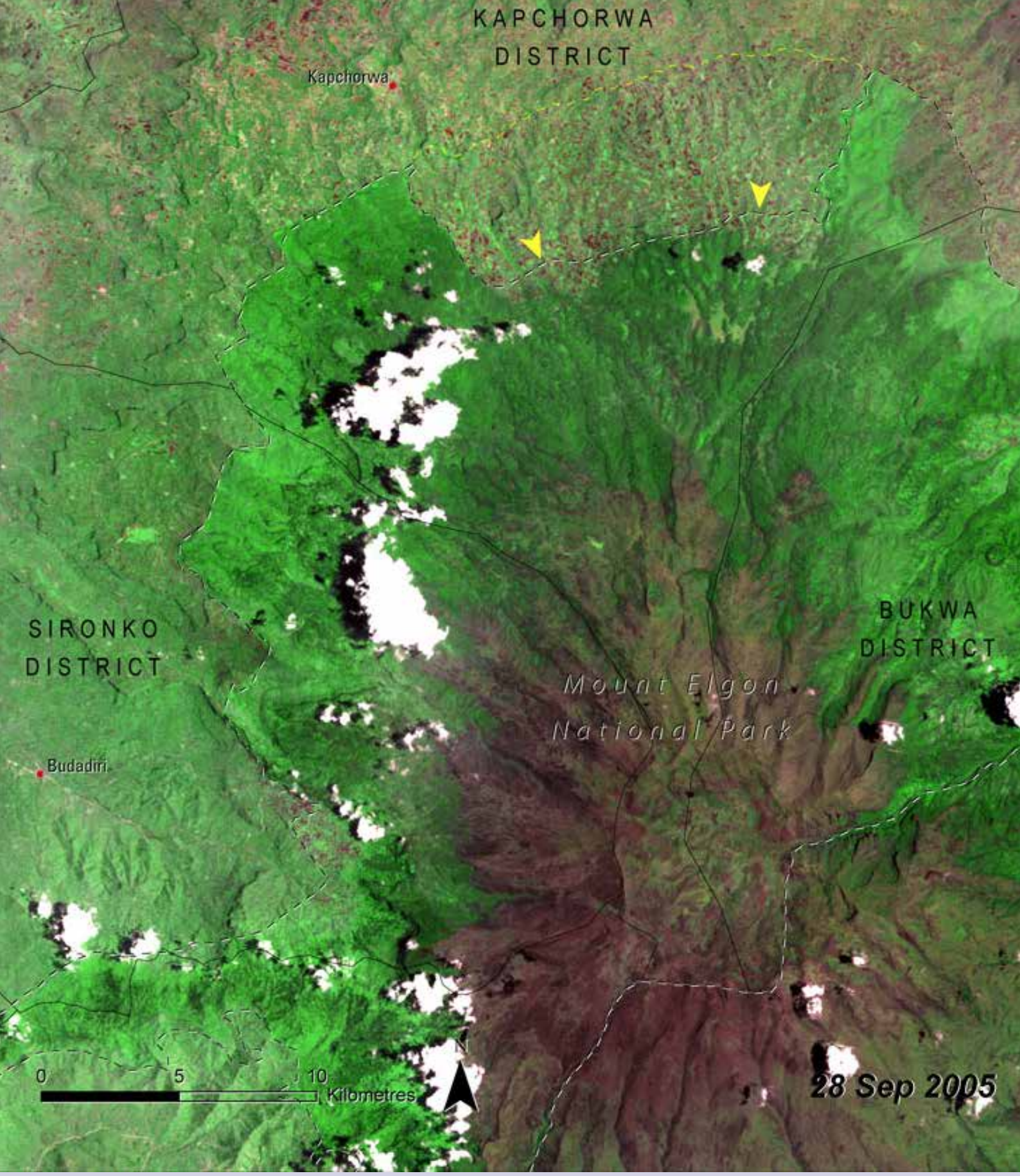
Andrea Egan / UNDP

Agriculture on mountain slopes.

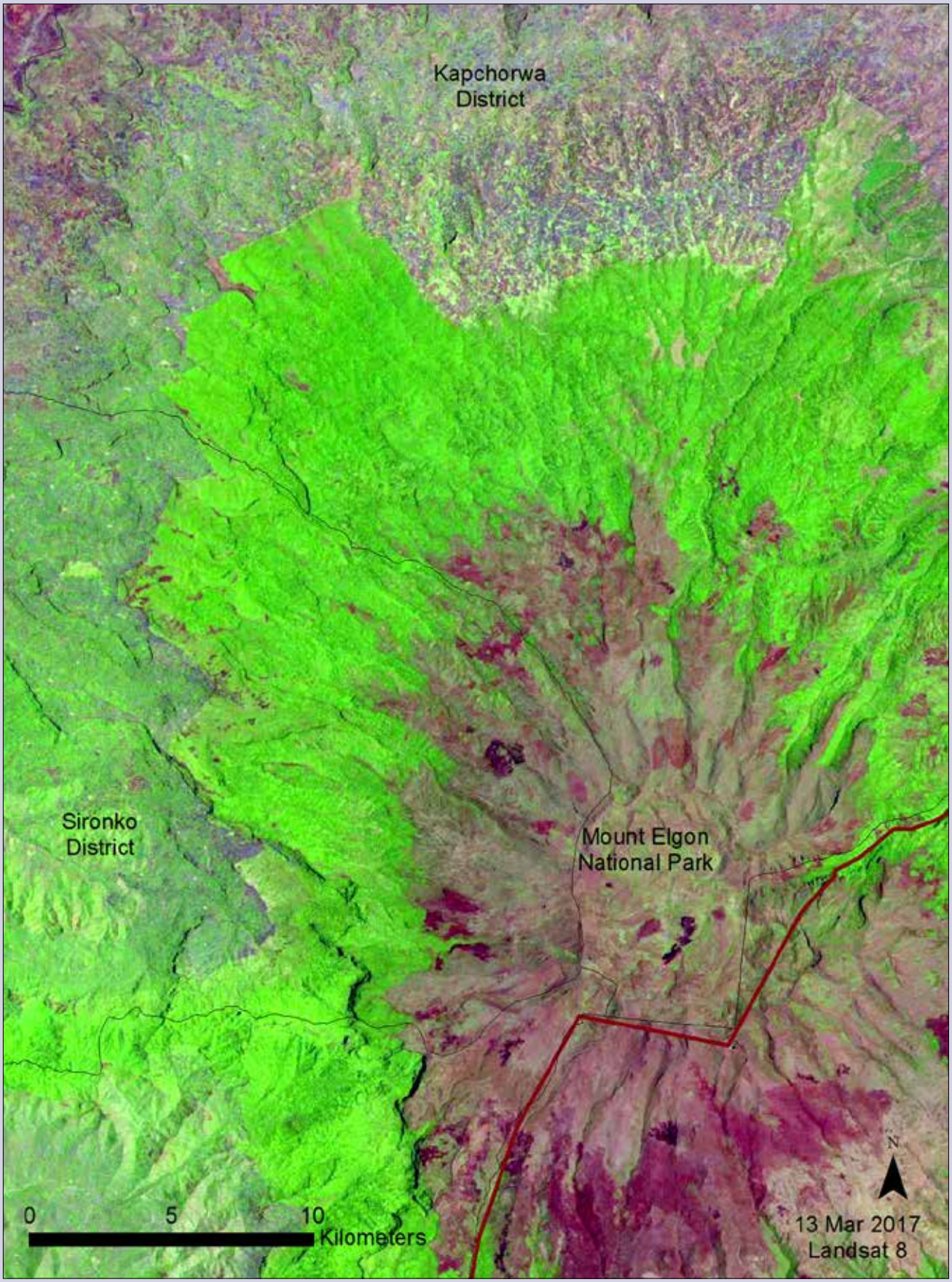


Mount Elgon National Park in Uganda

Before gazettement as a National Park, the mountain was originally a Forest Reserve. Government had several programmes to integrate the local livelihoods and the protected area approach. However, in 1983 population pressure on the forest forced government to allocate part of the forest reserve (Bennet Settlement) for the resettlement of local people. The Bennet Settlement can be



seen clearly in these images from 1973 and 2005. The resettlement was not well managed and has instead lead to more pressure on the forests (Dirkse, 2017). A 2017 Landsat 8 image of Mount Elgon. The National Parks and National Reserves, on the border between Uganda and Kenya, are outlined in red. The bright green color indicates forested and vegetated areas.



LP DAAC, 2017, Landsat 8 LC08_L1TP_170059_20170313_20170328_01_T1. These data are distributed by the Land Processes Distributed Active Archive Center (LP DAAC), located at USGS/ EROS, Sioux Falls, SD. https://earthexplorer.usgs.gov/ accessed December 01, 2017.

Mont Elgon National Park boundary

of the hillslopes being cleared for settlements and farming (Dirkse, 2017).

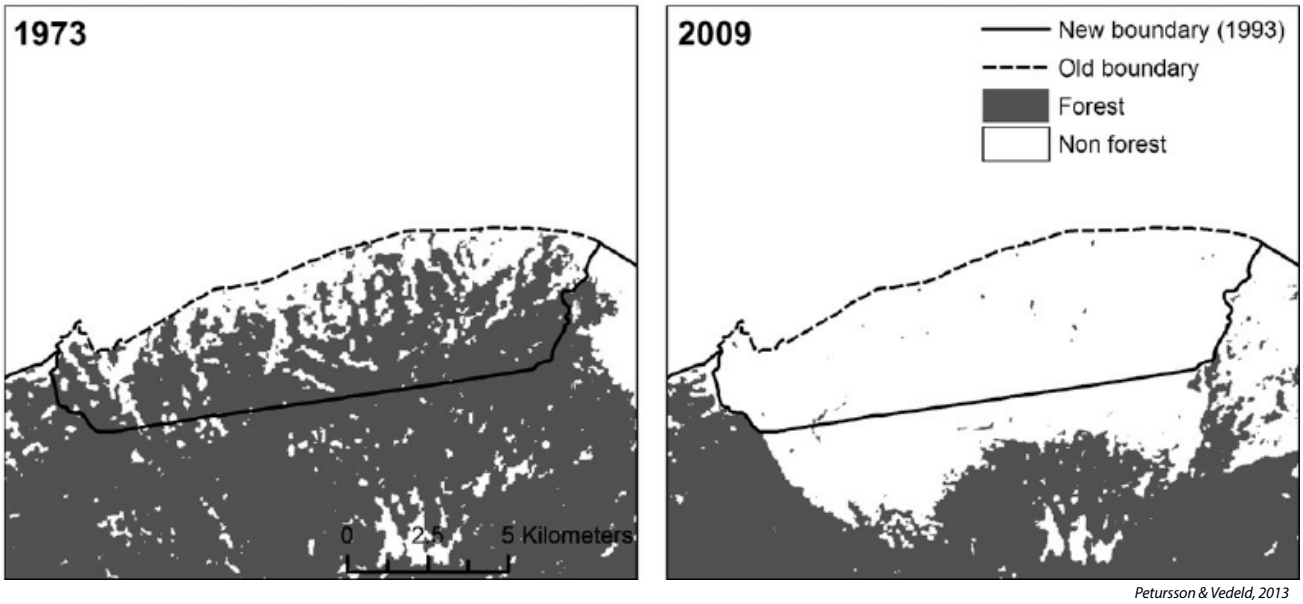
Climate change predictions indicate an increase in rainfall by 18.7 mm over the next two decades and temperature rises of between 0.5-0.6°C for the next 20 to 50 years (NaFORRI, 2013). The increase in rain is likely to lead to more climate-related events such as flooding, drought, soil erosion and landslides (NaFORRI, 2013) (UNDP, 2015a). In addition, the drier months (June, July and August) are likely to receive less rain. The combination of high population densities, heavy rains, steep slopes, poor agricultural practices, soil properties and soil erosion has led to excessive downstream flooding, landslides and siltation of the rivers (EAC, UNEP, and GRID-Arendal, 2016). For instance, the El Nino rains of 1997/98, March 2010 and June 2012 led to tragic landslides in Bududa and Manafwa districts (Masiga, 2012).

Land use

There has been a massive conversion of land use to agriculture in the region driven by the fast-growing population and land fragmentation. The lowlands are used mainly to cultivate beans, yams and onions, while the uplands are dedicated to Arabica coffee (the main cash crop) and maize. Bananas are important for both domestic use and for markets. Much of the cultivation takes place on steep slopes ranging between 36° and 58°. Despite cultivating on steep slopes, there is inadequate use of soil conservation measures which contributes to increasing incidents of landslides, soil erosion and soil nutrient loss. Analysis shows that between

The northern boundary of Mount Elgon. Image source is Google Earth, image date is December 30, 2016, Landsat/ Copernicus

Figure 4.2 - Forest cover in 1973 and 2009 in and around the Benet resettlement area, Uganda. The exact location of the 7,500 ha line was not available so not drawn.



Petursson & Vedeld, 2013

1960 and 1995 land cover was fairly stable. However, between 1995–2006 there was substantial loss of woodlands and forest cover most especially on the steep slopes (36°–58°) of the Mt. Elgon National Park (Mugagga, Kakembo, & Buyinza, 2016).

There is a need to restore forest cover on the fragile steep slopes and restrain local communities from opening up new areas for cultivation on critical slopes, particularly within the protected area (Mugagga, Kakembo, & Buyinza, 2012). The increasing frequency of landslides leads to damage to domestic and public infrastructure, loss of lives and economic disruption. These uncertainties lead to low adaptive capacity at all levels (Semambo, 2016).

3. What has changed and what is the perception of the communities around?

Improving land management

Drought incidents, water scarcity, soil erosion, flooding and landslides due to soil destabilisation, overexploitation and poor land management are predicted to become worse with climate change.

Adopting good land management practices such as tree planting and terracing was one of the ecosystem-based adaptation approaches used to reduce the impacts of landslides and floods. Additional strategies including livelihood diversification and the use of indigenous weather forecasting was also used to help farmers cope with climate change (Osuret J. , et al., 2016). Community sensitization played a big role in creating awareness on disaster mitigation measures and encouraging uptake of the sustainable farming practices. Other local initiatives included low technology options to improve water retention including the use of roadside drainage bunds and retention drains.

Restoration of forests

Mt Elgon is a major water tower in the region and the sources of water for key rivers and lakes including Lake Victoria, Lake Kyoga and Lake Turkana, which are all part of the Nile River Basin system.

Rehabilitating forest cover is a recognized ecosystem-based approach and is being used by the Uganda Wildlife Authority, through its Forests Absorbing Carbon Emissions project. So far, 6,000 ha of natural forest has been restored. Apart from sequestering carbon, it has the additional benefit of making the area more resilient to climate change. In addition, UNDP, UNEP, Mbale, Manafwa and Bududa district authorities and the Ministry of Water and Environment, have implemented the Territorial Approach to Climate Change, whose overall objective is to support local low carbon and climate change resilient development by helping local decision makers and planners to design integrated climate change (adaptation and mitigation) policies and strategies, and formulate solid action and investment plans that promote long-term sustainability and poverty reduction (EAC, UNEP, and GRID-Arendal, 2016).

The Forest Department has focused on preserving and conserving the pockets of indigenous forests in the landscape and attempting to maintain biological interconnections between them. Fragile hill tops, steep slopes and river banks are also conserved in accordance with the National Environment Act and Regulations on the Management of Wetlands, Riverbanks and Lake shores. Agroforestry involving local species is being encouraged. The upstream reforestation activities coupled with conservation agricultural techniques, agroforestry and rehabilitation of the riverbanks have various socio-economic and environmental benefits including increasing water security (UNDP, 2015a).

Ecotourism to support ecosystem conservation

The policy of ecotourism development has several advantages including encouraging the local communities to become protectors of the local natural resource as opposed to only resource users; and to encourage income generation for conservation projects (Ransom, n.d.). The benefit sharing that was introduced to the Mount Elgon

National Park in 1994, introduced collaborative arrangements to improve relations between the park and communities and improve livelihoods. Some additional offshoot initiatives include beekeeping and Taungya farming which has contributed to a small increase in domestic incomes (Vedeld, et al., 2016) (Cavanagh, 2015).

Encouraging the use of fuel-conserving stoves

Promoting approaches that can reduce pressure on the forests such as the use of fuel-efficient cook stoves is one way of conserving the ecosystem services that are provided by the forests of Mt. Elgon and making the population more climate-resilient. The Lorena fuel-efficient cook stoves that are being promoted reduce fuel consumption by up to 60 per cent and thus enable the population adapt better to the reducing wood fuel in the region (Kyeyune, 2015). In addition, with the adoption of fuel-efficient cookstoves, women and girls who are normally tasked with the job of collecting fuelwood from the forests will spend less time collecting firewood. They are thus able to use the extra time in other productive income-generating activities such as looking after livestock or crop farming (UNDP, 2015b). There are also health benefits as smoke is channeled through a chimney out of the kitchen reducing indoor air pollution which cause respiratory infections and other health complications.

4. How have the interventions influenced national policy if at all?

Embedding EbA in strong national policy and legislation

When ecosystem-based adaptation is integrated into national and local level policies, it places the issue at the centre stage of planning and implementation and long-term development. The National Climate Change Policy was developed and is being implemented by the Climate Change Department under the Ministry of Water and Environment. The Second National Development Plan calls for long-term policies and strategies for adapting to the impacts of climate change. There is a wave of policy reviews currently underway in Uganda such as the review of the National Environment Management Policy, and the National Environment Act among others. These reviews will take into account new and emerging issues and ensure the integration of ecosystem-based adaptation among others.

Environment policy development is also on-going at the lower levels. For instance, Butaleja and Mbale districts have developed an Environment Policy and a District Environment Ordinance respectively. However, the Mbale District Environment Ordinance run into implementation challenges and has been shelved for the moment.

5. What needs to be done?

Strengthen institutional and policy integration

A strong national governance framework is required to implement EbA throughout national and local government policies and strategies. Climate adaptation and mitigation is already integrated into key policy documents. But it should also be mainstreamed into national sectoral policies such as agriculture, forestry and energy so as to ensure integrated implementation and decision making. The Climate Change Policy 2015, provides a blueprint for implementing adaptation and mitigation, but implementation remains a challenge. Involving local communities in climate risk assessments and the design and implementation of adaptation options could be one means of ensuring enforcement (IISD, 2013).

The Climate Change Bill 2018 needs to be enacted, implemented and enforced fully. To do so, there will be need for capacity building at all levels

and this should be included and budgeted for in all development plans from national to district and lower levels. At the lower levels, especially, mainstreaming of environment and in particular climate should be stronger. Ecosystem-based adaptation is an opportunity to encourage the cross-sectoral collaboration that would enhance this.

Develop a Local government mechanism for cooperation on Mt. Elgon EbA

Decentralized governments have the potential to serve as champions for sub-national EbA strategies and lead development of subnational climate change initiatives (Russell, Ongugo, & Banana, 2016). This should be encouraged. Other approaches could include supporting strong farmer institutions and NGOs.

The initial successes of the ecosystem-based adaptation practices in the Mount Elgon region has shown that there is need to develop policy and plans for land use and business development based on sustainable natural resources management approaches. Such a policy would guide the development of regulations about the way resources are managed and used in this region. A financing mechanism to support implementation should also be developed in order to avoid infringing on the meager local government budget. An integrated policy that also caters for population, environment management, food security, disaster risk, early warning systems and infrastructure is needed. Currently the only safety nets available are at the national level but local level safety nets within a policy framework are needed.

Since there are a number of districts that surround the Mt. Elgon National Park, it is imperative that a cooperation mechanism be expounded that will allow them to work together in a manner that is bound by law. This will enable adopted decision to be carried forward from the District councils District Development Plans (DDPs) and Budget Framework Papers (BFPs) after which they become legal documents.

Link ecosystem-based adaptation to livelihoods

If ecosystem-based adaptation practice is linked to livelihoods and income generation, it is likely to be taken more seriously. It is therefore necessary for research be undertaken to identify more synergies between EbA practice, ecosystems and climate change adaptation based on existing livelihoods. Focus should also be on both subsistence and commercial crop businesses including the non-traditional crops (UNDP, 2015a).

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Chapter 5

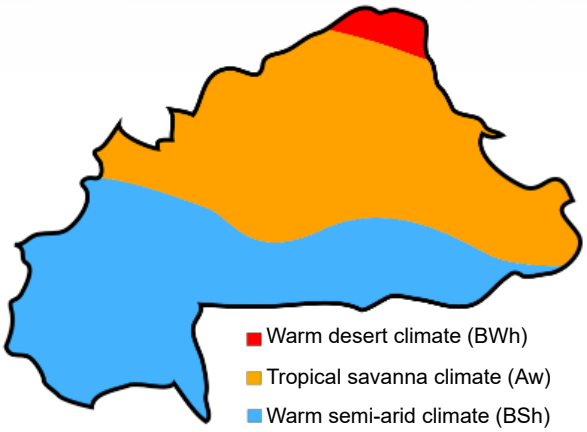
Ecosystem-based Adaptation—Southern Burkina Faso Case Study

1. Introduction

Burkina Faso is a landlocked country on the west coast of Africa bordered by Cote d'Ivoire, Togo, Ghana, Benin, Niger and Mali. The average total precipitation in Burkina Faso is 780 mm with about 50 per cent of the land receiving an annual total precipitation between 610 and 900 mm (GFC, 2018). Its ecological and climatic zones include the arid Sahelian zone which averaging 750 mm of rain with mainly grassland vegetation. This borders the Sahara Desert and livestock rearing is popular amongst the pastoralists in this zone. The semi-arid Sahel-Sudan zone has rainfall between 750mm to 1250mm and grass, shrubs and Acacia vegetation. A mix of livestock rearing and agriculture is found. The Sudan-Guinea zone is found in the southern most parts of Burkina Faso that receive rainfall of between 1,250 and 1,500mm (FAO, 1985). A more wooded savanna grassland predominates and agriculture is the main occupation here. Only few livestock are found as this area is infested with Tsetse fly, the vector of Nagana disease in cattle.

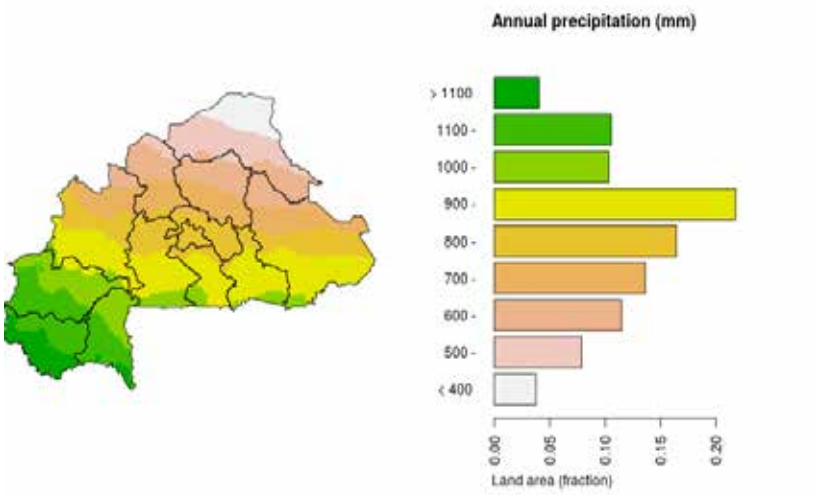
Burkina Faso witnessed a period of high rainfall between the 1930-1950's followed by a 3-decade long drought. Mean annual rainfall was estimated to have dropped by 30 per cent. The effects were devastating on populations and livelihoods and resulted in about half a million deaths and the migration of about 1 million people. Others remained and tried to adapt to the changing climate (rising temperatures and changes in rainfall patterns) (Brown & Crawford, 2008). Human activities such as deforestation, agricultural expansion, overharvesting, annual bush fires and overgrazing exacerbated the situation (Idinoba, Kalame, Nkem, Blay, & Coulibaly, 2009); (Karttunen, Wolf, Garcia, & Meybeck, 2017).

Figure 5.1 - Burkina Faso map of Koppen climate classification



The population is growing fast and Burkina Faso faces a challenge in preserving its environmental assets and feeding its growing population. The literature, however, shows that despite the expansion of agriculture, there are some improvements in land management (USAID; USGS, 2016b).

Figure 5.2 - Average annual precipitation (mm) for 1950-2000 in Burkina Faso



Nakileza, Majaliwa, Wandera, & Nantumbwe, 2017

2. What is the state of the environment?

Population growth

Population growth rate in 2015 was 2.9 per cent with the population having grown from 4.8 million in 1960 to 18.1 million in 2015 (World Bank, 2018). Population density is also increasing from a low of 18.9 people/km^2 in 1965 to a high of 66.2 people/km^2 in 2015. Southern Burkina Faso has experienced rapid population growth, mostly driven by migration for agricultural land. The migrants progressively encroach on the forests to convert them to cropland. Degradation of the environment is likely to continue if this rural migration is not checked (Ouedraogo, et al., 2009).

Poverty and environmental degradation

Using a wealth categorization of non-poor, fairly poor and the poorest,WorldClimBurkina Faso highlighted the fact that the poorest are not always necessarily the drivers of environmental degradation. For instance, non-poor farmers caused more deforestation than the poorest. In addition, the fairly poor and non-poor farmers have higher yields of cotton due to greater use of pesticides and other inputs thus contributing more to environmental degradation than the poorest (Etongo, Djenontin, & Kanninen, 2016).

Climate change

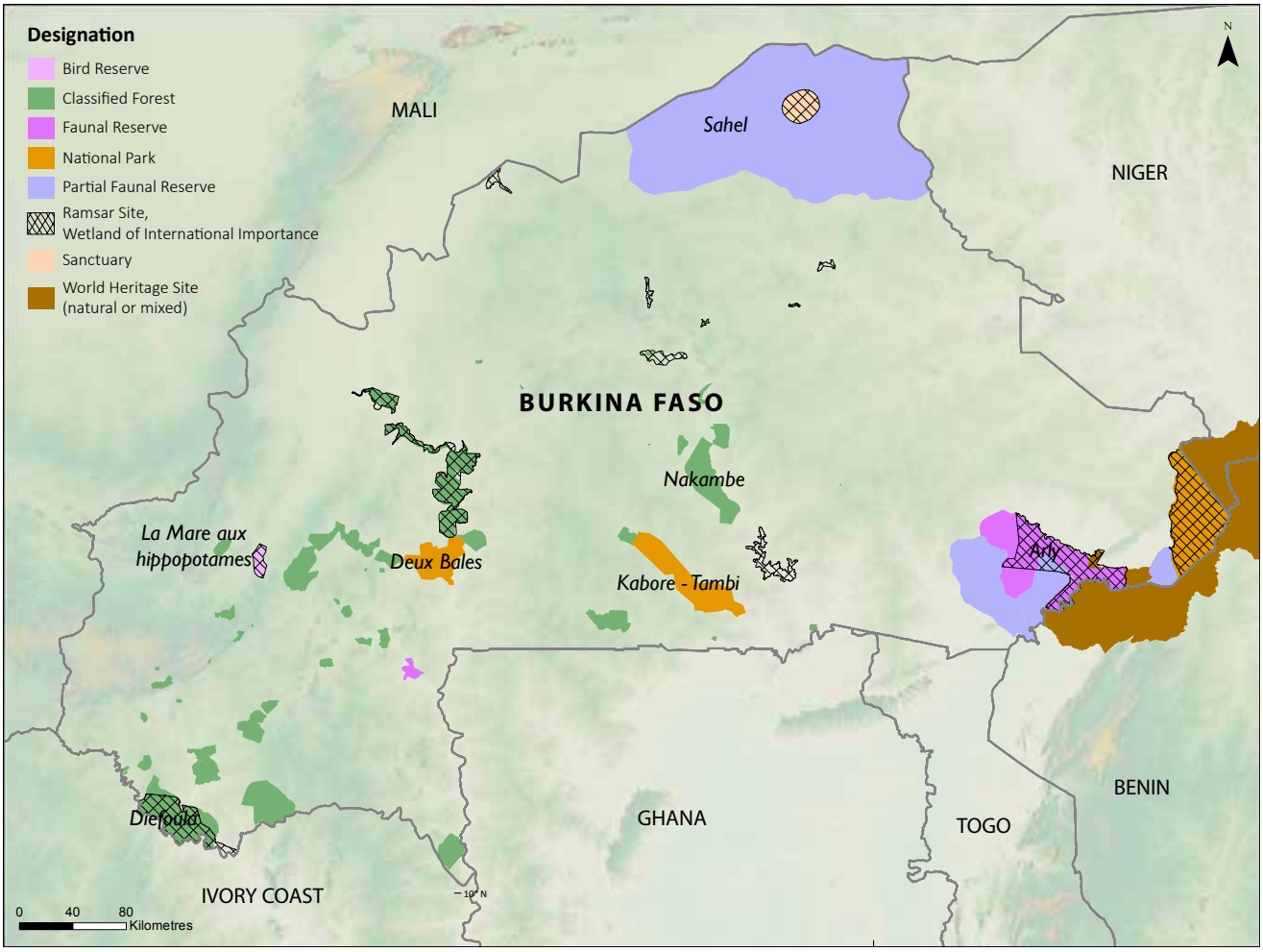
One of the major environmental issues facing Burkina Faso is the recurrent drought and the advance of the northern desert into the savanna. Desertification is being driven by overgrazing, slash-and-burn agriculture, and deforestation. In 1990 forests covered 25 per cent of the land area of the country and by 2015, this had declined to 19.5 per cent. Total forest area in 1990 was 68,470 km^2 and this declined to 53,500 km^2 in 2015 (World Bank, 2018). The frequency of droughts and proximity to the Sahara Desert all contribute to the water security issues.

Water resources

The Volta River system covers 63% of the country and makes up the bulk of the water resources of the country. Other water resources include the transboundary Niger (to the east and north) and Komoé (southwest) rivers that covers 30 and 7 per cent of land area (GFC, 2018). Total renewable water resources in Burkina Faso are 13.5 km^3 but by 2015, only 43.2 per cent of rural dwellers and 78.8 per cent of city dwellers had access to basic drinking water services (FAO, 2018). Pressures from population growth, degrading environment and pollution from the mining, agricultural and livestock sectors are all driving water scarcity. This is also being exacerbated by the impact of climate change. To address the water supply problem, the government has built over 145 dams which had a total capacity of 5.338 km^3 in 2015. However, in the 10 years between 2005 and 2015, the total dam capacity has only increased by 2.2 per cent despite population increase (FAO, 2018). For instance, between 2005 and 2014, population growth rate averaged 3.0 per cent declining only slightly to 2.9 per cent in 2015 higher than the expansion in dam capacity (World Bank, 2018).

Dams also have an impact on population growth. The Kompienga dam (in Kompienga province, southeastern Burkina Faso) built between 1985

Figure 5.3 - Large national parks of Burkina Faso



USAID; USGS, 2016b

and 1988 for electricity generation, irrigation and fisheries had by 1989 attracted a large population from the surrounding areas most attracted by the possibility of irrigated agriculture. While many of the communities near the park area are not new, a growing population and increasingly intense crop and livestock farming have clearly defined the boundary between the inside and outside of the protected area as shown in satellite images (USAID; USGS, 2016a). Also visible in the images are scattered burn scars (dark reddish-purple patches) as the dry season begins. Burning across most of the area is an annual occurrence.

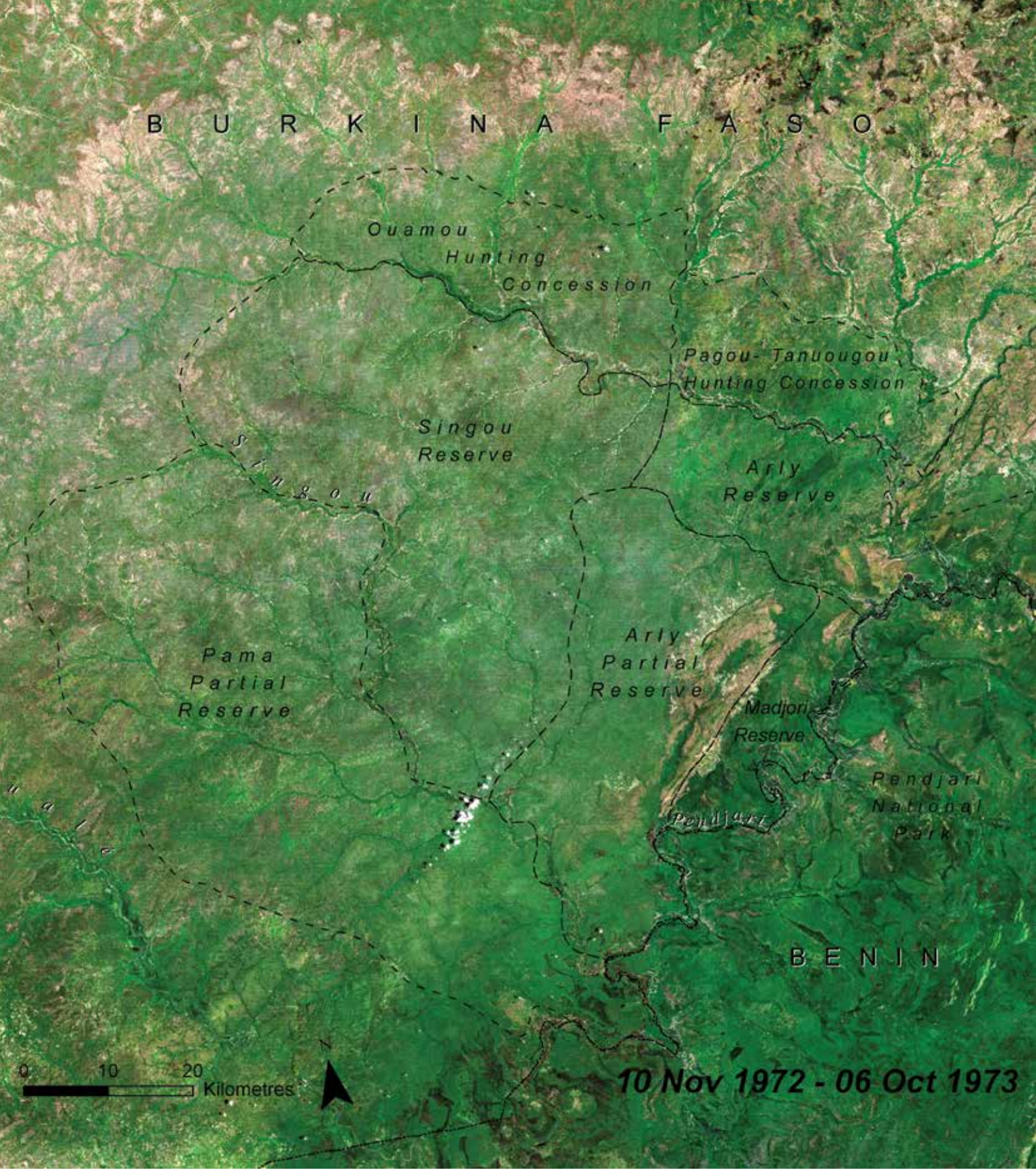
Biodiversity and ecosystems

The protected area network in Burkina Faso covers an area of 14.1 per cent of the total land area and comprises four national parks, a UNESCO Biosphere reserve, three Ramsar sites, a number of wildlife reserves and protected forests (World Bank, 2018). There are 1,100 known species of plants of which 2 are endangered (WRI, 2003). Mammals and bird species umber 147 and 138 respectively. Some mammals that are endangered include the African hunting dog, the chimpanzee, and the African elephant, while the Sahara oryx (or White oryx) are recorded as extinct in the wild.

flowcomm/Flickr / CC BY 2.0

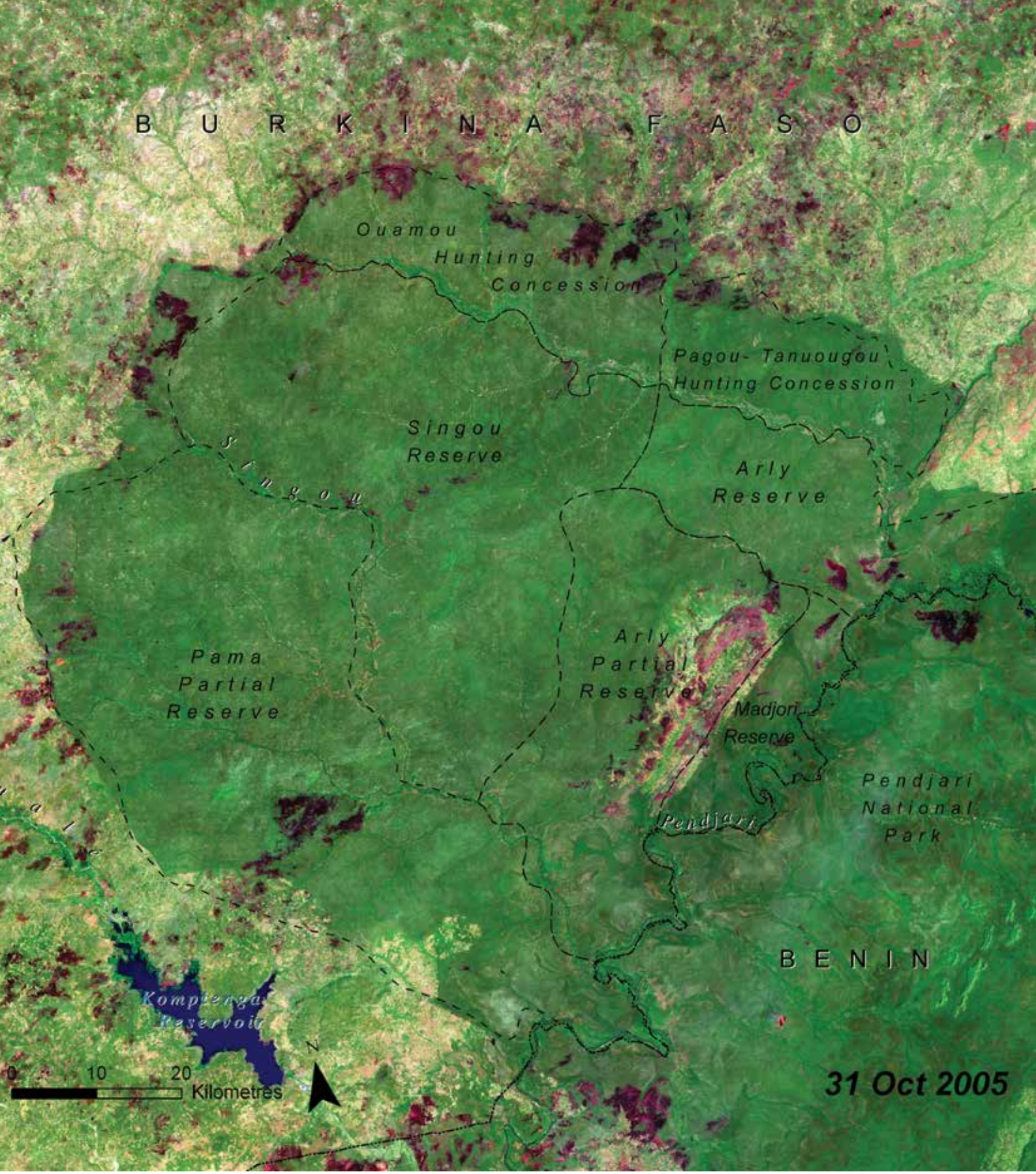
Ronald Woan/Flickr / CC BY-NC 2.0

Megan Coughlin/Flickr / CC BY-ND 2.0



Land cover changes in the W-Arly-Pendjari Complex.

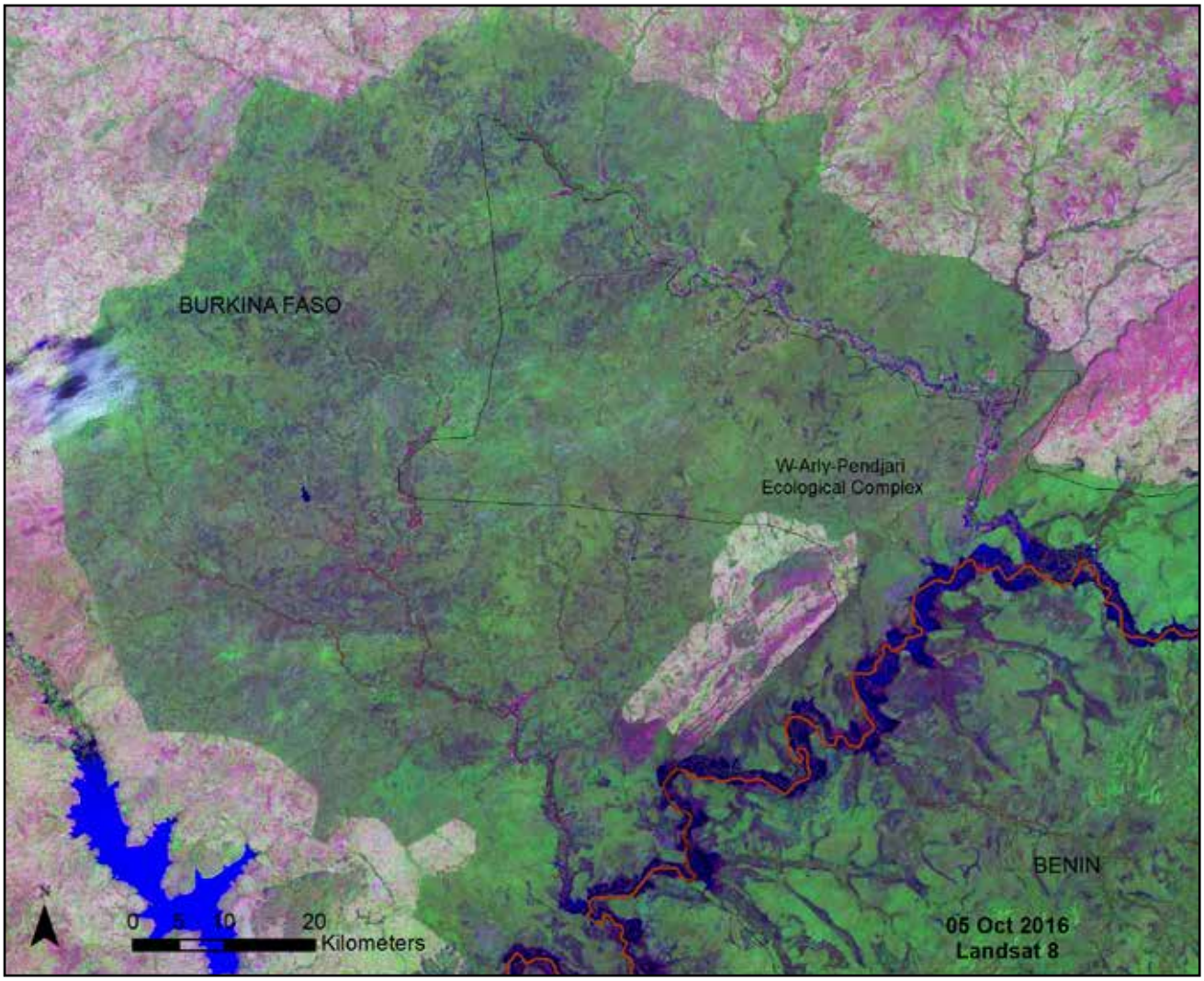
The Arly National Park in southeastern Burkina Faso, is part of a transboundary protected area system – the W-Arly-Penjari Complex. Also known as the WAP Complex, it is shared with Benin's Pendjari National Park in the south, and the Singou Reserve in the west and with the W National Park of Niger. They were all designated as Important Bird Areas by Birdlife International in 2001. It is on the World Heritage List and includes the largest and most important expanse of terrestrial, semi-aquatic and aquatic ecosystems in the West African savannah region. It is an important refuge



for a number of endangered species and home to the largest elephant population in West Africa (UNESCO, 2017). It is estimated to host about 544 plant species, 360 bird species and over 50 mammal species (UNEP, 2008).

Despite its protection status, the WAP complex is under pressure for agriculture for livelihood and economic growth and to feed the rapidly growing population. There is already evidence of loss of wooded savanna and gallery forests surrounding

Figure 5.4 - Land cover changes in the W-Arly-Pendjari Complex.



Source: (NASA LP DAAC, 2016)

the WAP complex's borders especially in the buffer areas and transition zones surrounding the central core of the complex (UNESCO, 1996). The partial extermination of the vectors of sleeping sickness and river blindness (the Tsetse flies and Black flies respectively), inflow of pastoralists due to the Sahelian droughts and the government programme to encourage cash crop growing of cotton led to a massive increase in the population in the late 1970s.

3. What has changed and what is the perception of the communities around?

Population pressure is fast becoming one of the most intractable problems in Burkina Faso where the demand for food and agriculture-led economic growth exceeds the production capacity of the land.

Forests and the forestry sector are key elements in poverty reduction strategies in Africa (Coulibaly-Lingani, Tigabu, Savadogo, Oden, & Ouadba, 2009). Therefore, pressure on forests is likely to negatively impact efforts by governments and communities in their quest to adapt to changing climates.

Conservation effectiveness of protected areas

The premise behind protected area systems are that they are effective in preventing biodiversity loss, habitat destruction and protecting ecosystems within their borders. However, it has been found that population pressure inside or outside the protected area can lead to loss of forest habitat around the protected areas and greatly contribute

A critically endangered West African male lion from Pendjari National Park, Benin.

Jonas Van de Voorde / Wikipedia / CC BY-SA 3.0

to increase the levels of ecological isolation (Clerici, et al., 2007). Indeed, analysis of the WAP ecological complex indicated that 14.5 per cent of savannah habitat was lost in the WAP peripheral areas while inside the protected area complex, 0.3 per cent was converted increasing the degree of fragmentation. The main drivers are agricultural expansion in the area, with the greatest expansion being seen where the commercial interests of cotton are driving an already fast-growing agriculture. These ecological changes are decreasing the capacity of the protected area to effectively conserve species richness (Clerici, et al., 2007).

Despite this, preserving the functions of ecosystems through the use of protected areas is proving to be an effective methodology especially where ecologically important and contiguous landscapes cross international boundaries. The extensive area provides connections between the habitats and allows for the preservation of migration corridors allowing biodiversity resilience to the effects of climate change (Mengue-Medou, 2002). For instance, the shared W-Arly-Pendjari complex between Benin, Burkina Faso and Niger, respectively is a refuge for many animals including the African lion (*Panthera leo*), the African elephant (*Loxodonta Africana*) and the Western chimpanzee (*Pan troglodytes verus*). Lions are estimated to have lost about 99 per cent of their former range habitat in West Africa negatively affecting their numbers. Of the remaining 500

Figure 5.5 - Distribution of the African lion (*Panthera leo*) in West Africa

Henschel, Bauer, Sogbohoussou, & Nowell, 2015

animals, about 85 per cent of them are found in the WAP protected area complex highlighting its importance in habitat and biodiversity conservation (Henschel, Bauer, Sogbohoussou, & Nowell, 2015).

Local level adaptation initiatives

Changes in climate are already being felt at local and household level. In some areas people are implementing self-driven adaptation activities to mitigate the impacts. For instance, in Boulgou province, households have adopted adaptation measures such as the use of crop residue and herd destocking to deal with the observed temperature and rainfall changes (Kima, Okhimamhe, Kiema, Sampaligre, & Sule, 2015).

4. How have the interventions influenced national policy if at all?

Implementing climate change policy

Burkina Faso has articulated its adaptation priorities in three national-level documents: its initial national communication to the United Nations Framework Convention on Climate Change (UNFCCC), its national strategy, and its National Adaptation Programme of Action (NAPA). Priority actions in these documents include support for agriculture, water resources, and forestry. The NAPA identified water, agriculture, stockbreeding and forestry/ fisheries as the most vulnerable sectors.

With water scarcity as the visible impact of climate change, it is imperative that water resources management strategies focus on improving water security and strengthening community resilience. To improve household access to clean water and meet the increasing demands of the population more innovative and effective ways of harnessing water need to be explored. There are efforts to integrate ecosystem-based approaches such as using natural assets for responding to climate change impacts and integrating these into policies, plans and laws (Muthee, Mbow, Macharia, & Filho, 2017)

Furthermore, climate change efforts need to be fully integrated into the government's institutional framework and should bring together ministries to enhance coordination and information exchange. Other activities could include improving the meteorological early warning system, environmental monitoring, specific adaptation aimed at women including planning and decision making, drought resistant crops and seeds and small-scale irrigation projects among others. Capacity must be built for responding to, and early warning for disaster risk reduction and climate change.

Decentralized management of natural resources

In Burkina Faso, there have been efforts towards decentralized environmental management since the 1980s. The aim of including the local communities is based on the premise that their involvement will foster sustainable environmental management and reduce poverty. However, the success of these policy reforms remains questionable. For instance, the State Forest Services is heavily involved in decision making and this limits the active participation of local people to some extent. In addition, an interesting finding is that the engagement extent of some communities seemed to be related to their ability to generate income related to their livelihood, with less emphasis placed on forest conservation (Coulibaly-Lingani, 2011).

Improving water management

The Water Management Policy Act 2001 articulated strategies for Integrated Water Resources Management (IWRM) which resulted in the development of an IWRM strategy action plan 2003-2015. The action plan established the institutional framework for implementation including the National Water Council as the coordinating body. Some of the areas considered in the action plan included providing an enabling environment, the

water information system, research and development, human resources and the institutional framework among others.

As part of its implementation, the IWRM action plan also led to the creation of 5 major water catchment basin to make the management of water resources in the country more effective. Other tools employed included the development of a water policy to determine cases of water use violation and fees for the use, pollution or alternation of water flow. This is especially important in the dry season when demand for water exceeds supply.

5. What needs to be done?

Improve policy implementation

It is important that the decision makers provide the right environment to support planning and policy implementation. Factors determining the success of policy implementation include institutional collaboration, involvement of key stakeholders and vulnerable groups, the level of funding, effectiveness of the coordination and the importance decision makers give to the policy. Regular policy evaluation and review are also important. (Kalame, Kudejira, & Nkem, 2011). For instance, to improve the outcome of forest management programmes, promoting the direct involvement of communities including vulnerable and marginalized groups such as women and migrants will be key to securing user rights, equitable benefit-sharing and empowering forest users (Arevalo, 2016) (Coulibaly-Lingani, 2011).

Agricultural expansion and other human activities such as illegal hunting, weak institutions and poor law enforcement are likely continue putting pressures on protected areas through habitat degradation. As forest encroachment continues, the likelihood of human-wildlife conflict over crop feeding behaviours increases (Ginn & Nekaris, 2014). It is thus important that institutions be strengthened and innovative conservation approaches such as the combination of communal and protected areas be explored and implemented (Schumann, 2011).

Implement improved land management practices

Some of the opportunities that can reduce the negative impact of agricultural expansion on forests include agricultural intensification, agroforestry approaches and encouraging the development of non-timber forest products businesses. In 2016, 69.3 per cent of the population is rural and it is growing at a rate of 1.7 per cent per annum (World Bank, 2018). This rural population is primarily dependent on agriculture for survival. Addressing issues of tenure security, yields, will thus reduce pressure to encroach on the forests. Land management practices that can be encouraged include traditional soil and water conservation methodologies such as the Zai pits systems, fallow and natural regeneration of indigenous tree species (Bau, 2016).

Improve infrastructure

Finally, infrastructure must be improved to better withstand the wet season, including better spatial management of rural and urban areas, as well as improved housing construction materials, design, and locations. Dams and drainage systems should also be strengthened so that intense rainfall does not easily overwhelm and break those systems (USAID, 2012).

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Chapter 6

Ecosystem-based Adaptation—Xai-Xai, Southern Mozambique, Case Study

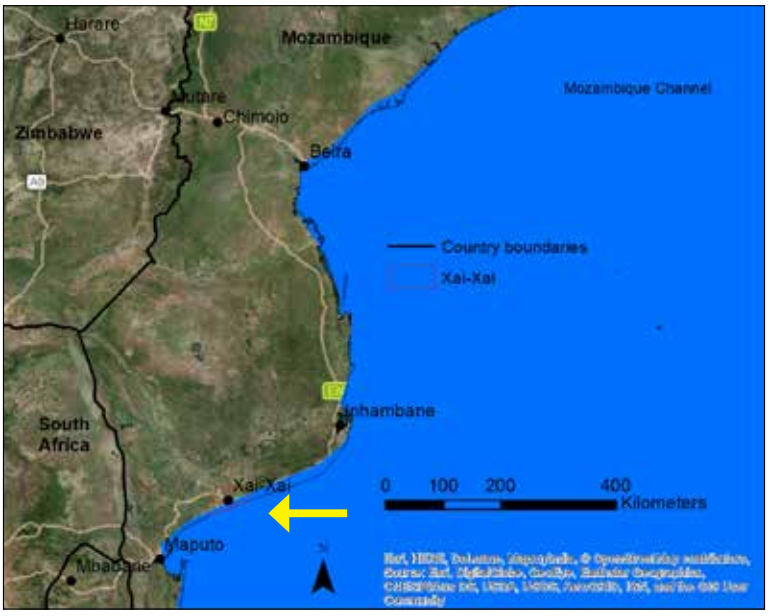
1. Introduction

Xai-Xai is a district located in the coastal province of Gaza in southern Mozambique covering an area of 1,745 km² (UNEP, FAO and PAP, 1998) The area is subject to droughts, floods and sea water intrusion. The key livelihood activities for the population are rain-fed agriculture, livestock production and other income generating activities.

The Limpopo, one of the biggest rivers in southern Africa, is a major livelihood resource for the Xai-Xai community. Located at the mouth of the river, the flow around Xai-Xai is slow and sluggish with a substantial amount of silt. Rainfall is seasonal and unreliable and the upstream communities that depend on rain-fed agriculture are increasingly impacted by declining precipitation. Population in the fertile lowlands is higher. Flooding can be a problem during the rainy season as seen in the 2000 and 2013 floods when low-lying farmlands in Xai-Xai district were completely inundated (Parkinson, 2013).

Xai-Xai district is about 2.73 per cent of the total area of Gaza Province. It has a coastline of 67 km, and beach tourism with activities such as snorkeling among the coral reef is a popular attraction (UNEP, FAO and PAP, 1998).

Figure 6.1 - Mozambique and location of Xai-Xai



2. What is the state of the environment?

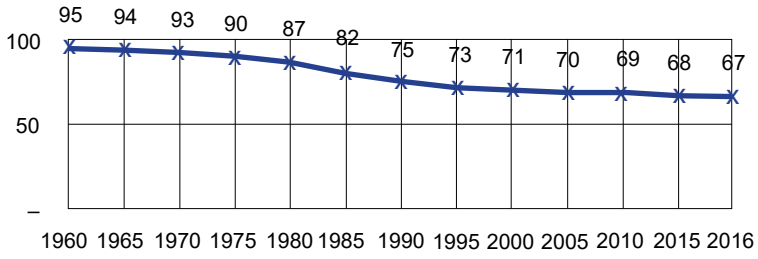
Population

Xai-Xai is a remote and underdeveloped place with high poverty levels and food insecurity. As a result, it is not resilient to the impacts of climate change. Water scarcity, dependence on rain-fed agriculture, floods and sea water intrusion leave the population extremely vulnerable (Midgley, Dejene, & Mattick, 2012). The percentage of the population living below the national poverty lines in 2014 was 46.1 per cent (World Bank,

Near Xai-Xai, Mozambique

F Mira / Flickr / CC-BY-SA 3.0

Figure 6.2 - Rural population (% of total population)



World Bank, 2018

2018). Gaza province had a population of 1,467,951 in 2017 with Xai-Xai district having 264,632 people in the same year. Average population density in Gaza province is 19.11 people/km^2 but ranges from a low of 1.5 people/km^2 in Chigubo to a high of 162 people/km^2 in Chongoene. Xai-Xai town has a population density of 1,058 people/km^2 (City population, 2018). Mozambique's rural population is growing as more people are moving to coastal cities, such as Xai-Xai town, increasing the proportion of the population susceptible to climate risks and putting pressure on coastal resource such as coral reefs, mangrove forests among others.

Climate change

The relatively high population in Xai-Xai is vulnerable to river flooding exacerbated by torrential rainfall, severe droughts and cyclones. Flooding affects the supply of food from agriculture and fisheries. As flood waters start to recede comes the risk of water- and vector-borne diseases such as cholera and malaria respectively. Droughts, also have consequences on rural food systems due to lack of irrigation water. The severe flooding in Xai-Xai in 2000, for instance, resulted in significant loss of agricultural produce, infrastructure and human and animal life. Flooding also has impacts on the ocean biodiversity. For instance, the reduced water salinity and the large amount of sediment discharged by the Limpopo River resulted in a decrease of about 58.5 per cent in hard coral cover (Pereira & Gonçalves, 2010). Coral plays a role in supporting tourism and recreation, shoreline protection and fish production.

Estimates of how changes in precipitation and temperature have been modeled for the major river basins in Mozambique. For instance, it is predicted that the Limpopo basin will experience a decline of between 5 to 15 per cent changes in precipitation, a 5 to 20 per cent change in evapotranspiration and a decline of 25 to 35 per cent change river runoff with a 0.2 to 0.5 temperature rise per decade (Ehrhart & Twena, 2006). Rises in temperatures will also reduce soil moisture, lower water table levels and slow aquifer recharge rates (Ehrhart & Twena, 2006)

Agriculture and the economy

Agriculture is the dominant sector and between 2015-2017 employed about 73 per cent of the population in Mozambique (World Bank, 2018). Most agriculture is done at subsistence level but there are also cooperative and commercial farms. In Xai-Xai about 99 per cent of households are involved in crop production with maize, cassava, cowpeas, groundnuts and sweet potatoes and vegetables as the main crops. Livestock is reared by about 67 per cent of households with poultry, goats, cattle and pigs as the main domestic animals (Filimone, Humulane, Fabião, & Dimande, 2014). The main challenges facing farmers are post-harvest losses due to weevil attack on stored grains, and low yields and productivity due to pests, disease and changes in precipitation. For instance, in 2016, yields of cereal in Mozambique were 823.8 kg/ha compared with 3,809.5 kg/ha in South Africa and 8.142.9 ha/kg in the USA (World Bank, 2018). Most households in Xai-Xai district are vulnerable to climate change, because of their dependence on rain-fed agriculture including crop and livestock production and the exploitation of forest resources. Climate change predictions indicate a 2–4 percent decrease in yields of the major crops, especially in the central region of Mozambique over the next 40 years (World Bank, 2010).

Lack of pasture and animal parasites is the main problem affecting livestock production in Xai-Xai district. Lack of pasture affects livestock farmers in the uplands between June-October due to drought; and between January-February in the lowlands due to flooding. Overstocking and encroachment on arable land by settlements and commercial agriculture are also reducing the available grazing area, commercial agriculture and settlement expansion (Filimone, Humulane, Fabião, & Dimande, 2014).

Mangrove loss

Deforestation for firewood, charcoal and timber production is a major concern leading to land use change and degradation of the environment through soil erosion, loss of habitat and wildlife. It is estimated that in the 30 years from 1972 mangrove loss in Mozambique reached the rate of 217 ha per annum (GCF, 2016). Climate change impacts such as flooding, increases in temperature and reduced precipitation are also likely to have contributed to the degradation of the mangrove forests.

3. What has changed and what is the perception of the communities around?

Promoting fish and crab farming

The climatic conditions favour aquaculture and this provisioning ecosystem service has been used to support food security and improve nutritional challenges. Food security is an issue in Xai-Xai district. The main causes are loss of arable land caused by flooding and salinization in the Limpopo river plain and high growth and concentration of population and refuges within the District's coastal area resulting in pressure and over-exploitation of natural resource. The literature shows that on average about 50 per cent of household's experience hunger for about 4 months in a year (Dixon, 2013). The main causes of this are loss of fertile land due to flooding and salinization, high population growth and over exploitation of resources in the district (UNEP, FAO and PAP, 1998).

Fish and crab farming is the ecosystem-based approach that was promoted as a means of enhancing food security, diversifying income streams and increasing resilience of local population to climate change. Fishery productivity and yield have increased, providing extra protein for households and the extra income for sales was used to purchase household necessities (Munang, 2012) (Menomussanga, 2013).

Conservation of local seed varieties

The conservation of local seed varieties is an ecosystem-based approach to enhance productivity and resilience to climate change and water scarcity. The high risk of crop failure due to low and irregular rainfall during the growing season is a major source

of food insecurity. The local populace adapted by utilizing traditional indigenous knowledge to improve a local variety of maize, through careful seed selection, maintenance of seed banks and seed conservation. These are then used in case of drought, flood or other emergency. For instance, local seeds were used after the 2016 drought, when many farmers lost their crops and seeds for the next planting season (Wise, 2017). The advantage with these locally selected seeds are they are not expensive like commercial seeds and they are adaptable to different ecological conditions and climate change impacts. The National Union of Farmers (UNAC) is implementing a national campaign to build emergency stockpiles of native seed varieties for key food crops.

Mangrove restoration

Mangrove restoration was employed as one of the ecosystem-based adaptation activities. Mangroves, sea grass, coral and other resources provide regulating and supporting ecosystem services that include carbon sequestration, nutrient mitigation and coastal protection. They are also habitat for biodiversity and support livelihoods by providing breeding grounds and food for aquatic biodiversity such as fish. They are a nursery area for numerous species of fish, seaweed and shellfish which are important food sources for the people. Coral reefs are important for tourism, recreation and for coastal protection by sheltering the beaches from strong waves. Mangrove restoration improved ecosystem functionality resulting in increased productivity, food security and incomes. An economic valuation determined the value of the mangrove ecosystems to be approximately $13.3 million annually, data that has encouraged greater interest in protecting mangroves (USAID, 2017).

Contributing to the ecosystems productivity Mangroves provide a nursery area for many marine species, most of which are important for food, like fish, crabs, and shrimp. Reforestation of mangroves has ensured the normal functioning of this ecosystem, which has in turn increased fishery productivity and yield, ensuring enhanced food security (Poio & Menomussanga, 2014).

4. How have the interventions influenced national policy if at all?

Improving fisheries management

Fisheries Policy (Resolution No. 11/96) was passed in 1996 with the aim of improving fish supply to address food insecurity in Mozambique. Since then, the Aquaculture Development Strategy in Mozambique 2008–2017 was approved in 2007, the Aquaculture Research Centre (CEPAQ) was established in 2008 and the 2016 National Plan of Aquaculture and developed the Aquaculture Development Action Plan. Although the formal Fisheries Sector, is generally well managed the artisanal sector still faces some challenges including pollution from mining industries, conflict between small scale and commercial fishers, climate change and decreasing stocks due to over fishing.

There is a National Agricultural Investment Plan 2014-2018 which recognizes the need to invest in the fisheries sector for employment and livelihoods support. The government has developed a Fisheries Master Plan 2010-2019 to increase the contribution of fish to food security, improving living conditions of fisherfolk and strengthen the contribution of fisheries to economic development.

At a regional level, in 2018, the African Union – IBAR established the Southern African Regional Platform for Non-State Actors in Fisheries and Aquaculture which will facilitate the implementation of the Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa (PFRS).

Improving coastal zone management

The main goals of the ICAM Strategy Framework for the Coastal Area of Xai-Xai are to encourage sustainable development through addressing the economic and societal wellbeing of the communities

through various means. For instance, natural resources with asset potential should be identified and used wisely to support livelihoods in the long term. Additionally, there should be efforts to enforce various carrying capacity tools to ensure environmental integrity. A mechanism for data collection, analysis and dissemination will be necessary to support policy and decisions. Since the management of the coastal zone cannot be done by government alone, there will be need to encourage public-private partnerships.

5. What needs to be done?

Continued support for mangrove conservation and restoration

Mangrove conservation and restoration is key to the continued delivery of regulating, provision, habitat and cultural ecosystem services they provide. These services support and strengthen the resilience of the coastal communities to the impacts of climate change. Some of the activities supported include medicinal plants, agriculture, artisanal fishing, woodfuel and charcoal, among other (USAID, 2013). For instance, in the Limpopo river estuary the economic value of fish products based on the amount harvested annually is MZN 183 million; while the value of fuelwood based on the annual harvested volumes is MZN 0.37million (USAID, 2014). The degradation of mangroves would thus have very negative impacts both social and economically.

Improve the institutional and legal framework

There is need to raise the profile of stakeholders in this area. Civil society, communities and government agencies need capacity building. Monitoring and enforcement of environmental laws, harmonization of the functions of ministries needs to be done to ensure efficient use of resources and effective on-the-ground impacts. An effective institutional structure for environment management needs to be developed and operationalized.

Integrated Coastal Zone Management

An integrated approach to the management of the entire coastal zone is called for. In 2004, Mozambique developed its National Strategy for Coastal Zone Management. This should be implemented fully. Some of the areas identified to enable this were to stop forest encroachment by agriculture and developing alternative livelihoods to encourage this shift, sustainably managing fisheries, methodologies to improve woodfuel efficiency and improve land use planning in the coastal zone among others (USAID, 2013).

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