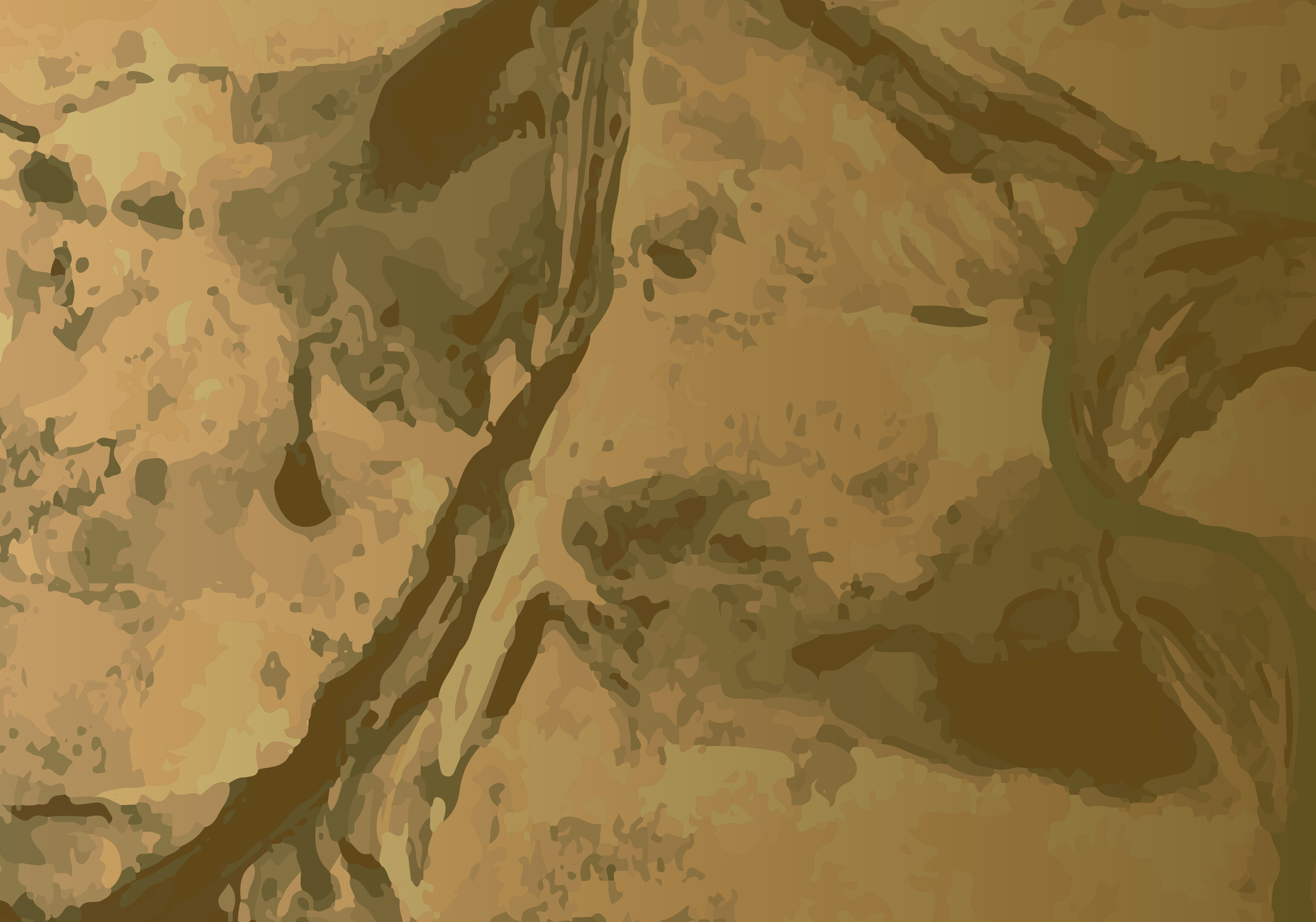
Sahara and Sahel Observatory

AFRICAN LAND: THE DEGRADATION AND THE ABSOLUTE REQUIREMENT OF SUSTAINABLE MANAGEMENT

Living in Harmony with Nature, Giving rebirth to our Land



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June 2024

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Contributions

Editorial team

This book took shape under the supervision of Mr. Nabil Ben Khatra, Executive Secretary of the Sahara and Sahel Observatory, and the coordination of Mr. Mourad Briki, Director of the Watch & Prospective and Capacity Building Department.

It was written by Ms. Malak Chalbi, Ms. Olfa Sehli, Ms. Olfa Karous, Ms. Dalila Hicheri, Ms. Hela Ghzel and Mr. Hamda Foughali, with the contribution of Mr. Youssouf Amadou, Mr. Emmanuel Sawadogo, Mr. Abina Abdoulkarim Bello, Mr. Mustapha Mimouni and Mr. Skander Jebali.

Review and supervision

The Directors of the Sahara and Sahel Observatory Departments, namely: Ms. Ndeye Fatou Mar (Land and Biodiversity), Ms. Khaoula Jaoui (Climate), Mr. Nabil Hamada (Strategic Development) and Mr. Lamine Baba Sy (Water) as well as Ms. Nadia Khammari, OSS Communication Specialist, monitored the drafting of the book.

Mr. Abdelkader Dodo and Ms. Apolline Bambara as well as Mr. Jean Luc Chotte, Mr. Ali Abaab and Ms. Mélanie Requier-Desjardins contributed to its technical review, and

Members of the OSS Strategic Orientation Committee, including H.E. Mr. Habib Ben Yahia (Honorary President), Mr. Luc Gnacadja (President), Mr. Ahmed Djoghlaf (Vice-president), Mr. Joseph Mulongoy, Mr. Jean François Donzier, Mr. Mounir Majdoub, Mr. Mokhtar Bzioui, Mr. Laurent Sedogo, Mr. Didier Tidjani and Ms. Alice Aureli and Ms. Roukiattou Ouedraogo, provided valuable guidance for the book to come forward.

Expert contributions

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Mapping and validation

The mapmaking process was supervised by Mr. Mustapha Mimouni, and the validation strategy was established by Mr. Louis Evence Zoungrana. The maps were produced by Mr. Amjed Hadj Taib, Mr. Anis Ghattasi, Mr. Thierry Tapsoba and Ms. Rym Sleimi.

Proofreading, translation and layout

The proofreading was done by Ms. Tharouet Elamri, Ms. Alia Ben Attia and Ms. Lilia Benzid.

Mr. Ahmed Ben Salah translated the book into the English version.

The graphic design and the layout were carried out by Ms. Tharouet Elamri in collaboration with Ms. Olfa Othman and Ms. Salma Ammar.

The book edition was coordinated by Ms. Olfa Othman.

Illustrations and photo copyright

All sketches and graphics were drawn up by Ms. Tharouet Elamri, Ms. Salma Ammar and Mr. Hamda Foughali.

Photos were selected by Ms. Lilia Benzid, Ms. Olfa Othman and Ms. Tharouet Elamri.

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Sahara and Sahel Observatory
Boulevard du Leader Yasser Arafat
P.O. Box 31 Tunis Carthage - 1080 Tunisia
Tel. : (+216) 71 206 633/634

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Preface

Land degradation is a complex reality that has a significant influence on the lives of populations and sustainable development. Our fertile lands are definitely crumbling under the devastating impact of this phenomenon. To date, almost two thirds of the continent's arable land is already affected.

Degraded land is a major obstacle to economic growth and directly affects the livelihoods of the communities. The importance of sustainable land management is undisputable and is simply linked to the economic, social and environmental development of the countries.

Preserving the lands of Africa, one of the most affected continents in the world, and restoring them is imperative to guarantee a prosperous and resilient future. Today, land degradation stands behind agricultural losses that amount to billions of dollars, and deforestation deprives communities of valuable forest resources. Fighting land degradation is just investing in the future.

The lack of up-to-date data and the disparity of existing approaches and figures on land degradation in Africa make it hard to understand all aspects of the phenomenon. The need for reliable and relevant data is at the heart of any effective sustainable land management strategy. From this perspective, Land Degradation Neutrality (LDN) is of particular importance, providing a framework for assessing progress towards a balanced land degradation/restoration linkage. Furthermore, restoration and LDN targets, national biodiversity strategies and action plans and nationally determined contributions are closely interrelated. This connection promotes the creation of cost-effective synergies between the three Rio conventions, enabling the achievement of the global objectives.

The Sahara and Sahel Observatory produced this documentary book which highlights existing knowledge on land degradation and sustainable management in Africa. This work includes maps of SDG indicator 15.3.1, covering the African continent with up-to-date, high-resolution data. It also provides a comprehensive view on the multifactorial framework of land degradation in Africa, deeply rooted in the environmental and socio-economic realities of the region as well as on the state and extent of this phenomenon, and its impacts on the various aspects of life. It presents the sustainable land management concept as a possible solution.

This publication is the result of an inclusive process that involved several regional and international partners and that made it possible to compile the knowledge, perspectives and recommendations of a range of stakeholders, reflecting the diversity and richness of experiences in land degradation in Africa.

I am deeply grateful to all contributors without whom this book would not be in your hands today. This book is much more than a compilation of data and analyses, it is a call to action and aims to inform, raise awareness and mobilize decision-makers and stakeholders concerned about the future of our continent.

We hope this work will trigger in-depth discussions and guide effective and concrete actions, interventions and collaborations for the conservation and restoration of our lands.

Nabil BEN KHATRA

Executive Secretary
of the Sahara and Sahel Observatory

Introduction

Land degradation is the result of human-induced actions, leading to the decline of their biodiversity, soil fertility and overall health condition. This accelerating degradation compromises food security of a growing global population. Although several natural drivers might be root causes, anthropogenic factors stand behind this phenomenon. Indeed, agricultural practices, urban pressures, pollution, deforestation and overexploitation of water resources lead to often irreversible land degradation.

At the current rate, 90% of land will bear our footprint by 2050 (UNCCD). The impacts of land degradation are felt across the globe and influence other factors of degradation such as rainfall patterns and the occurrence of extreme weather events such as droughts or floods. This situation is generating other increasingly worrying phenomena such as social and political instability, poverty, conflicts and migration.

Today, the African continent is facing land degradation, an insidious, complex and multifactorial phenomenon which threatens the survival of biodiversity, ecosystem services and the populations.

Covering nearly 20% of the land surface, Africa is home to rich biodiversity and great regional ecosystem variability. Over the years, African peoples have developed local knowledge and cultural heritage closely linked to their environment and more particularly to their land.

62% of the African rural population depends on the ecosystem services provided by the natural resources for their vital needs. However, these ecosystems are suffering from growing anthropogenic and climate pressures that hardly keep up with the rapid economic and demographic growth of the continent. In terms of food security, agricultural activities, which provide income to 70% of the population, contribute on average 35% to gross domestic product; hence the immediate need to protect, preserve and restore land.

According to the United Nations Convention to Combat Desertification (UNCCD), approximately 65% of Africa's productive lands are degraded and 45% are already desertified. This situation leads to billions of US dollars of economic losses every year. Moreover, it exposes the populations to more poverty, conflicts and forced migrations increasing their vulnerability.

Faced with this crisis, sustainable land management provides promising solutions, encouraging restoration and strengthening the resilience of ecosystems, in line with the Sustainable Development Goals and the 2063 agenda of the African Union. However, the absence of up-to-date data, inappropriate evaluation methods, and the lack of political commitment and funding are major challenges to be overcome.

This work aims to understand this complex and multifactorial phenomenon. It assesses the current state of degradation through a detailed analysis of SDG indicator 15.3.1, explores impacts on the countries and populations, highlights local sustainable land management initiatives and calls on decision-makers to the action. Updated maps, associated with an interactive digital platform and innovative participatory approaches support this awareness-raising approach.

This book targets regional and international institutions working on the implementation of degraded land rehabilitation initiatives and prevention measures. It also aims to guide any institution or Organization involved in sustainable land management and Land Degradation Neutrality.

It is based on four main sections:

The first section provides an overview of the African environmental context, emphasizing the interactions between Man and nature, and describes the main types of climate, water resources and soils of the continent, as well as its rich biodiversity. It then addresses poverty, people's livelihoods and their dependence on natural resources. Finally, this section deals with agricultural and food issues, environmental regulations and anthropogenic pressures on ecosystems.

The second section details the visible occurrences of land degradation in Africa, highlighting climate change, biodiversity erosion and desertification. It assesses the scale and severity of desertification through detailed mapping and an updated analysis of SDG indicator 15.3.1 and its three sub-indicators: land cover, land productivity and carbon stocks.

The third section studies the social, economic and health impacts of land degradation on African populations, focusing on food insecurity, health risks and associated economic costs.

Finally, the fourth section addresses sustainable land management approaches at the continental level to combat degradation, restore degraded lands and strengthen their resilience.

Armored landscape playing a protective role against erosion in the Niamey area, Niger

01 African context

The proliferation of typha makes certain lands unsuitable for agriculture and has harmful effects on economic activities, the well-being of populations and biodiversity. The various means of control available are expensive and thus, they are insufficient

The African natural environment is known to be diverse and unique, with different landscapes from arid desert to vast grassy plains and from tropical forests to rugged mountains. Each of these landscapes has specific climate, water resources, soil types and biodiversity specifications. This diversity makes it possible to understand the interactions between Man and nature, as well as the natural dynamics of the African continent. Indeed, Man needs to understand the African ecosystem and its interconnections to carry out environmental assessment and human prosperity studies.

This section falls directly within the scope of this approach. It provides an overview of the African context, emphasizing the natural environment of Africa and Man's connection with it. It thus aims to better understand the vulnerability of the continent to environmental threats, and more precisely to land degradation. It only takes an understanding of its environmental and socio-economic specificities.

I- Natural environment of Africa

I.1- Climates of Africa

With its impressive size and varied topography, Africa is home to a rich climate diversity determined by a number of factors including the apparent movement of the sun between the tropics and the impact of cold ocean currents.

According to the Köppen-Geiger map, the climates of Africa are divided into 20 classes (Fig. 1). For simplicity purposes, they are split into seven zones, each presenting unique climate properties: the hot and humid zone, the savannah zone, the steppe zone, the arid desert zone, the Mediterranean climate, the East African highlands and the southern African high plateau (Fig. 2).

Generally speaking, Africa's climate brings extreme weather conditions, marked by high temperatures and erratic rainfall and dominated by aridity. Nearly two-thirds of the land area of the African continent is made up of dry areas encompassing hyper-arid, arid, semi-arid and dry sub-humid zones. They represent more than 90% of the surface area of North Africa.

01 What is the difference between aridity and drought?

Unlike aridity which is defined by a permanent water shortage, drought reflects a temporary water deficit, compared to normal conditions and is therefore cyclical. An arid zone can experience, over a more or less short period of time, an abnormally dry period, which can affect the populations and land.

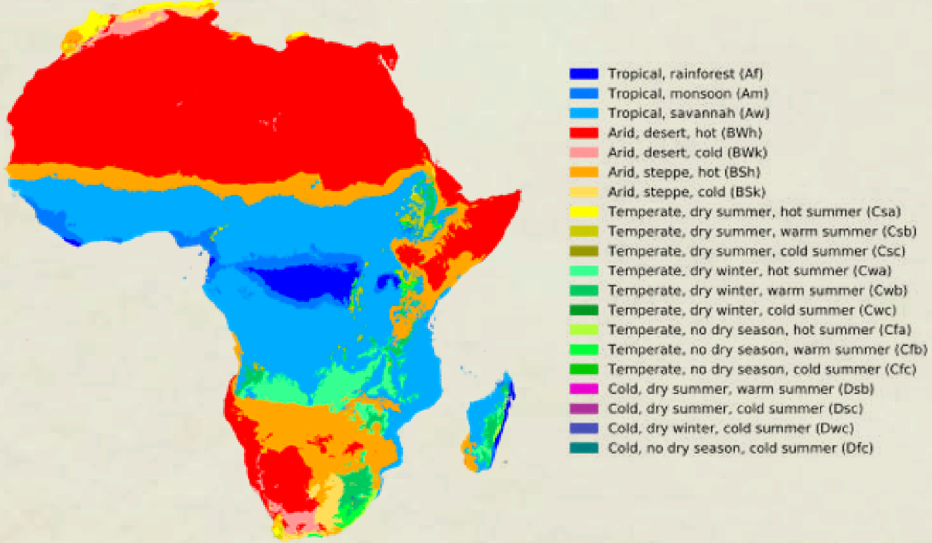

Figure 1: Africa climate classification map (Köppen-Geiger) [1980-2016] (Beck & al., 2018)

THE CLIMATE ZONES OF AFRICA

THE HOT AND HUMID ZONE

Stands for 14% of the continent. It is located around the equator where annual rainfall exceeds 1500 mm.

THE SAVANNAH ZONE

Occupies 31% of the continent. Semi-humid, it is located in the north and south with annual rainfall between 600 mm and 1200 mm.

THE STEPPES ZONE

Covers 8% of the continent's surface area. It is semi-arid with rainfall only during the summer months, averaging 600 mm or less.

THE HIGH PLATEAU OF SOUTHERN AFRICA

Where the climate is temperate. In winter, temperatures may drop enough to allow occasional frosts and snowfall, particularly in mountainous areas.

THE HIGHLANDS OF EAST AFRICA

Where rainfall covers all months of the year and temperatures are constant.

THE ARID DESERT ZONE

Occupies almost half, i.e. 47% of the continent's surface. Annual rainfall is irregular, sometimes less than 100 mm, or even absent in some areas. Temperatures are extreme, averaging above 35°C during the summer.

THE MEDITERRANEAN CLIMATE

Temperate, located in the northern and southern extremes of the continent with high temperatures in summer and warm and rainy autumn and winter months.

Figure 2: The climate zones of Africa (adaptation from Jones & al., 2015)

In the north, the Sahara dominates with its extremely high daytime temperatures and cool nights. Further south, the Sahel is characterized by long, hot dry seasons, with short periods of rain, contrasting with the equatorial regions which enjoy warm temperatures and large amounts of rainfall throughout the year. This climate is highly suitable for the development of rich ecosystems and exceptional biodiversity. Various other climates including tropical, Mediterranean, continental and oceanic, add to the continent's extraordinary climate diversity.

Widespread periods of drought

Droughts are commonly observed and more pronounced in many African countries due to the extreme variability of rainfall in desert, arid and semi-arid areas of the continent (UNCCD, 2023). The severe droughts that hit the Sahel between 1968 and 1984, as well as North Africa between 1980 and 1985, and again between 1999 and 2003, are strong reminders of the major drought challenges ahead of Africa (Hirche & Podwojewski, 2017). In recent years, severe droughts have become increasingly frequent, particularly in the Horn of Africa and the Sahel (UNCCD, 2023).

According to a report published in 2022 by the Intergovernmental Panel on Climate Change (IPCC), the five sub-regions of Africa are experiencing the different forms of drought (Tab.1).

Table 1: Drought by African subregion.

North Africa	The region becomes more arid due to a significant drop in rainfall (IPCC 2022a).
West Africa	The frequency of meteorological, agricultural and hydrological droughts has increased since the 1950s. Multi-year droughts have become more frequently viewed (IPCC 2022b).
Central Africa	Since the middle of the 20th century, drought intensified due to the decrease in rainfall and the increase in meteorological, agricultural and ecological droughts. Between 1991 and 2010, southern and eastern areas of Central Africa were identified as hotbeds of drought (IPCC 2022c).
East Africa	Since 2005, drought periods went double, from once every six years to once every three years. Many of these prolonged periods have occurred primarily in arid and semi-arid areas over the past three decades (IPCC 2022d).
Southern Africa	Agricultural drought increased between 1961 and 2016, and the frequency of meteorological droughts increased by 2.5 to 3 events per decade since 1961. The reduction in rainfall that caused the Cape drought in 2015-2017 was three times more likely due to human-induced climate change (IPCC 2022e).

A number of interrelated factors explain Africa's vulnerability to drought. First, Many African countries heavily rely on rain-fed agriculture which makes economies and populations sensitive to seasonal rain variations. Second, due to the overexploitation of natural resources and unsustainable agricultural practices, land degradation lowers the capacity of the soils to retain water and support crop growth. Additionally, climate change exacerbates the frequency and intensity of extreme weather events, such as prolonged droughts.

I.2- Water resources

Africa is thought to be the second driest continent in the world, even though it has abundant water resources and significant hydraulic potential. Indeed, the continent has 17 large rivers and 160 lakes (Fig. 3) (Bazié, 2014), not to forget the considerable groundwater tables.

According to various estimates, the continent accounts for 9% of the world's renewable fresh water resources, or nearly 4,000 km^3 of water mobilized per year. Furthermore, groundwater reserves (Seguin & Gutierrez, 2016) would amount to 660,000 km^3.

Behind this misleading abundance, Africa has a very large disparity in water resources and will face serious supply difficulties in at least 25 countries by 2025 (Seguin & Gutierrez, 2016). It is also one of the three global "hotspots" for rainfed agriculture..

Why is that? Because of the uneven distribution of the resources across the regions. Compared to the comfortable water situation in the equatorial zone, the North, the Saharan and sub-Saharan parts of the continent live a potential water shortage (MacDonald & al., 2012). Indeed, hundreds of millions of people experience the hardships of water shortage throughout the year which is due, not only to the lack of water availability, but also to increased urbanization, access conditions and poor governance of the resource.

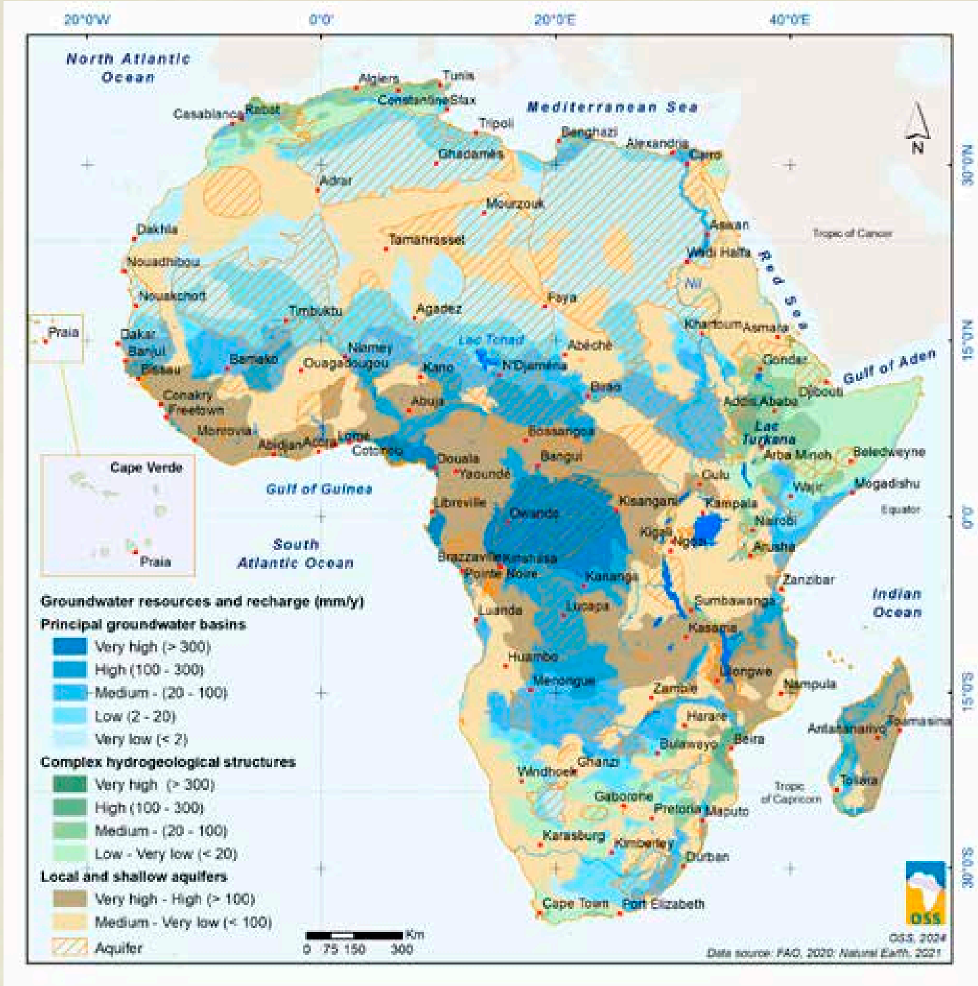

Figure 3: Groundwater resources, hydrogeological structures and aquifers (Data source: FAO, 2020, Natural Earth, 2021)

La Bouche du Roy, the mouth where the Mono River meets the sea and never mix (Benin

02 Every year, several billion m³ of water, flow into the oceans due to the inadequate or inappropriate retention and storage infrastructure. The establishment of such infrastructure faces environmental challenges and financial costs that often exceed local, national and even continental financial capacities (Bazié, 2014).

By 2050, nearly 350 to 600 million Africans would be exposed to the consequences of water stress. From the current population dynamics and the multiplication of water needs (irrigation, domestic use) that are crucial for ensuring economic and social development, it appears that a considerable number of African countries would reach the limits of usable terrestrial water resources before 2025 (GEF, 2011).

Ecosystems are particularly affected by water stress which depletes the plant cover and increases the risk of forest fires, thus exposing the soil to degradation factors. The overexploitation of the aquifers and the use of unconventional water can also spoil the quality of the soils, reduce the plant growth and cause serious losses to agricultural productions.

Intensified water stress and climate change will impact the agricultural production and ultimately food security, especially since most of small farmers depend on low-input rainfed agriculture. It is believed that by 2080, sub-Saharan Africa would lose around 75 million ha of land currently suitable for rain-fed agriculture, thus amplifying the land degradation phenomenon.

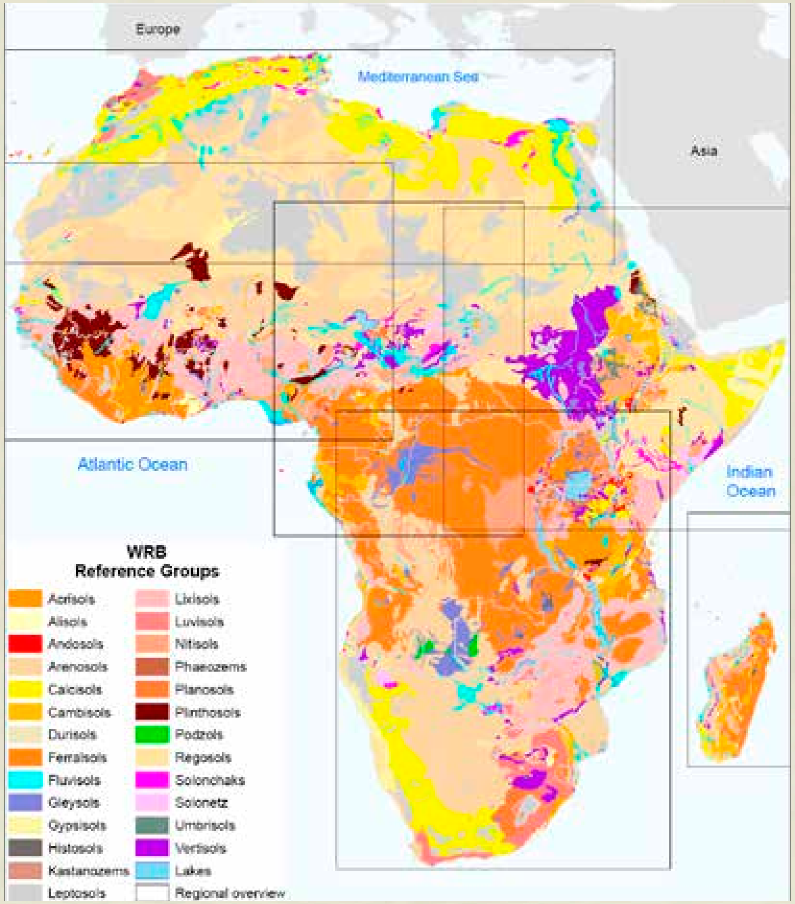

Figure 4: The main soil types in Africa (Jones & al., 2015)

I.3- Soil resources

Africa is home to exceptionally rich and diverse soil resources which play an indispensable role in building its economy and providing its livelihoods. Not only are these soils vital for agriculture and food security, but they also hide unique biodiversity and are a core element in its preservation, in the storage of atmospheric carbon and in the regulation of hydrological and climate cycles.

African soils are the result of the interaction of several variables, namely: the parent material, topography or position in the landscape, climate, living organisms, human activities and time.

Figure 4 shows the main soil types in Africa according to the World Reference Base for Soil Resources (WRB) classification. It is an update of the African part of the world digital soil map published by FAO. The different sub-regions of the continent have a variety of soils (Tab.2). Ferralsols and Acrisols dominate the wetter central areas, while Lixisols appear in drier regions. Plinthosols predominate in West Africa, and the northern and southern desert regions feature mainly Calcisols, Leptosols, Regosols, Arenosols and Gypsisols. Vertisols are mainly located in Sudan and Ethiopia, while Andosols are found in the Great Rift Valley. Kastanozems and Phaeozems mark the Mediterranean region. The Solonchaks and Solonetz are associated with the coastal plains. Technosols can be observed in urban areas and near large mines, although their presence is generally limited to localized areas and does not appear on a continental scale (Jones & al., 2015).

Thus, each subregion can be defined by a particular assemblage of soil types with the possibility of a certain superposition (for example, the ubiquitous presence of Cambisols, unlike Gypsisols restricted to arid zones). For illustration purposes, regions characterized by wetlands and river valleys may generally support a greater variety of gleyic, fluvial and organic-rich soils, compared to other regions of the continent. This soil diversity reflects the environmental complexity of the African continent and its impact on regional vegetation and agriculture (Jones & al., 2015).

Table 2: Description of soil types in Africa (Jones & al., 2015).

Soil type	Description
Ferralsols	Heavily impaired soils with low nutrient retention capacity.
Acrisols	Very acidic soils with a clay-enriched subsoil and low nutrient retention capacity.
Lixisols	Slightly acidic soils with a clay-enriched subsoil and low nutrient retention capacity.
Calcisols	Soils with significant accumulation of calcium carbonates, usually located in dry regions.
Leptosols	Shallow soils on hard rock or gravelly material.
Regosols	Weakly developed soils in unconsolidated material.
Arenosols	Easily erodible sandy soils with low water and nutrient retention capacity.
Kastanozems	Soils with a surface horizon rich in organic matter and calcium carbonate or gypsum accumulation in the subsoil.
Solonchaks	Salt accumulation soils.
Solonetz	Soils with a clay accumulation horizon, rich in sodium.
Technosols	Sealed soils or containing a significant number of artifacts.
Plinthosols	Iron accumulation soils which irreversibly harden by exposure to air and sun.
Gypsisols	Significant gypsum accumulation soils, usually located in dry regions.
Vertisols	Clayey soils developing large and deep cracks when dry.
Andosols	Young soils developed in volcanic deposits.
Phaeozems	Slightly acidic soils with a thick, dark surface layer.
Cambisols	Soils whose limited age allows only moderate development.

Sahelian landscape around the Niger River

The African continent is subdivided into seven soil regions (Tab 3, Fig. 5), each having its own specific geological, climate and/or ecological properties, as well as unique landscapes which influence the physicochemical characteristics of the soils.

Figure 5: The main African soil regions (Jones & al., 2015)

Table 3: Description of the main soil regions of Africa (Jones & al., 2015)

Key of the map	Description
Mediterranean – north and south of the continent	Bushy vegetation. Productive agriculture when water is easily accessible. Generally low organic matter levels. The predominant parent material is usually limestone or gypsum.
Deserts – including the Sahara, Kalahari, Namib and the northern Kenya-Somalia region	Limited or no vegetation. Shallow, rocky or gravelly soils, with a coarse texture. Finer particles can be blown away, leaving only the heavier fragments.
Sahel and savannah – covering more than half of the continent's surface area	Good soil drainage. Presence of a thin layer of organic matter, likely to thicken in wet seasons. Rapid soil depletion risk. Usual exposure of savannah regions to significant amounts of sand and dust from surrounding more arid areas.

Key of the map	Description
Forests	Soils usually lacking nutrients and showing acidity. Rapid decomposition of the organic matter. Intense washout of the soils. Variations in the floristic composition and structure of the forest, impacting soil properties depending on climate conditions.
Mountains	Limited development of the soil. Variability of the soils depending on the underlying geology. Eternal snow present at the highest peaks such as Kilimanjaro or Ruwenzori.
River valleys and wetlands	Floodplain soils of main river valleys: Stratified river deposits, good drainage, rich in nutrients. Swamps: Slow-draining mineral soils, possible formation of peat in case of water saturation. Mangroves: Clay and loamy soils, highly rich in organic matter.
Southern Africa	Thin and moderately fertile soils.

Mediterranean landscape, foothills of the Rherhaya basin, Morocco

I.4- Biodiversity

A quarter of the world mammal species and a fifth of bird species are found in Africa: isn't it mind-blowing?

A true sanctuary of biodiversity, Africa is home to a wide variety of ecosystems, ranging from lush forests to vast grasslands, arid areas to deserts, wetlands to inland waters and majestic rivers such as the Nile, the Zambezi and the Congo and Niger rivers. In addition to Tanganyika and Victoria, the largest fresh water Lakes in the world, the continent is surrounded by six major marine ecosystems, including the Benguela Current, the Canary Current, the Guinea Current and the Mediterranean Sea (Fig. 6).

Africa has 9 of the 35 global biodiversity hotspots, making it highly important for the planet. Indeed, the continent plays an essential role in the preservation of biological variety on a global scale, with habitats sheltering exceptional flora and fauna. The north Western part of the continent, integrated into the Mediterranean basin hotspot, is the second largest global hotspot, covering more than 2 million km². Even though it covers only 1.5% of the world, the forest of the Mediterranean basin is home to 25,000 plant species and 14 endemic genera (IPBES, 2018).

Africa stands out for its major contribution to the world's natural reserves, hosting 17% of the world's natural forests over an area of 675 million hectares. This contribution is illustrated, in particular, by the Congo Basin, the second largest uninterrupted block of tropical forest. Covering nearly a third of the continent's natural forest areas and extending over a 4 million km² area, this remarkable biodiversity ecosystem is home to more than 1,200 species of fish, 400 species of mammals, 1,000 species of birds

03 Afrothismiaceae: a new family endemic to tropical Africa

Afrothismiaceae (Dioscorales) stands out at the heart of the remarkable biodiversity of the African continent as a new botanical family endemic to tropical Africa linking their survival to soil fungi. According to the IUCN assessment, despite their uniqueness, most taxa in this family are threatened with extinction (Cheek & al., 2023).

Rapid deforestation and fragmentation of forest habitats are compromising their natural environment, with most species being critically endangered or already extinct. Although many secrets of their biology have been discovered, important elements still remain partially known, highlighting the need for their conservation and in-depth study

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Figure 6: African biomes (OSS, 2022)

and more than 10,000 species of vascular plants. The Congo Basin alone provides around 30% of Africa's freshwater resources, supporting the lives of nearly 77 million people. It also holds 31% of the world's "other forested lands" (IPBES, 2018).

In Africa, more than 62% of people live in rural areas and depend on natural ecosystems for their food, water, energy, health and livelihood security. African biodiversity is a true genetic treasure, ensuring the livelihoods of local populations and representing a strategic asset for the sustainable development not only of the continent but also on a global scale (IPBES, 2018).

Africa has a unique biocultural heritage, shaped through the constant interactions between an evolving environment and intercultural human exchanges. This biocultural heritage can be seen through the wide range of animal and plant genetic resources for food and agriculture, held by small farmers, breeders and pastoralists, and which help mitigate the harmful effects of drought, pests and environmental changes. Some of these resources are species such as wheat, barley, millet and sorghum, as well as teff (Eragrostis tef), coffee (Coffea arabica), rooibos (Aspalathus linearis), certain subspecies of cowpea (Vigna unguiculata) and oil palm (Elaeis guineensis). Preserving this biocultural diversity could be the key to protecting the continent's biodiversity, and an essential asset for establishing a sustainable model for exploiting natural resources.

However, despite this magnificent biological diversity, African terrestrial ecosystems are increasingly exposed to various risks such as habitat fragmentation due to land use changes, deforestation, which are exacerbated by climate change. Freshwater biodiversity is also impacted, particularly along the region's Mediterranean and Atlantic coasts. Marine and coastal ecosystems, such as the continental stretch of the northwest coast of Africa and the mangroves of West and East Africa, face numerous threats such as overfishing, degradation of habitats, acidification, pollution and sea level rise (IPBES, 2018).

Pastor and his cows heading to the pastures, Benin

II- Man and the natural environment

Since time immemorial, African populations have maintained a tight relationship with nature, shaped by unique traditions, beliefs and lifestyles (Burgess & al., 2004). However, this complex relationship is being challenged more than ever by interconnected factors such as urbanization, deforestation, climate change and increasing demographic pressure, which have significant impacts on the environment.

Many African cultures worship nature and believe it is a sacred life-giving gift. Sometimes, societies think of the trees, rivers, mountains and animals as living entities with spirits. These beliefs impact the relationships between communities and their natural environment, encouraging them to adopt sustainable resources conservation and management practices. Tribal communities have always been able to make the best of nature while paying attention to its limits. Hunting, fishing and agriculture were practiced in a balanced manner and in full compliance with natural cycles and traditions passed on from generation to the other.

However, the rapid evolution of the African society is putting this olden time harmony to a challenge. Rampant urbanization increases pressure on land and natural resources and threatens fragile ecosystems and traditional ways of life. Deforestation, resulting from logging and land conversion for agriculture, menaces biodiversity and essential ecosystem services. Climate change and its increasingly frequent extreme weather phenomena (prolonged droughts and devastating floods) is an aggravating factor. Rural communities depend on natural resources for their livelihoods and are the most affected, facing deeper food insecurity and loss of traditional livelihoods (UNEP, 2010).

II.1- Demographic profile

Africa faces major demographic challenges. According to United Nations estimates, the African population is expected to double by 2050 and reach 2.5 billion people. Such a demographic development will have a significant impact on the continent's economic and social development strategies. This is why the study and knowledge of the African demographic profile is highly important. Reflection on development strategies to be adopted or pursued frequently calls into question the crucial role of young people within the current and future African population.

04

The interaction between Man and nature in Africa is central to understand and combat land degradation. This complex relationship is shaped by various factors, including the demographic profile, the link between the population and natural resources, agriculture and food security, and environmental regulation.

Today, young people -15 of age represent 40.6% of the population and those aged 15 - 24 represent 19.4%. Young people -15 are expected to increase by 50%, from 474 million to 711 million people, those between 15-24 of age are expected to increase by more than 90%, from 226 to almost of 437 million people (IPBES, 2018). These developments highlight the pressing need to seek appropriate investments to increase opportunities accessible to young people.

Even though Africa is what we call a young continent, the increasing aging of its population starts to become apparent. While less than 12% of the population of most African countries is expected to be over 60 by 2050, the absolute number of older people will increase significantly over the coming decades (Sajoux & al., 2015).

This rapid population growth is putting considerable pressure on the continent's natural resources, including arable land, forests, fresh water and biodiversity. The growing demand for agricultural land to feed an expanding population, combined with rapid urbanization, is leading to worrying land degradation, with negative consequences for food security, ecosystem health and people's resilience to climate change. It is believed that high demography leads to land degradation: well, this remains to be proven. Indeed, land degradation results mainly from poor farming practices and demographic pressure leads to accentuated degradation of land having lost its agricultural potential (Oldeman & al., 1991; Jones & al., 2013).

The impact of demographic pressure is different from place to place. In some cases, the increase in population can lead to an improvement in agricultural production techniques, and consequently an increase in soil productivity. Investment in advanced agricultural technologies, the use of sustainable agricultural practices or the introduction of new, more efficient cropping methods may explain this improvement in soil productivity (Houngbo & al., 2008).

Demographic, geographic and natural resources analysis in Africa reveals crucial challenges for sustainable development. It is essential that population growth be aligned with the preservation of natural resources, by adopting sustainable urban planning policies and environmentally friendly agricultural practices. Additionally, an integrated approach needs to be adopted to address global challenges such as climate change, food security and poverty, with a focus on environmental sustainability, social inclusion and economic development. Finally, international cooperation is fundamental to support African countries in the sustainable management of their resources through stronger capacities, easier technology transfer and adequate financing.

II.2- Interactions between the populations and natural resources

Africa's rich and diverse ecosystems generate a great deal of goods and services that are critical to meeting the continent's needs for food, water, energy, health and secure livelihoods. Thus, biodiversity and ecosystem services constitute the foundations of human well-being and sustainable development in Africa (AMCEN, 2019). Indeed, the continent is home to a variety of natural resources including various mineral and energy resources: 54% of the world's platinum reserves, 78% of diamonds, 40% of chrome and 28% of manganese (ECA, 2013). The continent is also home to a particularly rich soil and has 24% of the world's arable land (Ramdoo, 2019). Agricultural activities which provide income to 70% of the population contribute 35% to African gross domestic product (GDP) (Moussa Dembélé, 2015).

05 Despite being the most rapidly urbanizing region in the world, the majority of people in most African countries are still living in rural areas. Africa remains the least urbanized continent on the planet. However, it is expected to be predominantly urban by 2050 (UNFPA, 2016).

06 Poverty of agricultural producers plays a role in land conservation, as Houngbo & al. (2008) reveal that the poorer the producer in the area, the less he implements soil conservation agricultural practices.

Despite this abundance, Africa faces an uneven distribution of its natural resources that generates conflicts and which is one of the factors leading to episodes of extreme famine. The unbalanced distribution of natural resources stands behind the "natural resource curse" expression widely debated in the literature (García-Luengos, 2020). This states that abundant natural resources and economic prosperity do not necessarily go hand in hand and rather have negative impacts on the continent.

Therefore, the adequate management of the resources, combined with strong institutions, is essential to ensure sustainable development for Africa and its populations who highly depend on natural resources, especially if we consider the challenges of population growth, technological weakness and unsustainable production practices, which contribute to a worrying degradation of the continent's natural resources. In the end, well-advised and sustainable use of natural resources can lead the way to positive development and bring balanced economic benefits with the long-term preservation of Africa's environment.

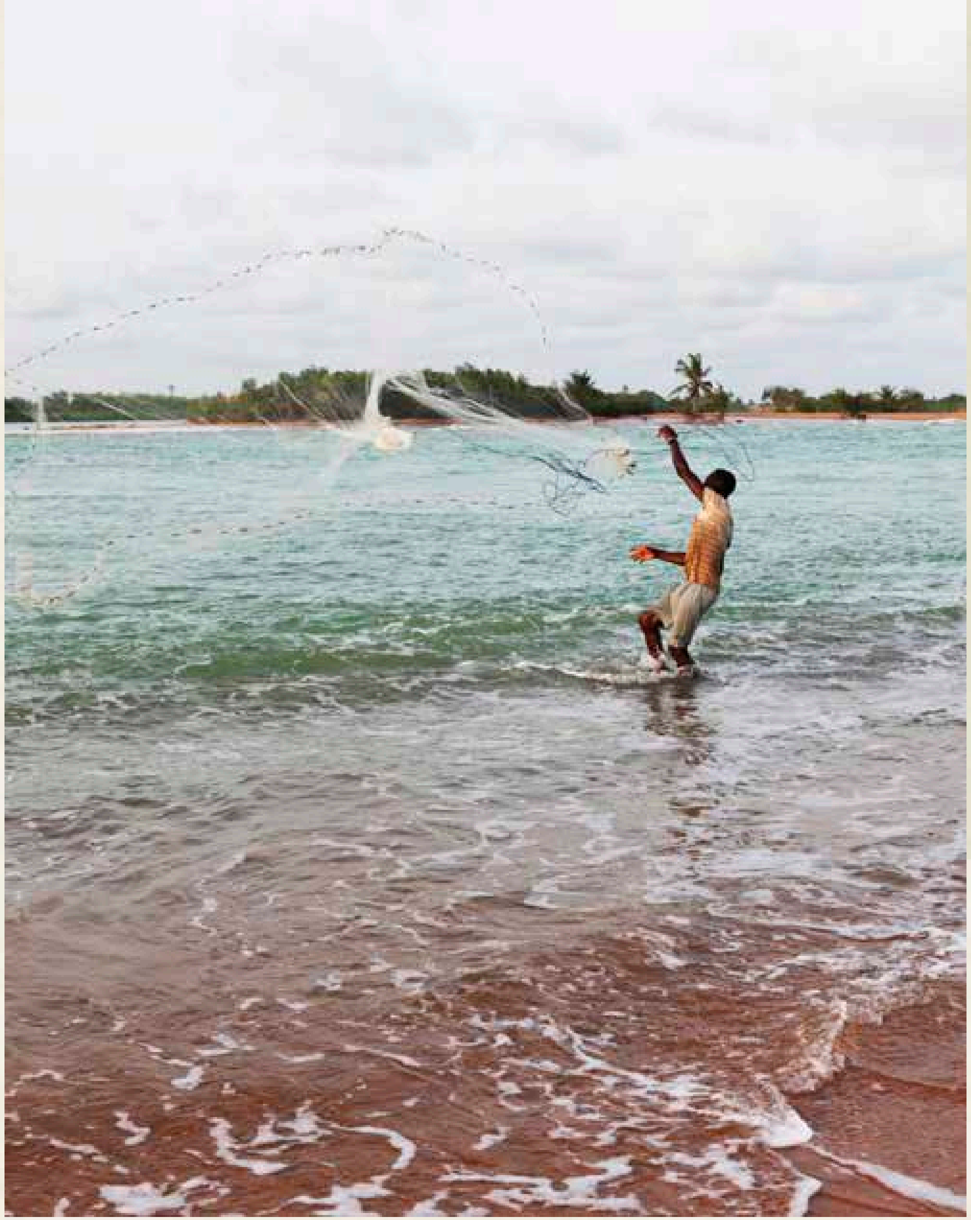
II.3- Agriculture & Food Security

Agriculture is the primary provider of subsistence for many African communities, but it is often practiced unsustainably. Unsustainable agricultural methods such as intensive monoculture and excessive use of agricultural inputs such as fertilizers and pesticides (Hugon, 2014) deplete the soils and reduce their fertility. The resulting land degradation compromises food security, puts rural populations to tougher food shortages and makes them prone to humanitarian crises (UNCCD, 2019).

The sustainable social and economic development of Africa is closely linked to the development of its agricultural sector. However, food insecurity remains one of the significant limits to the development of the continent (Fig. 7). The prevalence of malnutrition in Africa increased from 19.4% in 2021 to 19.7% in 2022, due to increases observed in North and South Africa. The number of people experiencing hunger in Africa has increased by more than 57 million since the start of the Covid19 pandemic (FAO, 2023).

Food insecurity is a complex challenge driven by various factors, such as extreme weather events. According to the IPCC (2022), the increase in these climate events has put millions of people under severe food insecurity and reduced water availability, with particularly serious consequences in Africa and among small producers, low-income households and indigenous populations.

According to Kemoe & al., (2022), the heavy reliance of domestic food production to weather conditions leads to a strong dependence on imports of everyday consumer products. It is worth mentioning that approximately 85% of these products come from outside the region. If food imports make it possible to absorb internal shocks, consumers go through the impact of inflation caused by weather shocks in the regions where imports come from.



Traditional fishing in the Bouche du Roy region, Benin.

Shocks linked to climate, health and conflict phenomena used to take place every 10 years, now they occur every 2.5 years. They meet with global-scale price inflation and jeopardize the government efforts made to improve food security (World Bank, 2023).

On the other hand, cultivated areas cover an approximately 211 million ha surface, or 27% of the continent's arable land. The Sudan-Sahel region has the greatest potential for arable land. However, the exploitation proportion stands at only 19%, compared to more than 40% in the North, Gulf of Guinea and Islands regions (FAO, 2023).

Figure 7: Prevalence of malnutrition in sub-Saharan Africa by subregion: 2015-2019 and 2030 projection (World Bank, 2022)

For Africa's many agriculture-based economies with high levels of poverty, poverty-related agricultural practices and other land use problems largely contribute to the continent's land degradation problems (Elloumi & al., 2007).

Poverty can be a true driver of land degradation (ELD Initiative & UNEP, 2015). Farmers and nomadic shepherds whose activities depend directly on the land's resources and who cannot wait for the regeneration of the soils and the vegetation, are compelled to adopt inappropriate land management practices. The elimination of fallow periods, the exploitation of already poor soils in marginal areas and the prolonged retention of livestock in the same places aggravate the land degradation process. Land degradation and the loss of livestock will thus force people to put more pressure on fragile resources.

However, there is still room for stronger resilience with the development of sustainable, breakthrough and job-creating agricultural systems. Income-generating activities ensuring sustainable food security should be adopted. According to IMF (2022), climate change, constantly fluctuating prices and the particular situations of different countries contribute to food insecurity in sub-Saharan Africa. Faced with this crisis, countries have taken second-best short-term measures, such as tax cuts and subsidies, which should be phased out gradually. In the longer term, it will be essential to increase the production and productivity of climate change resilient agriculture, with the constant support of the international community, to overcome food security issues while laying the foundations for greater physical and economic accessibility of foodstuffs.

According to the World Bank (2023), productivity in East and Southern Africa could go double or triple with:

- the adoption of better agricultural inputs and production technologies;

- the improvement of the efficiency of water and land resources exploitation;
- the restoration of natural capital and ecosystems.

Food insecurity in Africa is not a question of fate; political will combined with good planning and use of scientific research could help the continent eradicate famine and approach development with a clearer vision to achieve better sustained outcomes. This political will should place particular emphasis on the rational management of land and ecosystems.

In addition, land degradation causes the displacement of populations in Africa as do armed conflicts and insecurity. For Williams (2019), food insecurity linked to the degradation of agricultural land, reduced pastures for livestock and reduced reserves of water, firewood and other natural resources, will cause more displacement and permanent resettlement.

II.4- Environmental regulations and land management

The socio-economic and prevailing political circumstances contribute immensely to conditions that lead to land degradation. Demographic growth and the lack of developed agricultural land in Africa lead to land

07 Rural women and land degradation

Rural women are more affected by land degradation than men due to their gender-specific roles and responsibilities. They often manage natural resources, agricultural production and domestic tasks. According to the FAO (2011), they represent almost 43% of the agricultural workforce in developing countries. They produce food crops that rely on the health and condition of the soil. However, land degradation, characterized by nutrient loss, erosion and desertification, leads to reduced agricultural yields, thereby compromising the food security of the households. Despite their essential contribution, farms run by women produce on average 20-30% less than those run by men (IFPRI, 2010), mainly due to unequal access to resources and technology.

Additionally, women's domestic responsibilities, such as preparing meals and parenting, are also affected by land degradation. This situation is compounded by the declining availability of basic natural resources, such as clean water and firewood, which hampers their ability to maintain healthy living conditions and meet their family's food needs. The World Bank (2019) highlights that rural women spend an average of 200 million hours per day collecting water, a burden that increases with the resource scarcity due to environmental degradation.

Due to their limited access to financial resources, education and training, women in Africa often have difficulty coping with the impacts of climate and environmental shocks. According to the United Nations Environment Program (UNEP, 2019), they have less weather information and less access to climate adaptation technologies. These factors expose them to extreme weather events such as droughts and floods, which exacerbate land degradation. Furthermore, lack of asset diversification and limited resources to cope and recover from damages make women and other disadvantaged groups particularly vulnerable to the effects of climate shocks (Aguilar & al., 2022).

Despite their leading role as a pillar of the global agricultural workforce and their active involvement in land conservation, women are often underrepresented among agricultural land owners, with only less than 15% on global average (FAO, 2018

To address this disparity, the UNCCD's inaugural Gender Equality Action Plan (GAP) proposes to:

- Ensure the participation of women at all stages of land restoration initiatives;
- Integrate women's economic empowerment to eliminate extreme poverty;
- Strengthen women's land rights and their access to resources; and
- Improve women's access to knowledge and innovative technologies.

Inclusive land governance and securing land tenure are indispensable to a better gender mainstreaming in the SLM in Africa (UN Women, 2019).

overexploitation which can adversely impact the environment and the sustainability of agricultural practices. It is therefore essential to think of policies and implement strategies aimed at promoting adequate development of agricultural areas to guarantee sustainable land use and a long-term preservation of the soil productivity.

Very often, institutions responsible for enforcing environmental regulations operate under numerous challenges such as lack of human, financial and technological resources. These limitations seriously hinder their ability to monitor and enforce regulations, as highlighted by studies such as those by Mala & al. 2019. In some cases, short-term economic interests may take priority over land conservation goals. Research such as Nyiwul (2018) highlights these challenges. Environmental regulations in Africa are often fragmented and lack consistency, limiting their overall effectiveness. A more integrated and coordinated approach is required to holistically address land degradation, as suggested by the Zereyesus & al. (2017) study.

The land issue is however, becoming increasingly important due to the strong demographic growth in Africa. Many dryland countries, facing land degradation, experienced a sharp increase in their population during the 20th century, due to a decline in infant and child mortality and a birth rate that increased much more gradually (Droy, 2017).

Public policies give little importance to controlling population growth and the consequences it may have on community relations and the degradation of natural resources. The land issue is generally a source of community conflicts and sometimes pits populations against central authorities. Any new resource created through public action transforms its land dimension and leads to a new distribution of access and use rights between the different actors, with repeated exclusion and marginalization. These actions bring inequalities and social exclusions and ultimately have counterproductive effects on the achievement of the targeted objectives (Requier-desjardins & al., 2017).

Very limited land security is a major problem for significant investments. Agricultural companies, private businesses and even individuals find it hard to invest on unsecured land and rural communities are very concerned.

Young lady in a traditional rainfed rice field in Dévé, in the commune of Dogbo, Benin

Indeed, millions of people still do not know whether or not their land rights are guaranteed, in particular the rights to their forests and non-agricultural pastures. For decades, rural communities have been told that their customary rights are not considered property rights and are therefore not protected (Nkuintchua, 2016).

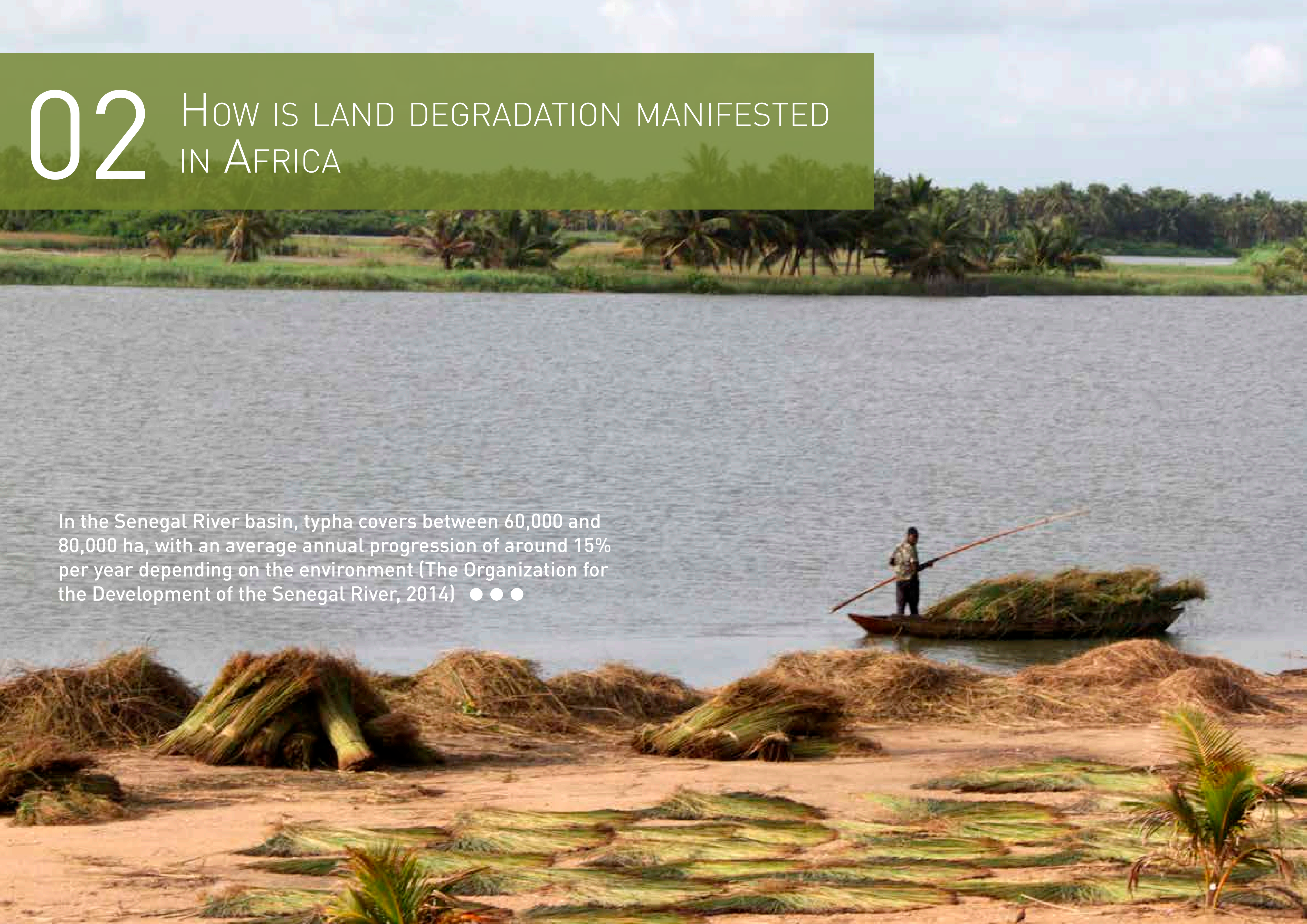
The lack of guaranteed land ownership increases the fragility of communities already impacted by climate change. Nearly 16% of the total area of the countries studied in sub-Saharan Africa benefits from the ownership or control of indigenous peoples and local communities compared to 18% globally (Rights and Resources Initiative, 2015).

It is therefore crucial to invest in institutional capacity building, providing adequate resources and improving coordination between the different entities responsible for enforcing the regulations. Effective governance measures must be put in place, including transparency and accountability mechanisms, to ensure that environmental regulations are applied fairly and effectively.

An integrated and consistent approach to environmental regulation, considering social, economic and environmental aspects, is necessary to effectively address land degradation. It is crucial to involve local communities and stakeholders in the formulation and implementation of the rules, to ensure their acceptance and long-term effectiveness.

Olive grove in North-West Tunisia

02 How is land degradation manifested in Africa



In the Senegal River basin, typha covers between 60,000 and 80,000 ha, with an average annual progression of around 15% per year depending on the environment (The Organization for the Development of the Senegal River, 2014) ● ● ●

Land degradation in Africa is a complex and multi-faceted problem, closely linked to other environmental alterations, namely climate change and the biodiversity erosion. This interconnection creates a set of vicious relationships where each alteration acts simultaneously as a factor and consequence of the others. Faced with this multidimensional complexity, the international community questioned the reality of this degradation and assessed its severity through its different manifestations, in order to provide solutions for prevention, conservation and restoration.

I- Environmental alterations: complex phenomena

Land degradation, the loss of biodiversity and climate change are seen as interrelated threats to various aspects of the Man/Environment relationship, thereby fueling a downward spiral in the availability and productivity of the terrestrial natural resources (Fig. 11).

The purpose of this subsection is to understand each environmental alteration in the African context and explore its relationship with land degradation.

I.1- Climate change in Africa: a strong impact on a small polluter

Climate change is a major concern, as demonstrated in the World Meteorological Organization's (WMO) 2022 Africa Climate Report. In recent decades, the continent has faced unprecedented climate variations, such as higher temperatures, changes in rainfall patterns and an increase in extreme weather events. These climate variations significantly impact agriculture, access to water, food security, biodiversity and the livelihoods of populations.

During the 20th century, the average temperature on the continent increased by around 1.5°C compared to the pre-industrial era, exceeding the global average of 1.1°C. This rise increased from 1991 to 2020, affecting all African sub-regions, with peaks of extreme heat in North Africa. According to World Bank projections for 2080-2099, all African sub-regions are expected to experience higher temperatures. For example, in Algeria, where the current

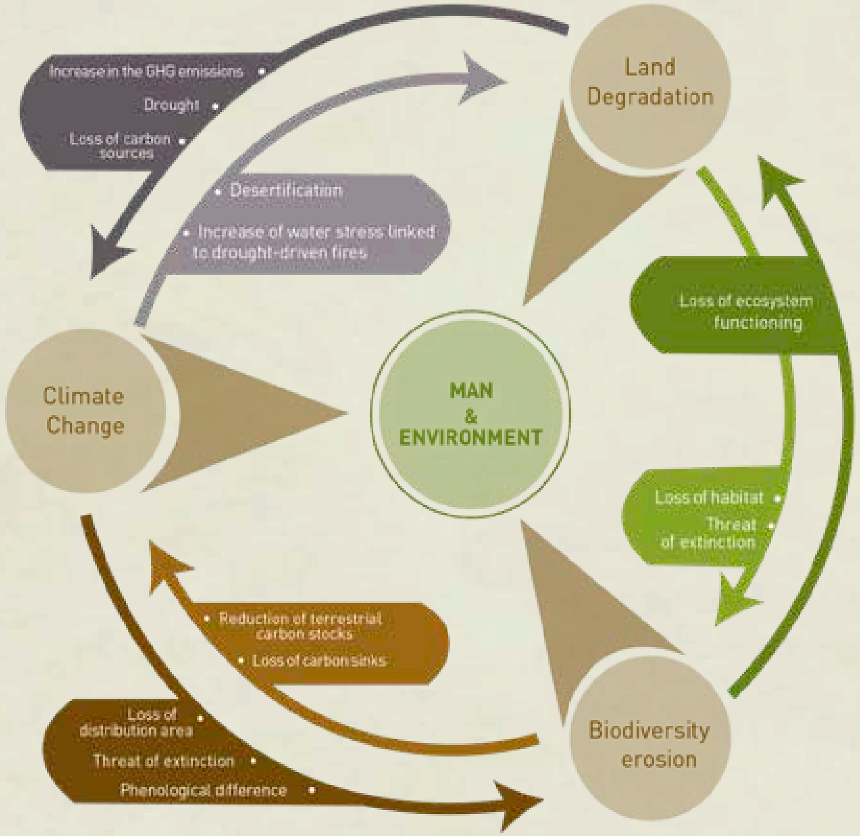


Figure 8: Interconnection between environmental alterations and Man (Adaptation inspired by Barron J. Orr, 2021)

annual average varies between 23 and 27°C, the climate will be hotter, with an expected average between 27 and 30°C. Similarly, Mali, Niger and Chad are expected to face temperature increases, with averages between 30 and 35°C (Fig. 9). Although forecasts for the average increase in annual temperatures by the end of the century, estimated at between +1 and +4°C according to the IPCC and World Bank scenarios, are slightly lower than the global average (+ 3 to +6°C), heat waves are expected to become more frequent, intense and prolonged, especially in tropical regions (World Bank, 2021).

According to the IPCC, a one-degree global warming by 2050, would cause additional suffering for 1.4 million African children, exposing them to severe stunting due to malnutrition. In terms of biodiversity, a 2°C global warming could cause the extinction of 36% of freshwater fish and the vulnerability of 7 to 18% of terrestrial species.

Climate change also causes variations in the rainfall patterns. Certain areas, such as the southwestern part of the continent and the coasts of North Africa, shall experience a drop in rainfall. Conversely, the average annual rainfall in the eastern Sahel region, East and Central Africa, shall increase.

Along the Mediterranean coast, periods of drought could double, from 2 to 4 months per year in the second half of the 21st century; a trend that is expected to persist for several centuries, whatever the scenario considered. These changes further expose populations living in low-lying coastal areas to the threats of erosion, saline intrusion, flooding and submersion.

In addition, climate change is causing sea levels to rise faster than the global average, especially along the tropical coasts of the South Atlantic and the Indian Ocean, with respective rates of 3.6 mm. and 4.1 mm per year. Similarly, mountain glaciers are shrinking at a faster rate than the global average, suggesting complete deglaciation by the 2040s (IPCC, 2021). Thus, the early disappearance of the glaciers of Mount Kenya, would intensify the environmental challenges facing the African continent.

Although Africa's share of global greenhouse gas emissions is limited to 9%, the continent already experiences extreme weather events (UN, 2023).

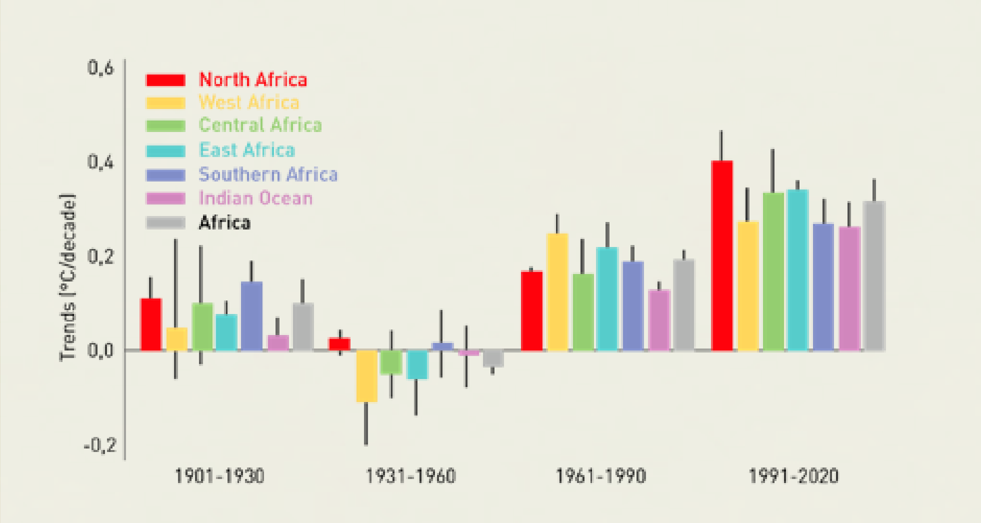


Figure 9: Trends in time series of zonal mean temperature anomalies for sub-regions of Africa and for the entire region over four sub-periods (WMO, 2021)

Oum Zassar watershed, Medenine, Tunisia

This gap between Africa's low historical responsibility for emissions and the significant impacts it experiences, endangers the ecological stability, the well-being and the daily lives of African communities, particularly children and women.

The occurrence of climate disasters in Africa leads to an increase in massive population displacements and migrations, deepening the threats and conflicts linked to the scarcity of the resources. In 2022, more than 7.5 million internal displacements were recorded, marking the emergence of the climate migration era, according to Amy Pope, Director General of the International Organization for Migration (IOM).

In addition, the climate change impacts on the continent have costs estimated between 290 and 440 billion US$ over the 2020-2030 period (CAPC, 2023). Anticipating a 4°C of warming by 2080 and without a robust regional adaptation plan, Africa could face annual "residual damage" costs equivalent to 3% of its projected GDP.

- How do climate change and land degradation interact?

The relationship between climate change and land degradation is a vicious circle where each phenomenon amplifies the occurrence and impact of the other, creating a complex connection of causality.

Intensified climate variability heavily impacts land degradation by disrupting the hydrological cycle. In some countries, such as Nigeria, one the ten countries most vulnerable to climate change, increased climate variability causes more intense and unpredictable rainfall, thus favoring flash floods, landslides and soil erosion.

Windstorms and other extreme weather events also influence land degradation processes, including coastal erosion.

Higher temperatures and periods of drought have dramatic consequences on the living component of the earth, triggering various degradation processes such as biological invasions, pest outbreaks and increased fire

Oued in Adrar, Mauritania

risks. Between 1991 and 2022, Africa recorded a +0.3°C average warming per decade, slightly exceeding the global average. These extreme weather conditions have significantly fueled forest fires in Algeria and Tunisia.

Additionally, warmer temperatures and drought make trees more susceptible to pests that proliferate due to more favorable conditions, exacerbating disease outbreaks. For example, a 1 to 2°C rise can worsen coffee boron infestations in several regions of East Africa.

Likewise, climate change may affect the spread and impact of invasive species at all stages of their introduction and establishment. For example, variations in mean annual temperature between 1900 and 2005 have been associated with increased establishment rates of invasive alien insects in several continents. A 1°C increase in temperature has been linked to an increase of 0.5 species per year, even after accounting for other factors such as increased international trade (Huang & al., 2011).

When land is degraded, soil carbon can be released into the atmosphere, along with nitrous oxide, making land degradation one of the main causes of climate change. It is estimated that two-thirds of all terrestrial carbon stocks from soils and vegetation have been lost since the 19th century due to land degradation. Agriculture, forestry and other land use sectors generate around a quarter of all anthropogenic greenhouse gas emissions (IUCN, 2015).

I.2- Erosion of biodiversity in Africa: declining species and weakened ecosystems

Like climate change, the erosion of biodiversity, often referred to as impoverishment, is a major challenge that calls into question the benefits that nature brings to humanity, thus impacting the daily lives of the populations and hindering the socio-economic development.

This phenomenon emerges through the decline of specific populations, or even the extinction of some species. It mainly results from the fragmentation and destruction of natural environments (due to human activities: increasing urbanization, intensification of agricultural practices, land clearing, etc.) and their pollution (domestic, industrial and agricultural origin), overexploitation of wild species (overhunting, overfishing, poaching, deforestation, etc.), the introduction of invasive alien species and also climate change (Fig. 10).

Evidence of the scale and acceleration of biodiversity erosion is regularly provided by various international Organizations. According to the WorldWide Fund for Nature (WWF), the population of vertebrates on Earth fell by around 68% between 1970 and 2016, with an extinction rate estimated to stand between 100 and 1,000 times higher than the natural rate. Based on paleontological data, we can say that species would have an average lifespan of 5 million years.

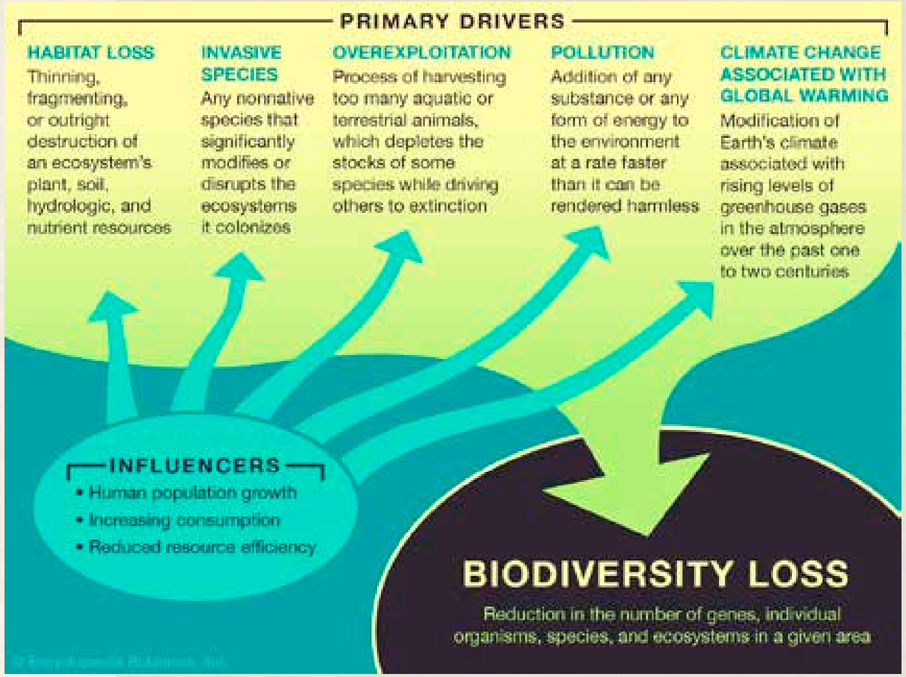


Figure 10: Main causes of biodiversity erosion (Rafferty, 2024)

In Africa, the rapid loss of biodiversity, reported by the Intergovernmental Science and Policy Platform on Biodiversity (IPBES, 2018), is mainly due to unregulated exploitation and fragmentation of natural habitats. According to the Living Planet Index (LPI), an indicator used by the UN to assess the state of biodiversity, vertebrates in Africa lost 39% of their abundance since 1970. This decrease is particularly felt in forest areas that feature a rich diversity of endemic species, particularly in West and Central Africa as well as Madagascar (Tab. 4).

On the other hand, Africa is experiencing a significant loss of forest area. Between 1990 and 2010, it registered the second largest decline in forest cover after South America. Although the rate of loss in these regions has slowed down in recent years, the average forest area per capita declined between 1990 and 2015, from 0.8 to 0.6 hectares (FAO, 2015). The conversion of natural habitats never stopped, with more than 3 million hectares converted each year (COMIFAC, 2011). Over the 2010-2020 period, Africa experienced the highest net loss of forest area, i.e. 3.94 million hectares per year, followed by South America with 2.60 million hectares per year. An accelerated net loss rate has been reported since 1990 (FAO and UNEP, 2020). Africa and the international community are called upon to make everything possible to reverse the trend like the rest of the world (Fig. 11).

Likewise, freshwater ecosystems, essential for biodiversity and vital resources, face threats such as dam construction, unsustainable exploitation, wetland drainage, invasive species and pollution, leading to widespread degradation.

Table 4: Species listed by CITES in Africa: number and percentage by subregion (CITES, 2023)

	Central Africa		East Africa and adjacent islands		North Africa		South Africa		West Africa	
	No	%	No	%	No	%	No	%	No	%
Birds	134	20.24	181	27.34	107	16.16	127	19.18	113	17.07
Mammals	122	21.94	170	30.58	62	11.15	103	18.53	99	17.81
Fish	11	12.22	22	24.44	21	23.33	24	26.67	12	13.33
Amphibians	1	2.78	33	91.67	0	0	0	0	2	5.56
Plants	261	9.71	1349	50.15	50	1.86	892	33.18	138	5.13

Figure 11: Net change in forest area, by region, 1990-2020 (million hectares per year) (FAO and UNEP, 2020)

The International Union for Conservation of Nature (IUCN) Red List is a key indicator for assessing global biodiversity. For the African region, Brooks & al. (2016) specifically studied this list, and the corresponding data are presented below (Tab. 4; Fig. 12). This analysis is based on taxonomic groups such as birds, mammals, fish, amphibians and plants, for which comprehensive global assessments have been carried out, covering more than 90% of the species in each group.

With nearly 1,781 threatened species, representing nearly 19% of the total species listed in these taxonomic groups, the situation of biodiversity in Africa is increasingly worrying (IPBES, 2018). This vulnerability is particularly observable among the region's 5,016 endemic species, approximately 23% of which could go extinct. The most affected regions are in East Africa and surrounding islands, where almost 17% of all living species are threatened, with a worrying 43% for species endemic to the sub-region. However, the Central African region stands out for the highest percentage of endangered endemic species, reaching up to 50%. In contrast, Southern Africa has the lowest proportion of endangered endemic species, with only 23%. With only 9%, North Africa has the lowest percentage of threatened species.

This situation is partly due to the significant presence of endangered endemic species in critical biodiversity zones (CBZs) such as the Eastern Arcs mountains, the coastal forests of Tanzania and Kenya, as well as those of Madagascar and the islands of the Indian Ocean (Tab.5). The alarming decline of iconic species such as elephants, hippos and rhinos, often compelled to living in part of their historical land, is a living proof of the fragility of African biodiversity and its vulnerability to human and environmental pressures. A striking example is forest elephants, whose populations declined by 62% between 2002 and 2011.

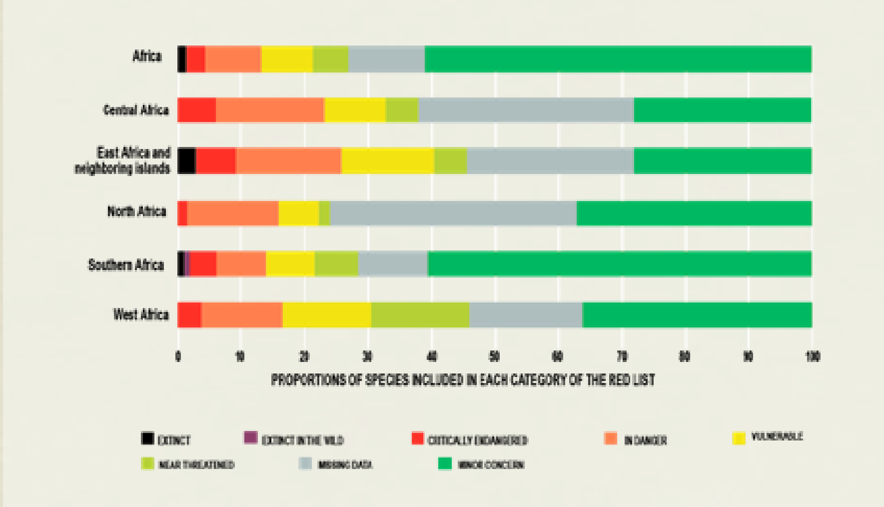


Figure 12: Risks of extinction of endemic species in Africa and its sub-regions (IPBES, 2018)

Cuvier's gazelle (Gazella cuvieri), endemic to North Africa, Jebel Serj National Park, Tunisia

Table 5: Endemic species at biodiversity hotspots in Africa (IPBES, 2018)

Biodiversity hotspots in Africa	Endemic plant species	Threatened endemic animal species			
		Birds	Mammals	Amphibians	Extinct species
Cape Floristic Region	6.210	0	1	7	1
East African coastal forest	1.750	2	6	4	0
Eastern Afromontane	2356	35	48	30	1
Guinean forests of West Africa	1.800	31	35	49	0
Horn of Africa	2.750	9	8	1	1
Madagascar and the Indian Ocean Islands	11.600	57	51	61	45
Mapuland-Pondoland -Albany	1.900	0	2	6	0
Succulent Karoo	2.439	0	1	1	1
Mediterranean Basin	11.700	9	11	14	5

- How do biodiversity loss and land degradation influence each other?

Biodiversity loss and land degradation are closely linked and influence each other in many ways. Land degradation is often the result of unsustainable practices such as deforestation, intensive agriculture or unplanned urbanization, and leads to a loss of natural habitats for many species, reducing biological diversity and depleting ecosystems.

Reduced biodiversity can worsen land degradation. Natural ecosystems, rich in biodiversity, play a crucial role in stabilizing the soils, regulating the water cycle and protecting against erosion. The loss of plant species weakens the water-retention capacity of the soils, thus increasing the risk of erosion and desertification.

Additionally, land degradation can lead to habitat fragmentation. This results in the isolation of populations of species and the reduction of their genetic diversity, which makes species more vulnerable to disease, environmental change and extinction.

In conclusion, land degradation and biodiversity loss drive each other in a harmful cycle, which is exacerbated by the impacts of climate change that disrupts natural habitats and modifies the distribution of the species. For example, some species may be pushed to higher altitudes or more north western latitudes as their habitat gets hotter. These changes can intensify conflicts with human activities and increase habitat fragmentation. For this trend to be reversed and the environmental sustainability promoted, an integrated and systemic approach, which considers land management, biodiversity conservation and climate change mitigation measures, needs to be adopted.

I.3- Land degradation and desertification in Africa: a double environmental challenge

Considered the most precious asset in Africa, land plays a central role in the various aspects of life and development. It is at the heart of food production, infrastructure development as well as the preservation of ecosystems and biodiversity. However, despite its capital importance, various factors threaten the Land productive capacities, thus compromising its vital role in the sustainability of African ecosystems. These factors are leading to intensified desertification, soil degradation and especially land degradation. Even if these terms might look similar and usually lead to the same result, they do not have a single definition and there is often confusion between them, which sometimes hinders their proper evaluation.

Soil degradation is a change in the state of soil health that results in a reduced capacity of the ecosystem to provide goods and services for its beneficiaries. Degraded soils can no longer provide the usual goods and services, whether in terms of quality or quantity.

Land degradation is a more-encompassing term than soil degradation because, occurring in all climate zones, it gathers all negative changes in the ecosystem capacity to provide biological goods and services as well as socio-economic services linked to land production. Land degradation can take multiple forms, from visible soil erosion to more subtle changes in plant species composition.

The term **"desertification"** was the first to be used and introduced by Aubréville in 1948 to describe the transformation of African tropical forest regions into "desert" regions. Over time, it became a permanent and dominant part of the vocabulary of land degradation, and was even institutionalized through the creation of the United Nations Conference on Desertification (UNCD) in 1977 and the United Nations Convention on the Fight against Desertification (UNCCD) in 1994.

The relationship between land degradation and desertification is quite complex. Recognizing it while highlighting the complexity and diversity of these phenomena allows us to better understand the challenge and to develop more effective strategies to deal with it. A holistic approach must be defined to effectively address land degradation and the multiple forms it can take.

- *Drivers of land degradation*

Clarifying the complex and interconnected dynamics of the land degradation process raises the question whether to link it to socio-economic or

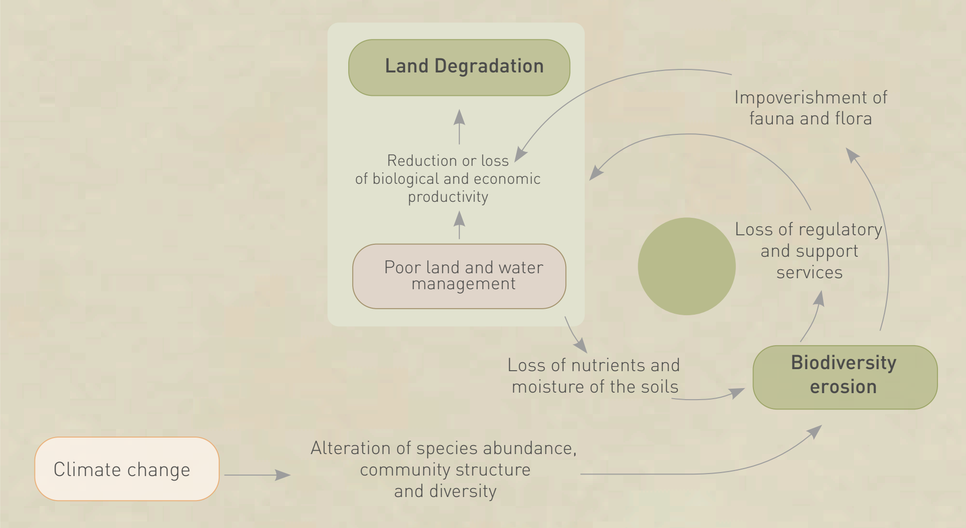


Figure 13: Interactions between biodiversity erosion and land degradation (Adaptation inspired by Requier-Desjardins, 2017)

biophysical factors, and to what extent do these factors have a natural or anthropogenic origin?

According to Geist & Lambin (2004), it is agreed that no single factor can be held responsible for desertification or land degradation. Geist & Lambin insist on the need to consider the joint interaction of socio-economic and biophysical factors. This interaction is all the more complex as it is reinforced by the difficulty, even the impossibility of differentiating natural and directly or indirectly man induced degradation.

Land degradation can be the outcome of occasional natural phenomena that occur in a few years or in thousands of years. However, it is important to emphasize that these phenomena can sometimes be intensified by anthropogenic activities. For example, the effects of human-caused climate change amplify the consequences of many natural phenomena, acting as a trigger element for land degradation.

Furthermore, it is true that climate change intensifies the pace and magnitude of several land degradation processes. Land degradation, in turn, is also a driver of climate change through greenhouse gas emissions (GHG), reducing carbon absorption rates and reducing the capacity of ecosystems to act as carbon sinks in the future (Olsson & al., 2019).

These complex interactions between natural events and human activities highlight the need for a comprehensive approach to understanding and mitigating this phenomenon.

This part of the book does not list all land degradation factors as defined by the scientists. Its purpose is rather to focus on land degradation aspects specific to the African continent in order to better understand its root causes. These land degradation factors were divided into climate and anthropogenic factors, referring to and drawing inspiration from an IPCC report for their characterization (Olsson & al., 2019).

- **Climate factors**

Drivers of land degradation linked to climate and climate change include gradual changes in temperature, rainfall and wind, as well as changes in the distribution and intensity of extreme weather events (intensified cyclones, siroccos, sand and dust storms, etc.) (Lin & al. 2017).

Changes in rainfall patterns lead to changes in the vegetation cover and composition and trigger processes such as agricultural soil erosion. Thus, plant cover is a key factor in determining soil loss through water and wind erosion.

08 Land vs. Soil

According to the UNCCD, **Land** designates the terrestrial bio-productive system which includes the soil, plants, other living beings and the ecological and hydrological phenomena within this system.

Soil specifically represents the upper layer of the Land's crust, including mineral particles, organic matter, water, air and living organisms. Land includes a global picture, while Soil includes the fertile component that fosters plant growth.

09 Desertification

According to the UNCCD, desertification refers to land degradation in arid, semi-arid and dry sub-humid zones as a result of climate variations and human activities. It not only means the expansion of desert land forms and landscapes to areas where they were not present in the recent past, but it also means irreversible change in land function, causing the emergence of conditions similar to those of the desert environment.

If hydraulic factors such as rain and water runoff and wind factors such as wind action increase soil erosion rates, they can also be boosted or aggravated by other natural factors such as the type of the soil, aridity, extreme phenomena and the absence of plant cover linked to drought, locust invasion or any other form of wildlife degradation.

Climate-related events, such as sea level rise, also influence coastal erosion rates (AGNES, 2020).

- **Anthropogenic factors**

In Africa, land degradation is mainly the result of human activities (Tab.6), from land conversion or mineral extraction on a local level, to species invasion on a regional level, or even climate change on a global scale.

Africa's population is expected to double by 2050 and reach 2.2 billion. This population growth would put increased pressure on land which remains the main source of subsistence and meets the needs for sustainable economic and social development of the continent.

In addition, migration causes urban expansion, land abandonment and land speculation.

In order to contend with the growing demand for production, populations intensify agricultural and livestock activities on marginal land, overuse fertilizers and pesticides while reducing fallow periods. Poor agricultural practices reduce the reproductive capacity of the soil, leading to lower yields and speeding up erosion, acidification and other phenomena. The degradation of soil quality due to cropping activities, aggravated by climate change, leads to a loss of the productive potential of land and to the conversion of non-agricultural land, such as forests, to agriculture (AGNES, 2020). Degraded forest landscapes intensify the effects of climate change and constitute an obstacle to building resilient and prosperous communities.

Furthermore, uncontrolled urban expansion puts additional pressure on land, with a potential reshaping of the spaces, territories and the resettlement of the populations. Urbanization in Africa is experiencing exponential rates (urban spread, proliferation of shanty towns, etc.). In the case of unsustainable planning, urbanization can reduce vegetation cover and green spaces, and increase the exposure of land to various degradation factors such as natural disasters and urban contaminants (Seifollahi-Aghmiuni & al., 2022). Development of sanitation, waste management and drinking water supply infrastructure that does not keep pace with urban growth leads to increased pollution and land degradation. In addition, the expansion of urban and industrial infrastructure in coastal areas induces soil sealing, erosion and marine pollution. The construction of roads, ports and industrial zones destroys natural habitats, weakens coastal ecosystems and increases the vulnerability of cities to flooding.

Additionally, mining and fossil fuel extraction destroy natural habitats, contaminate the soil and groundwater, and contribute to landscape degradation, in addition to the harmful effects on the health of local populations.

Table 6: Some of the main anthropogenic factors

Anthropogenic factors	Examples
Expansion of agriculture	• Fodder production • Growing needs for food production • Industrialized agriculture • Monoculture • Invasive species and/or disease carriers introduced • Genetic erosion: loss of genetic diversity of local species • Phase out of traditional agriculture/intensive plowing • Use of chemical fertilizers, herbicides and pesticides • Land reconversion • Introduction of new products/innovations (watering technology, earthworks and transport technology, pesticide, GMOs, etc.) • Poor maintenance of the sanitation and drainage system, loss of water, etc.) • Property rights problems (failing traditional land ownership regimes, territorial zoning)
Urbanization and coastal development	• Hydraulic infrastructure (waterworks, dams, boreholes, etc.) • Transport (roads, railways, airports) • Human habitats and industrial and tourist areas • Change in land use (conversion of agricultural land into urban areas, reducing the area available for food production, etc.) • Market growth and marketing

Firewood or energy wood	• Households harvest wood for domestic purposes • Use of fuel wood for carpentry and crafts
Mining and quarrying/ fossil fuels	• Mining extraction (oil, gas, heavy metals, salt, etc.) and quarry products by public/private companies to meet the urban development and infrastructure needs
Deforestation	• Deforestation linked to agricultural expansion, logging, charcoal production and urbanization
Livestock breeding and pastoral pressure	• Overgrazing and uncontrolled transhumance • Conflicts between farmers and breeders

Other factors such as species invasions, the spread of plant pests and diseases, change in fire regimes, and burning policies in wild and semi-natural ecosystems contribute to land degradation (Olsson & al., 2019 and Agnes, 2020).

- *Forms of land degradation*

Land degradation processes occur at different scales, ranging from minor changes to major alterations of the landscape. A "focal point" is identified for each form, representing a specific component of terrestrial systems such as soils, water and biota. As the process begins, multiple effects and interactions affect other components of the system (Fig.14).

- **Forms of soil degradation**

In 2015, the State of the World's Soil Resources report (FAO & ITPS, 2015) identified the main threats to these resources. Among the most important on a global scale are soil erosion, the reduction of organic carbon and nutrient imbalances. Then come salinization, sodification, loss of biodiversity, contamination, acidification, soil compaction, as well as flooding, soil sealing and land occupation (UNCCD, 2017).

A review of the literature made it possible to identify the main forms of soil degradation in Africa, based, in particular, on the African Soil Atlas (Jones

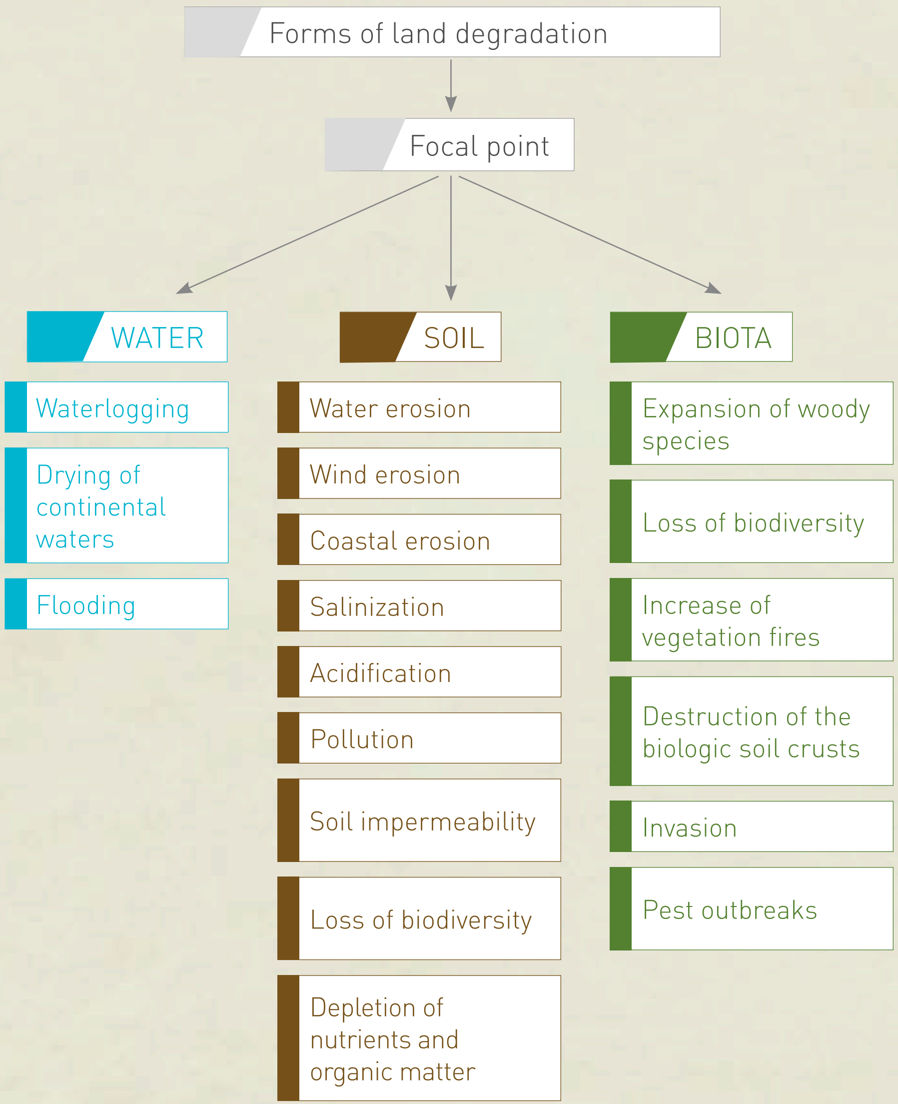


Figure 14: Forms of land degradation; adaptation inspired by Olsson & al., 2019

& al., 2015), the Global Outlook (UNCCD, 2017) and the land degradation chapter of the IPCC Climate Change and Land report (Olsson & al., 2019). This part details the most significant forms of degradation.

10 **Definition of a soil**

A soil results from the alteration of rocks (parent rock) following several factors: climate, biological and human activities (Bonneau & Souchier, 1979). This process, called pedogenesis, results in vertical differentiation in the form of horizons and lateral differentiation following the shapes of the landscapes. Compartment or building (described according to a soil profile) formed by a set of particles of variable size (clay, silt, sand) generally strengthened together by organic matter. This organic matter contributes to the alteration of the parent rock, facilitates the aggregation of constituents and the porosity between the clods and increases water stock. Finally, it is a source of plant nutrients and fertilizing elements: fertile soils (better agronomic potential), less fertile soils (degraded and with agronomic constraints). A ranking and classification of these factors makes it possible to distinguish soils which are suitable for rainfed crops or pastures, others which are suitable for irrigated crops in an agro-ecological zoning.

11 Soil erosion, often confused with soil degradation, refers specifically to the loss of the topsoil and nutrients. This process is characterized by the spread of solid parts such as sand, silt, clay and humus, which are torn from the ground and transported over distances, ranging from a few hundred meters to thousands of kilometers. Mainly observed in sloping areas, this phenomenon is sharpened by inappropriate agricultural practices, including slope-wise plowing, annual crop and deforestation.

Figure 15: Forms of soil degradation (UNCCD, 2017)

12 **Sand transportation mechanism by the wind**

The transportation of particles by the wind can take place in three different ways depending on the size of the materials, the speed of the wind and its level of turbulence, namely: saltation (movement by leaps or jumps), creeping in surface (particles roll or slide at ground level), suspension (floating in the air of fine particles and movement in the form of dust, even in light wind over great distances (thousands of km), the avalanche effect (increase of particles displaced by saltation).

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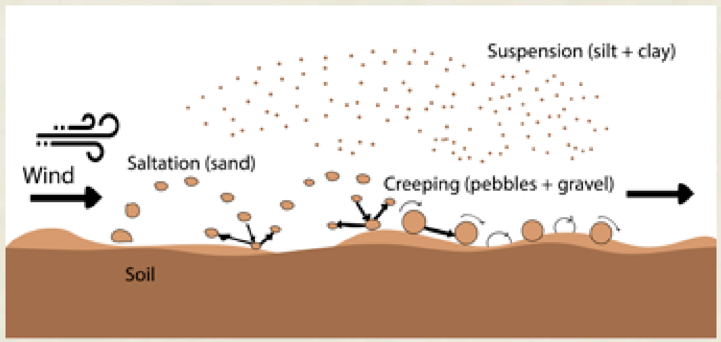


Water erosion

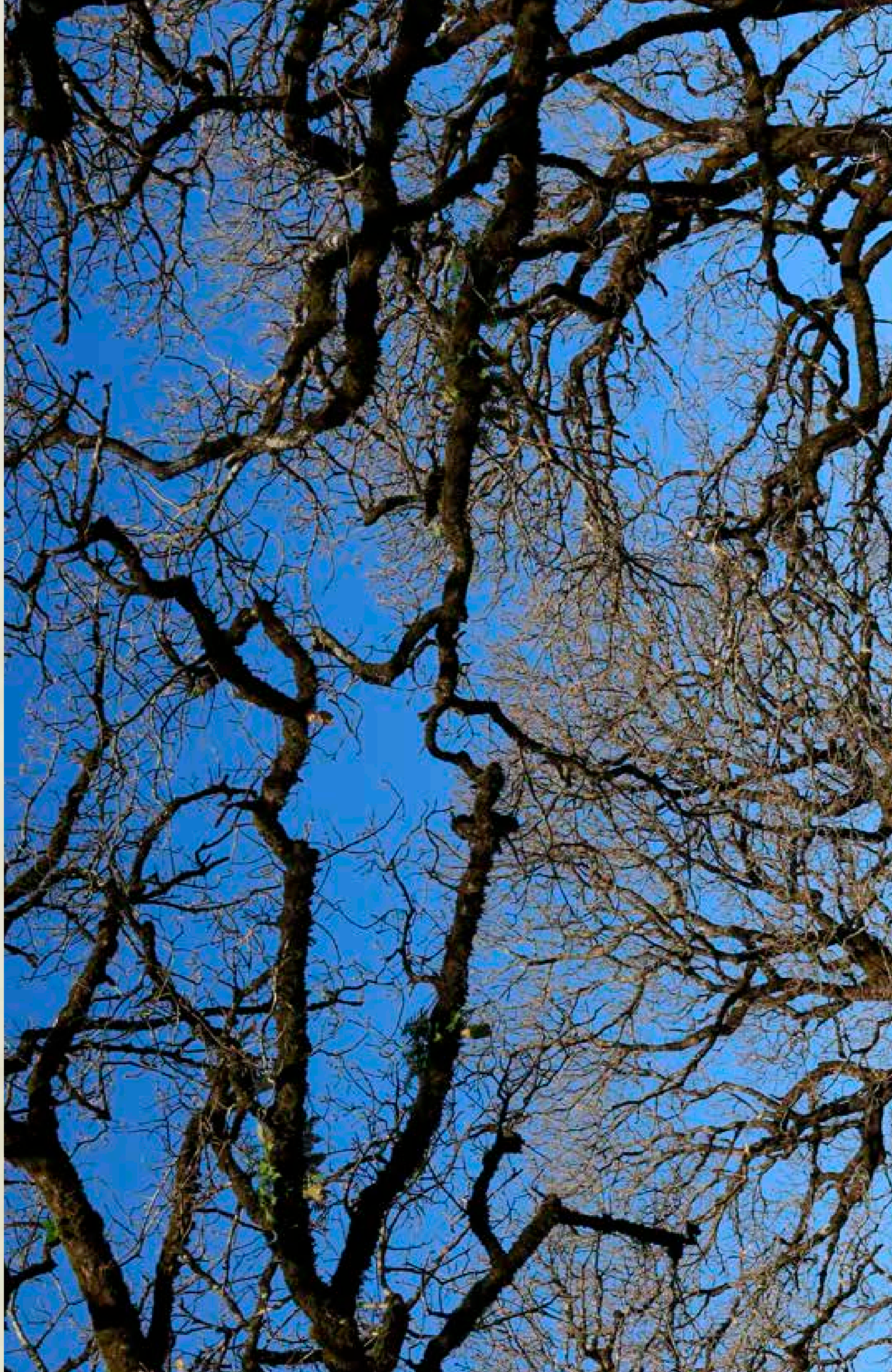
In Africa, water erosion is mainly observed in regions receiving more than 300 to 400 mm of annual rainfall. It mainly takes two aspects often observed simultaneously: diffuse erosion and linear erosion. Moving erosion materials off site can have varied consequences depending on their destination. They can feed a neighboring plain when they are deposited in the form of alluvium in a neighboring plain or cause problems when they obstruct a reservoir. The Chari River which flows through the Central African Republic (CAR) towards Lake Chad is a telling example: unlike Chad which benefits from it, the CAR suffers a loss of soil resources due to the movement of erosion materials. The transportation of these materials to the sea results in a net loss of soil resources for the African continent. The loss of billions of m^3 of arable land caused by water erosion shows how important is the phenomenon and its impact on the environment and societies.

Wind erosion

Although less common than water erosion, wind erosion occurs under specific conditions such as open, sparsely forested landscape, dry climate, and soils with a sandy or loamy surface. It is mainly observed in four regions of Africa: the Sahara and its surroundings, the desert areas of the Eastern Horn along the Red Sea, the Kalahari and the coastal fringe of Namibia. Elsewhere, it appears locally on small areas and is associated to water erosion. When occurring on land, wind erosion can modify the ground, or not. It can also have harmful extraterritorial effects such as the covering of fertile agricultural land, the obstruction of roads (example of Mauritania), or the silting of waterways such as the Suez Canal.

Coastal erosion

Coastal erosion is the loss of sediment and rock along shorelines, causing beaches, cliffs and mangroves to recede. Although it is a natural process, human activity, including the construction of infrastructure and the removal of dune vegetation, significantly exacerbates this phenomenon. In Africa, the threat of this process is particularly worrying in Nigeria, Senegal, Benin, and now Côte d'Ivoire and Ghana (Almar & al., 2023).



Death of oak trees due to global warming.

13 Soil organic matter is mainly made of plant debris and organic residues and fosters soil structure, water retention and nutrient availability to plants, thereby contributing to soil fertility. Losing it would seriously compromise ecosystem health and agricultural productivity.

Depletion of nutrients and organic matter

According to the International Center for Soil Fertility and Agricultural Development (IFDC, 2017), Africa loses 8 million metric tons of soil nutrients each year, leading to the degradation of over 95 million hectares of land and a significant reduction in agricultural productivity. Estimation results reveal that more than 85% of African countries experience a nutrient withdrawal exceeding 30 kg per hectare per year, of which 40% suffer losses exceeding 60 kg per hectare per year. Sub-Saharan African countries are thus hit hardest by this phenomenon. Current demographic pressure has led to a reduction or elimination of fallow time, inevitably leading to a drop in agricultural production. This degradation is often associated with diffuse water erosion in savannah lands, where eroded soil retains a high level of organic matter linked to clay and nutrients. The loss of organic matter is also the result of various factors such as intensive agricultural activity, overgrazing, land clearing and inappropriate waste management practices. As a result, soils lose their ability to support plant growth, leading to a decrease in biodiversity and compromising resilience to erosion and drought.

Depletion of soil biodiversity

Often less highlighted than large land mammals, soil biodiversity is of vital importance for our ecosystem. Composed in particular of fungi, bacteria, arthropods and earthworms, this microscopic diversity works in harmony to decompose organic matter and produce humus, essential for soil fertility and health. Organisms such as tardigrades and springtails can survive extreme conditions, regulate the soil microflora and promote the movement of nutrients. Earthworms and cicadas play an essential role in the ventilation and fragmentation of soil organic matter. This soil biodiversity is threatened by human practices such as land take and intensive agricultural exploitation, which deplete it and, consequently, contribute to land degradation.

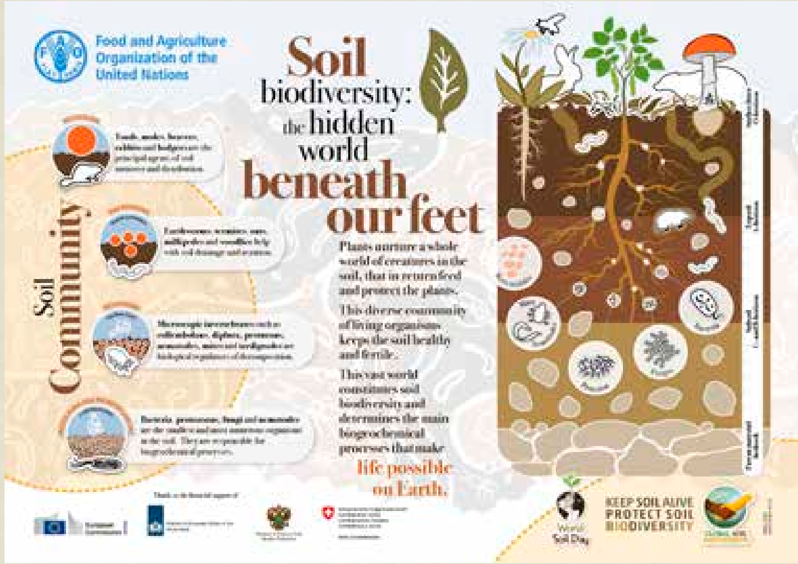


Figure 16: Erosion of soil biodiversity (FAO, 2020)

Salinization

Salinization is a predominant concern in arid and semi-arid regions featuring limited rainfall and intense evaporation. In these areas, water in the soil evaporates, leading to salt precipitation and gradual accumulation. Several factors stand behind this phenomenon, namely the intensive exploitation of the originally salt-rich soils, the pollution of groundwater by marine intrusions, and irrigation with water presenting high salt concentrations. In Africa, approximately 40 million hectares are affected by salinization, representing 10% of the world's saline land. This scourge mainly impacts North Africa, but coastal countries remain particularly vulnerable, such as Senegal where salinization affects 645,000 hectares, or 9% of the country's degraded areas according to the INP (2016).

14 Although soil **acidification** and **salinization** are two distinct processes, they can be linked when acidification contributes to the release and accumulation of salts in the soil.

Soil salinization in an oasis of Kébili

Acidification

Acidification occurs when the soil pH is below 5. It is more commonly observed in Central Africa, particularly in equatorial and subequatorial zones with high rainfall. In forested areas where forest soils present pH below 5 in their natural state, it is hard to distinguish the impact of agricultural practices from natural soil acidity.

Acidification increases with the duration of land use and leads to a significant drop in fertility, as is the case for soils in Libreville cultivated for more than 10 years (Doso, 2014). Ferruginous and ferralitic soils, which are the most cultivated in sub-Saharan Africa, are particularly vulnerable to this degradation. In Burkina Faso, it has been found that ferruginous soils become acidic after 6 to 7 years of exploitation and ferralitic soils after only 4 years of exploitation (AGNES, 2020).

Pollution

Soil pollution has become a major global challenge that impacts land quality and hampers agricultural activities, with the soil contamination playing a central role. According to a recent study by Tindwa & Singh (2023), soil pollution in sub-Saharan Africa results from industrial, agricultural, mining, quarrying, and waste management activities. Trace elements, pesticides, hydrocarbons and polychlorinated biphenyls are the main contaminants. The exponential growth of waste generation in sub-Saharan Africa in the coming decades, with a peak beyond 2100, will only amplify soil pollution.

15 Soil metal toxicity is a form of pollution that mainly results from the excessive accumulation of heavy metals in the soil, originating from various industrial activities. Metals such as lead, cadmium and mercury can persist in soil over long periods of time, causing adverse effects on biodiversity, groundwater quality and food security.

Practices such as excessive use of pesticides, irrigation with contaminated water, and industrial waste dump contribute to intensifying metal toxicity in the soil. This degradation process compromises the soil ability to support healthy plant growth, affects the food chain and poses potential risks to human health.

Soil impermeability

Soil impermeability is often the result of several phenomena, in particular compaction and crusting. Soil compaction is a major process that limits agricultural yield by significantly increasing soil density. The resulting reduction in pore space negatively affects ventilation, drainage and water absorption. This physical alteration thus limits root expansion, leading to a poor development of the roots and inefficient absorption of the nutrients. This phenomenon results from intense pedestrian traffic and compression by construction equipment.

16 Soils that are physically healthy are ideally made of 25% water, 25% air, 45% mineral matter and 5% organic matter.

The crusting of the soil surface is the result of raindrops on a soil that is inadequately protected by vegetation. Disintegrated clods of earth by rain lead to the formation of few millimeters of stratified clay, silt and sand. This layer acts as an ice cover which significantly reduces the water infiltration capacity of the soil and hinders the seed germination process. Crusting has a direct impact on the agricultural productivity of the soils. In Niger (Ado & al., 2023), it is one of the main causes of agricultural productivity drop and the increase in flood risks.

- **Forms of degradation linked to the water component of the land**

The land water component is an important focal point subject to various forms of degradation such as waterlogging, drying of wetlands .

Waterlogging

Waterlogging occurs when the soil becomes temporarily or permanently saturated with water, disrupting its normal absorption process. Congestion restricts normal air intake, decreasing oxygen levels and increasing carbon dioxide and ethylene levels and brings serious consequences as it deprives plants from oxygen, weakens their roots, compromises their growth or simply leads to their death. Waterlogging can persist even without apparent signs of excess surface water. It often follows seepage and runoff from lakes, aquifers, canals and rivers, as well as groundwater movements such as a water table rise. Agricultural practices, such as excessive irrigation without adequate drainage, can add insult to injury.

Drying of continental waters/wetlands/lowlands

The drying of wetlands is a usual consequence of developments on neighboring watercourses such as damming and recalibration. These practices often result in a cut-off of the watercourse, leading to a sinking and a reduction in the level of the water table which supplies these wetlands. The significant drying of water sources, wetlands and oases is a particularly alarming situation in areas where intensive extraction of groundwater for irrigation seriously threatens water tables. In North Africa, it is a particularly worrying situation, because aquifers are overexploited

17 How to check the quality of the soil to face erosion and improve agro-systems?

A good assessment, supported by laboratory analyses, makes it possible to define the main physicochemical properties of a soil. The overall evaluation of a set of parameters helps determine the agronomic suitability of a soil and to identify the constraints to better use it and protect it from different degradation processes. A preliminary pedological survey will successively identify: the depth of the loose layer, the texture, the structure, the humidity, the porosity, the organic matter content and the activity of the micro-organisms, and finally the precipitation of the salts... "The soil fertility and use largely depend on its morphological characters..." (Ruellan & Dosso, 1993). A healthy soil is a soil that requires less fertilizers to give the same yield, is more stable and less prone to erosion.

Porosity is one of the elements that come in the dynamics and behavior of the soils with respect to external agents such as water and plant nutrients (Duchaufour, 1991). Water and gases circulate in the soil through the pores. There are macro-pores through which air and water circulate, and micropores in which water is stored. The number of pores in a soil is important, so is the quality of their configuration.

Determining the nature and properties of a soil makes it possible to measure its vulnerability to climate change and pressures linked to human activitie.

to cope with water stress. Unlike sub-Saharan Africa, home to abundant groundwater resources, overexploitation of the aquifers in North Africa leads to increased costs, more technical complexity and stronger energy demand.

Flooding

Flooding is a land degradation process that occurs as a temporary increase in water level with significant impacts on the soils and ecosystems. It is often the result of heavy rains, river flooding or tropical cyclones. Floods can cause the loss of soil fertility, erosion, crop destruction, degradation of infrastructures and natural habitats and increased soil salinity. These phenomena are exacerbated by other elements such as climate change, deforestation and the modification of waterways.

- **Forms of degradation at the level of the land-living component (biota)**

Biota represents all living organisms that interact in the terrestrial environment, including plants, animals, fungi, bacteria and other microorganisms. This section reviews some of these processes such as the expansion of woody species, loss of biodiversity, species decline and species drift, destruction of biological soil crusts, spread of wildfires, pest invasion and outbreaks.

Impact of quarries on land quality

18 Water and soil interactions: How could water retention and storage in the soil be improved?

In the current climate change situation, water and in particular soil water, will become an increasingly precious source for human societies (agriculture, urbanization, tourism), even in regions having a water comfort status.

Did you know that during rainy seasons, only part of the rainwater reaches the ground? In fact, a part directly evaporates during and after rain. The water that reaches the ground can run off or infiltrate deeply depending on the soil surface condition (vegetable cover, mulch, beating, plowed, etc.). The roots absorb a part of this water which the stem and leaves evaporate through transpiration. The other part can reach the water table at a speed determined by the type of the soil.

The water content of the soil depends on its porosity and its permeability based on its clayey, loamy or sandy texture. The maximum volume of water that a soil can hold is called "field capacity" or "soil retention capacity" (water stock). It is therefore easy to determine the water profile from the surface to the depth and see all the variations in order to monitor the needs of the plants. The increase in the amount of surface water does not necessarily lead to an infiltration to deeper layers. Indeed, water is subject to two main forces in the ground: capillarity which acts in all directions and gravity which is a downward force. When the soil water retention capacity is exceeded, the water descends under the effect of gravity (drainage water) to reach the lower layers (crusted level, water body, aquifer).

Expansion of woody species

The invasion of woody species is characterized by the excessive proliferation of shrubs and woody species in areas originally dominated by grasslands. This phenomenon leads to a limited grassy component, disrupting the vegetation ability to regulate woody density and maintain diversity under the canopy. These alterations affect the structure and functions of ecosystems, jeopardizing biodiversity, ecological resilience and ecosystem services. In Africa, overgrazing plays a major role in this process, particularly in regions such as Ethiopia, eastern Ghana and South Africa, where it stands for more than 30% of woody species invasion.

Specific decline and specific drift

Species decline and species drift are processes of land degradation, illustrated by a decrease in the woody cover in various biomes across the continent. In Africa, studies have reported a 21.6% decline in species diversity and 42% decline in species abundance in African biomes. Projections indicate further loss of biodiversity by 2100, linked to intensified land use. Arid areas registered a loss of 50% of plant species and 30% of animal species. Agro-forestry systems present more complex dynamics. They often show cyclical changes in the number of species and stem density during changes in the development of plant populations. While these changes were initially associated with complete degradation, it is important to say that these systems may evolve toward greater diversity and productivity at early stages.

Destruction of biological crusts of the soil

The destruction of biological crusts of the soil is a land degradation process that poses a threat to communities of microorganisms that blossom on or just below the soil surface. Crusts play an important role in soil stabilization, carbon and nitrogen fixation, and water infiltration. The destruction of these crusts can have harmful consequences on the overall quality of the soil, compromise underground biodiversity and disrupt the carbon cycle.

Increase in vegetation fires

Fire is, at various scales and seasons, a specific component of many plant systems and its role is crucial, thus the absence of fire in fire-prone landscapes represents a major factor in land use and land cover change. Furthermore, in most studies, fire is considered as a major contributor to the regression and degradation of grasslands. Thus, conditions that stimulate more devastating fires can be caused by inappropriate land use practices, waste management and climate change. The challenge is to marry infrastructure development and fire regimes for the proper functioning of ecosystems and the conservation of biodiversity.

Landslide in the Maziba region, Uganda

Biological invasion

Biological invasion is a process where non-native species invade and colonize ecosystems and replace local species. This phenomenon plays a major role in land degradation by disrupting ecological balances, biodiversity and soil productivity. Invasive plant species can impact the structure and composition of the soil, as well as the land ability to maintain healthy plant diversity.

Pest outbreaks

Pest outbreaks are also a land degradation process during which massive populations of pests invade ecosystems. These episodes can make major ecological disruptions, affecting biodiversity, soil health and agricultural productivity. The locust invasion in East Africa in 2020 is a telling example. In Kenya, a 2,400 km² estimated swarm, almost the size of Moscow, contained up to 200 billion locusts. These insects can travel up to 150 kilometers per day and a 1 km² swarm can eat as much food as 35,000 people in one day.

II- Land degradation, an observation based on the existing situation

Africa has often been associated with apocalyptic images of drought and land degradation. Although some of these pictures may be closer to cliché than general representations, the true sprawling degradation and desertification raises serious concerns about the future of the continent. In response to these concerns, the international community mobilized to rigorously assess the extent and severity of this degradation, anticipate and implement effective solutions for prevention, conservation and restoration.

This subsection tells the current state of land degradation knowledge and trends, produced by a range of international Organizations over several decades. It also explores how land degradation assessment methods have evolved over time, focusing on the approaches and methodologies used,

Cracks in the ground, the Gezira State, Sudan and then explores a direct application of LDN indicators, produced by the OSS using finer data than those used by international authorities. Finally, a comparative evaluation of the updates and findings obtained is carried out. The purpose is to assess their consistency and provide a complementary, more recent quantification, considering the current environmental context.

II.1- Disparate figures

Literature provides a wide range of figures and information on aspects related to land degradation. Today, different international Organizations agree that 65% of productive land in Africa is degraded (FAO, 2021). Desertification affects 45% of land, 55% of which present a high or very high risk of degradation (ELD & UNEP Initiative, 2015). Furthermore, the "Africa Open DEAL" initiative aiming to monitor land degradation and progress towards Sustainable Development Goal 15.3 - Land Degradation Neutrality, reveals that approximately 30 million hectares of land in Africa are classified as degraded due to changes in land use, including deforestation (Socande & al., 2022). Previous figures from the GLASOD, FAO TerraSTAT, GLADA and FAO Pan-tropical Landsat programs vary from 9 million ha to 1,222 million ha, i.e. 0.3% and 40% of degraded land over the African total land area (Gibbs & Salmon, 2015). These are disparate figures due to the approach followed by each project.

Table 7: Figures quantifying land degradation in Africa

Estimated land degradation in Africa	Phenomena	Source
321 Million ha (10%)	Degraded area in Africa	GLASOD 1990 (Gibbs & Salmon, 2015)
1222 Million ha (40%)	Degraded area in Africa	FAO TerraSTAT (Gibbs & Salmon, 2015),
660 Million ha (22 %)	Degraded area in Africa	GLADA 2009 (Gibbs & Salmon, 2015)
9 Million ha (0,3%)	Degraded area in Africa	FAO Pan-tropical Landsat (Gibbs & Salmon, 2015)
65%	Degraded productive lands in Africa	(CNULCD, 2014) FAO and AUDA-NEPAD (Mansourian & Berrahmouni 2021)
45% de la superficie de l'Afrique	Desertification across Africa's surface area, 55% of which is at high or very high risk of degradation	ELD & UNEP Initiative (2015)
29,51 Million ha (0,99%)	Estimated degraded land in Africa	(Socande *& al.*, 2022)
46%	Estimated degraded land in Africa	(AGNES, 2020)
263,15 Million ha (11,96%)	Reportedly degraded land in Africa (based on reports from 42 countries)	CNULCD 2023 https://data.unccd.int (last viewed: May 27, 2024)

In this worrying context and with a view to having updated data on land degradation, the UNCCD has launched its own data dashboard[1]. This table compiles various information, including data related to land degradation and drought, submitted by Contracting Parties to the Convention in their national reports covering the 2018-2021 reporting period. However, some estimates are still missing for some Parties did not yet submit their national reports and some crucial indicators have not been reported. A rigorous comparison is therefore a difficult thing to do and land degradation trend analyses and interpretations must be carried out cautiously.

Nevertheless, data reported gives a general idea of land degradation in Africa. According to the national reports of the 42 African countries that submitted their national reports between 2015 and 2019, 263.15 million hectares of land would be degraded, i.e. 11.96% of their total area[2].

The assessment and quantification of land degradation generally depends on its forms, context and the specificities of the area, the scale of assessment and the quality of the data used. An indicator can hardly be used alone to determine the state or condition of the land. Sub-indicators can help monitor essential variables that reflect the capacity to provide ecosystem services. However, the final determination of the land degradation extent by national authorities should be put in context by considering other data and information as well as on-the-ground verification.

Thus, the existing figures must be considered according to the measurements context, for their calculation can not be the result of the same methods and does not use the same databases, the same resolution of satellite images, nor the same periods of reference and reporting. Indeed, available data show that, until now, the information available on land degradation in Africa is quite disparate. This can be explained by the lack of accurate and up-to-date data on the degradation extent, severity and trend at national and local scales, as well as the adaptation of the proposed indicators to the specificities of different landscapes and ecosystems.

1 https://data.unccd.int

2 https://data.unccd.int/land-degradation?grouping=UNCCD&region=aprL8rz, viewed on May 27, 2024.

II.2- Multiple evaluation methods over time

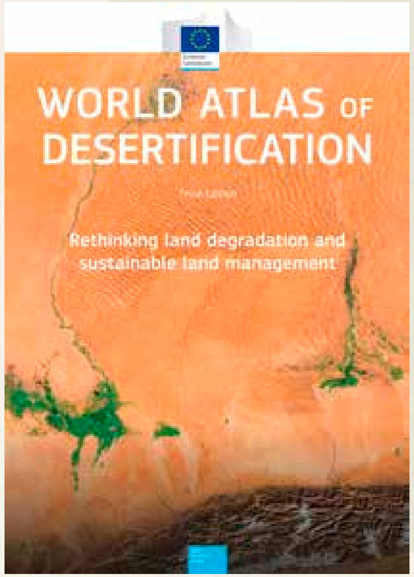


Figure 17: World Atlas of Desertification (Cherlet & al., 2018).

For the harmful trends of land degradation to be reversed, it is essential to assess the size of land currently degraded and identify the critically endangered areas. The first difficulty in assessing the extent of land degradation is how to accurately define this phenomenon and how to quantify it. Over time, various attempts to understand and measure the phenomenon have been undertaken.

After the serious damage caused by drought in the Sahel of Africa, UNEP organized the Conference on Desertification in 1977 in Nairobi to raise awareness of the issue among the international community. From 1987, global land degradation and drought assessment methods emerged with the launch of the GLASOD program. At the end of the program in 1990, a first global map of human-induced land degradation was presented at the World Congress of Soil Sciences in Kyoto that same year, and then at the Rio Summit in 1992. This map was one of the first to describe global land degradation trends and served as the basis for other assessment initiatives. Although it has been widely used, studies found shortcomings related to the use of local knowledge rather than measurements (Gibbs & Salmon, 2015).

The United Nations Convention to Combat Desertification (UNCCD) was established in 1994, placing land degradation assessment among its priorities. In 2009, the ninth Conference of the Parties (COP9) highlighted the importance of land degradation and the identification of relevant indicators (UNCCD, 2009). However, making a clear and consistent assessment is a hard task to achieve due to the complexity of the land degradation process.

Given the many driving factors and multiple contextual responses required, developing a single indicator to represent or map land degradation has been, to date, a major challenge.

To overcome this complexity, experts and scientists have developed several approaches and indicators, trying to consider the different drivers of land degradation. The MEDALUS methodological approach, for example, aimed to assess the sensitivity to desertification based on four elements: soil; vegetation; climate and human activities (Benjalleb & al., 2021). Likewise, the methodology adopted for the 3rd edition of the Desertification Atlas went beyond conventional analyzes of land degradation. It highlighted global anthropogenic land change processes, particularly cropped land and pastures. (Cherlet & al., 2018; UNCCD, 2017).

Gibbs & Salmon (2015) brought together the main assessment approaches into four broad categories: expert opinion, satellite-derived net primary productivity, biophysical models and the maps of abandoned cropped land, in an attempt to produce a global-scale land degradation map. However, although these approaches provide a relatively adequate assessment, none provide a complete state of degradation (Gibbs & Salmon, 2015; Olsson & al., 2019). The reason is there is no standard methods that can be applied for all landscapes on earth and allowing the extent and severity of degradation to be objectively and consistently estimated.

According to the scientific and political community, land degradation is a silent and insidious scourge that requires immediate and concrete actions based on the past experiences.

The combination of several tools such as remote sensing, local expertise and field methods can help assess and monitor land degradation over large areas. Generally speaking, the assessment is a complicated task because of the choice of indicators, the extent of land to be assessed, the costs associated with this assessment, the availability of technical expertise and reliable and up-to-date data.

Considering the disparity in available figures, the UNCCD has established a constantly evolving framework aimed at aligning land degradation monitoring and evaluation through the management of target 15.3 of the Sustainable Development Goals (SDGs), aimed at Land Degradation Neutrality (LDN) and the adoption of indicator 15.3.1, which aims to define the proportion of land degraded over total land area.

For this to happen, the Convention provides strategic objectives, indicators and sub-indicators, good practice guides and an indicator 15.3.1 calculation tool from international data for land degradation assessment which is based on the information provided by three sub-indicators: land use change, land productivity and soil organic carbon, which can be supplemented by other relevant indicators that are adapted to the specificities of the countries and regions and by national targets to ensure maximum consistency and reliability (UNCCD, 2016).

Furthermore, SDG indicator 15.3.1 was classified as level I in December 2018, which means that "the indicator is conceptually clear, has internationally established methodology and standards and data is regularly collected for at least 50% of the countries".

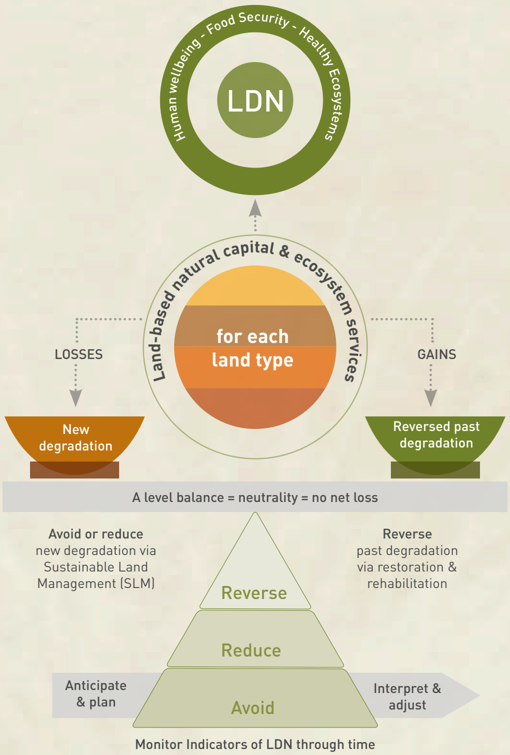
Dune fixation to prevent silting

19 Land Degradation Neutrality

Objectives, approaches and methodology

Land Degradation Neutrality (LDN) refers to "a state in which the quantity and quality of land resources needed to support ecosystem functions and services and improve food security remain stable or increase in temporal and spatial scales and specific ecosystems" (UNCCD, 2015b).

In other words, LDN is a national voluntary target aimed at opposing land degradation through sustainable land management and restoration. The ambitious objective of the LDN is to preserve or improve the natural capital of land and ecosystem services.



Graphic of the scientific conceptual framework for land degradation neutrality

SDG15 : Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation and biodiversity loss.

Target 15.3 : By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world.

SDG indicator 15.3.1 : Proportion of land degraded over total land area.

The UNCCD introduced the LDN concept into the global dialogue, which was accepted by the international community at the Rio+20 conference in 2012 (UNCCD, 2015) and adopted as part of the 2030 Agenda for Sustainable Development in 2015 (UNCCD, 2021). This concept was later included in SDG target 15.3 (UN, 2015). Following this inclusion, a scientific conceptual framework relating to land degradation neutrality through the science-policy interface of the UNCCD (Orr & al., 2017) operational technical guidelines allowing countries to set land degradation objectives (UNCCD, 2016). The LDN scientific conceptual framework, developed following the UNCCD COP12, serves as a scientific basis for LDN planning, implementation and monitoring.

The main elements of this framework are:

- **Vision** - which summarizes the LDN objective;
- **Reference framework** - which explains the LDN reference condition against which progress is measured;
- **Neutrality mechanism** - which describes the opposing mechanism;
- **Achieving Neutrality** - which presents the theory of change (logic model) explaining the way forward to implement LDN, with preparatory analysis and adapted policies;
- **Neutrality Monitoring** - which presents LDN indicators.

The figure shows that achieving LDN requires a strategic and iterative approach to avoid, reduce or reverse land degradation. This approach involves planning and institutional support that goes beyond the implementation of sustainable land management practices. It also shows that neutrality needs to be preserved over time through land use planning that anticipates losses, predicts gains and applies adaptive learning.

The LDN conceptual framework applies to all land types, land uses and ecosystem services, so that countries can use it according to their specific circumstances.

A neutrality baseline level must be established to assess whether neutrality has been achieved. The reference level is therefore the initial value of each of the indicators used for monitoring the LDN. The reference values of the indicators (t0) are compared to the values taken on the target date (t1) to determine the evolution of terrestrial natural capital.

Here follow the sub-indicators adopted to report progress towards achieving LDN targets:

- **Land cover**
- **Land productivity**
- **Carbon stocks**

Changes in the sub-indicators are described as follows:

i. Positive or improving;

ii. Negative or declining; or

iii. Stable or unchanged.

The indicator is calculated by assessing changes in the sub-indicators over time, to determine whether the size of degraded land is increasing or decreasing over the total land area. Consequently, the "one-out, all-out" principle is applied in the calculation method.

If one of the sub-indicators is declining or negative for a landscape unit (or stable when it has been degraded during the reference period), it can be considered potentially degraded, subject to validation by national authorities.

Drones are being used for vegetation monitoring in the Kounounkan forest reserve, Guinea Conakry

In order to have a better land degradation assessment, the UNCCD adopted the [2018-2030] strategic framework (decision 7/COP13) which contains five strategic objectives (SO) and an implementation framework. The strategic objectives aim to improve the state of affected ecosystems, combat desertification and land degradation, promote sustainable land management, improve the living conditions of affected populations, mitigate the effects of drought and mobilize the necessary resources for the implementation of the Convention. Furthermore, the implementation framework establishes the roles and responsibilities of the Parties and institutions of the Convention in three areas: financial and non-financial resources, general policy and planning, as well as field action.

The indicators used in the national reports are those adopted by the Parties in decisions 7/COP13, 9/COP13 and 11/COP14 including 5 new indicators, (SO 2-3, SO 4-3, SO 5-3, SO 5 -4 and SO 5-5) (Tab. 8). Their use by the parties is optional from the 2022 reporting cycle until the new decision to be taken at the 20th session of the Committee for the Review of the Implementation of the Convention, to be held back-to-back with the Conference of the Parties (COP20). The Parties will then be able to assess the relevance of these new indicators and decide whether or not to maintain them.

Dry hillside lake, Tunisia

Table 8: Summary table of indicators updated by the UNCCD for the 2022 reporting cycle.

Strategic Objectives	Indicators
SO.1. Improving the state of affected ecosystems, combating desertification and land degradation, promoting sustainable land management and fostering land degradation neutrality	**SO.1.1.** Proportion of degraded land over total land area (SDG indicator 15.3.1) **SO.1.2.** Evolution of land cover structure **SO.1.3.** Evolution of land productivity **SO.1.4.** Evolution of carbon stocks in the soil and on the surface
SO.2. Improving the living conditions of affected populations	**SO.2.1.** Evolution of the population living below the relative poverty line and/or income inequality in affected areas **SO.2.2.** Evolution of access to drinking water in affected areas **SO.2.3.** Evolution of the share of population exposed to land degradation, disaggregated by sex
SO.3. Mitigating, adapting and managing the effects of drought to strengthening the resilience of vulnerable populations and ecosystems	**SO.3.1.** Evolution of the proportion of land affected by drought over total land area **SO.3.2.** Evolution of the share of the total population exposed to drought **SO.3.3.** Evolution of the drought vulnerability degree
SO.4. Delivering global environmental benefits from effective implementation of the United Nations Convention to Combat Desertification	**SO.4.1.** Evolution of carbon stocks in the soil and on the surface **SO.4.2.** Evolution of the abundance and distribution of certain species **SO.4.3.** Evolution of protected areas in territories rich in biodiversity

SO.5. Mobilizing significant and additional financial and non-financial resources for the implementation of the Convention through the establishment of effective global and national partnerships	**SO.5.1.** Bilateral and multilateral public resources **SO.5.2.** National public resources **SO.5.3.** National and international private resources **SO.5.4.** Resources allocated to technology transfer **SO.5.5.** Future support for activities related to the implementation of the Convention
SO.6. Voluntary targets, additional indicators and affected areas	**SO.6.1.** Voluntary targets for strategic objective 1 **SO.6.2.** Voluntary targets for strategic objectives 2, 3 and 4 **SO.6.3.** Additional indicators (to be defined in consultation with the stakeholders) **SO.6.4.** Affected areas (to be defined in consultation with the stakeholders).
SO.7. Implementation framework: financial and non-financial resources, general policy and planning, field actions	**SO.7.1.** About the implementation framework **SO.7.2.** Financial and non-financial resources **SO.7.3.** General policy and planning **SO.7.4.** Field actions

II.3- Status report on land degradation in Africa (Application of UNCCD indicator 15.3.1 by the OSS using more detailed data)

The UNCCD is now recommending the use of three essential variables to obtain an indication of where degradation is occurring. These variables were chosen to reflect the ecosystem services of terrestrial natural capital:

A. "transformational" variable – land cover change;
B. "fast" ecological variable – the dynamics of land productivity;
C. "slow" ecological variable – soil organic carbon stocks.

The reporting framework on SDG indicator 15.3.1 proposed by the UNCCD is based on the use of low/medium resolution satellite data from international and freely available sources, while recommending that Parties use finer data at national and local levels. Thus, the accuracy of the SDG indicator 15.3.1 depends on the accuracy and quality of the data used as input.

In Africa, the low/medium spatial resolution satellite data recommended for the calculation of SDG indicator 15.3.1 make it hard to capture an accurate image of the losses and gains of vegetation and ecosystem services and thus the real link with land degradation/restoration.

Given the complexity of land degradation assessment, the Sahara and Sahel Observatory collaborated with the African Union, international entities (UNCCD, FAO), sub-regional institutions (CILLSS, CICOS, ICPAC and RCMRD), as well as other national and research institutions, to improve the reporting process of SDG indicator 15.3.1, and thus adopted a multi- scale approach which consists of:

- Supporting countries through projects that aim at assisting the reporting process;
- Integrating high spatial resolution data into SDG 15.3.1 sub-indicators evaluation, namely 30m spatial resolution data instead of the data currently used (300m – 1km) by African countries;

- Integrating very high spatial resolution data to describe the state of land degradation/restoration on the islands; and
- Raising awareness about land degradation issues.

Thanks to this approach, an improved kit of indicators was achieved integrating:

- The production of land cover maps of Africa from Landsat data for the reference years 2000, 2015 and 2021;
- The assessment of land productivity using 30 m spatial resolution Landsat data;
- The estimation of carbon stock based on more accurate land use data produced by the OSS.

This brainwork is part of the OSS support to African countries, and aims to promote the use of finer satellite data for reporting while supporting technical and institutional strengthening for the achievement of land degradation neutrality.

Pending validation of this kit by African sub-regional and national authorities in a participatory and collaborative process, the preliminary results show a first land degradation accurate image that is globally aligned with the national reports and studies, and shows the availability of OSS to support African countries in reporting.

Land use change

It is an indicator of the major changes in the dynamics of the land surface resulting from different factors, which can be interpreted as a sign of land degradation or restoration related to the loss/gain of ecosystem services.

20

"With an appropriate processing, the Landsat 5-8 archives could provide information throughout the reference period in order to derive information on annual land cover changes at a higher spatial resolution than that provided in the UNCCD datasets.

The challenges of assessing land productivity are greater due to the preference given to observing vegetation at the biomass peak time each year."

"Significant developments are required to improve the assessment of carbon stocks from Earth Observation data sources, and in particular to address the assessment of carbon stocks above and below the ground".

Source: Satellite Data Requirements for SDG Indicator 15.3.1 - CEOS Coordination Group on Sustainable Development Goals – Aug 2022.

With a view to ensuring the sustainability of the monitoring approaches where it is recommended to use freely accessible spatial data, and in order to better understand this sub-indicator considering the specificities of African landscapes, the OSS mapped the African continent land use using the finest satellite data freely accessible, namely 30m spatial resolution Landsat data of Africa for the years 2000, 2015 and 2021 (Fig. 18).

These maps are being validated in a process involving African sub-regional and national authorities, as well as the UNCCD focal points and the Joint Implementation Network – JIN[1] experts set up by the OSS and the African Union Commission as part of the GMES & Africa project.

1 http://projet.oss-online.org/GMES-Africa/jin/

Figure 18: Land cover maps of Africa produced by the OSS based on Landsat data (top, from left to right: 2000, 2015, 2021).

The cross-analysis of land cover maps makes it possible to identify the flows of land cover/use change which represent the losses and gains resulting from the transition from one land cover class to another, according to the transition flow matrix (Tab. 9) where improvement takes green, stability takes yellow and degradation takes red. It should be noted that each country/region has specific land cover changes that should always be interpreted in this context.

The map of land use changes between 2000 and 2021 produced by the OSS (Fig.19) clearly shows that the pace and extent of changes are different from one region to another, and that major transitions of land cover change can be summarized mainly in the transitions between forests and steppes and rangelands, the disappearance of rangelands and steppes, the extension of urban areas, the expansion of crop areas and pastures to the detriment of forests.

These changes can also affect food security and cause the loss of biodiversity. For example, agricultural clearing modifies runoff conditions which will reduce the availability of water for ecosystems and impact agriculture practices.

Table 9: Land use change flow between the reference and the base

		Year of Destination (T2)					
Year of reference (T1)	Classes	Tree areas	Grasslands	Cropland	Wetland	Artificial surfaces	Other lands
	Tree areas	Stable	Loss of vegetation	Deforestation	Flood	Deforestation	Loss of vegetation
	Grasslands	Afforestation	Stable	Agricultural expansion	Flood	Urban expansion	Loss of vegetation
	Cropland	Afforestation	Decline of agriculture	Stable	Flood	Urban expansion	Loss of vegetation
	Wetland	Brushland	Wetland drainage	Wetland drainage	Stable	Wetland drainage	Wetland drainage
	Artificial surfaces	Afforestation	Establishment of vegetation	Agricultural expansion	Creation of wetlands	Stable	Decline of human settlements
	Other land	Afforestation	Establishment of vegetation	Agricultural expansion	Creation of wetlands	Urban expansion	Stable

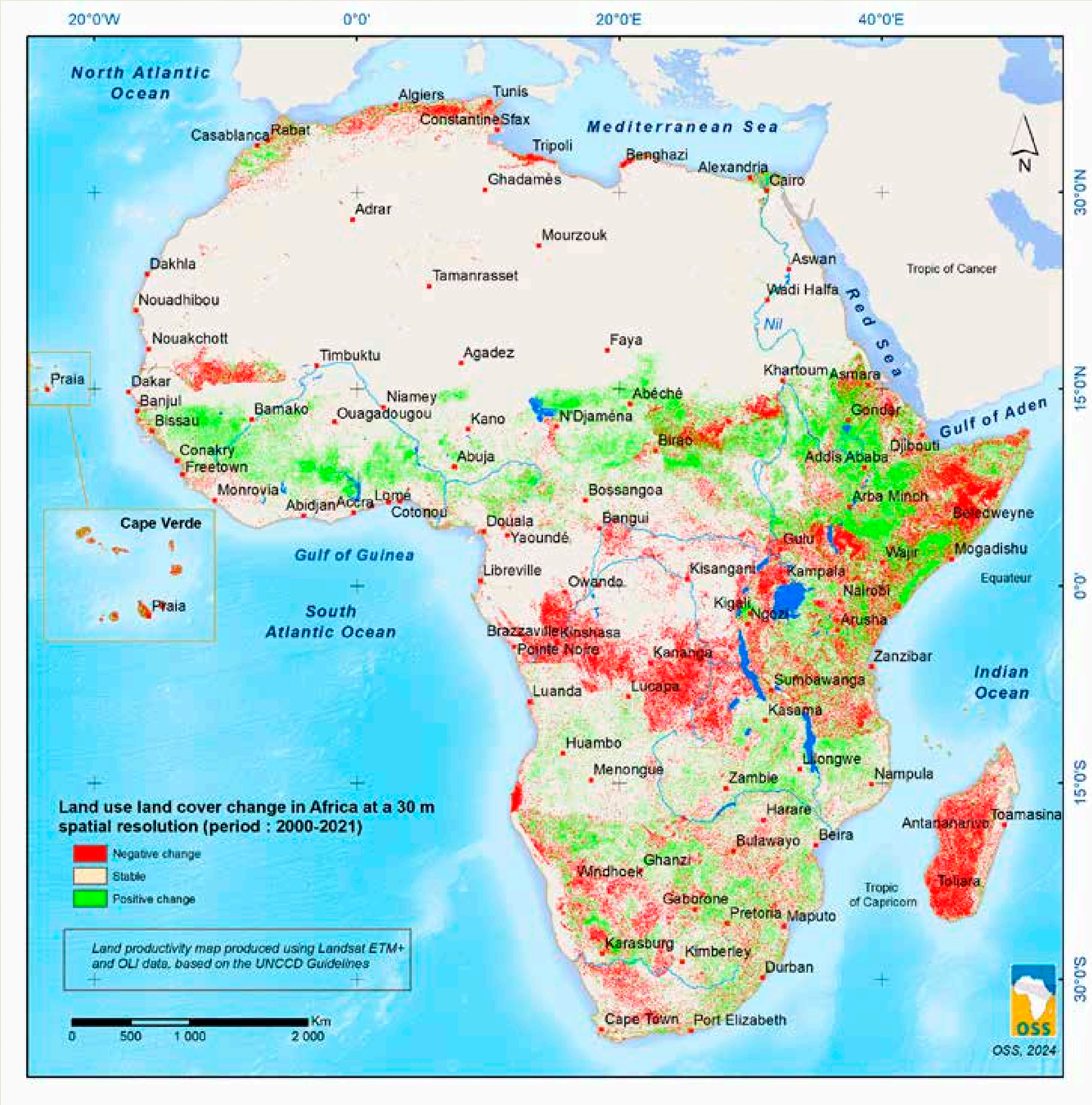


Figure 19: 2000/2021 land cover change map, calculated from 30m spatial resolution Landsat data using the UNCCD guidelines

Land productivity

Unlike the "agricultural income per unit area" as understood in conventional agricultural terminology, "land productivity" reflects the overall productivity of aboveground plant biomass resulting from all land components and their interactions.

Farmer observing his cassava plant in the Dévé region, Benin

Its dynamics refers to the primary productivity of a steady terrestrial system which is generally highly variable in different years/cycles of vegetation growth depending on environmental conditions. This indicator provides a combined qualitative measure of the intensity and persistence of negative or positive trends and developments in the vegetation cover, through statistical analysis applied to time series of production of vegetation indices, assimilated to the net primary production. This assessment is made through three sub-indicators: (i) the path which measures the rate of productivity change over time, (ii) the state, which makes it possible to detect recent changes in primary productivity, and (iii) the performance which captures local productivity compared to other similar vegetation types in other bioclimate stages.

The "Non-degraded/stable" class on the maps (Fig. 20) indicates a low probability of vegetation cover decline and therefore a low probability of active land degradation. It does not exclude the possibility that these lands have already undergone degradation processes and have reached a new balance showing neither further degradation nor reconstruction. The red "Degraded" areas reflect the decline in land productivity, probably indicating the recent action of one of the land degradation processes.

The analysis of time series of long-term Landsat data (2000-2023), covering the continent at 30 m spatial resolution, made it possible to study vegetation dynamics and thus net primary production. According to the preliminary results of this analysis, approximately 6.25% of the continent has experienced degradation, compared to approximately 93.75% of the total area considered stable.

Thus, this analysis made it possible to detect areas where persistent and active drops in primary productivity signal ongoing land degradation rather than areas which have already undergone degradation processes and which have reached a new balance from which they no longer deteriorate during the observation period in the time series used. Auxiliary data and country feedback and contributions would make it possible to refine this sub-indicator at the continental level.

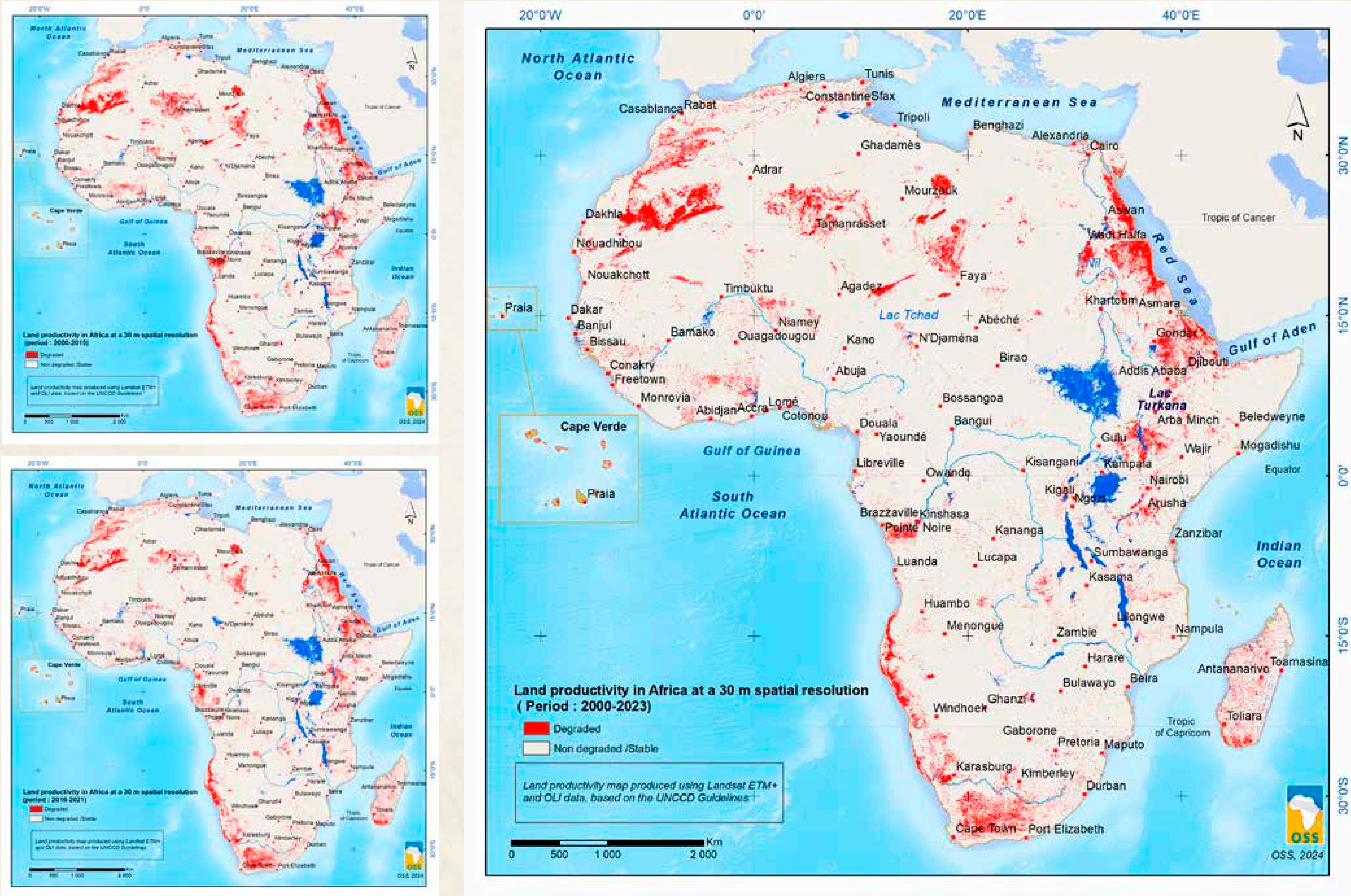


Figure 20: Maps of land productivity in Africa produced by the OSS using Landsat data (top left: reference period 2000-2015, bottom left: analysis period 2016-2021, right: period 2000-2023)

Agroforestry in the Lokossa region, Benin

Soil Organic Carbon (SOC)

Above and below ground carbon stocks provide an indication of the amount of carbon in living and decaying biomass above and below the ground, including soil organic carbon. These stocks are highly important to a wide range of ecosystem services and reflect land use and management practices.

Soil organic carbon is adopted as a reference measure (until it is replaced by the total carbon stock of the terrestrial ecosystem once the methodological approach is finalized and validated by the UNCCD). It is the main component of soil organic matter, highly impacts the physical, chemical and biological properties of the soil and plays a crucial role in improving soil fertility and water retention, in reducing land erosion and increasing crop productivity.

This indicator is calculated based on level 1 of the IPCC, which is also recommended by the UNCCD. The reference SOC stocks are estimated based on global assessments of default SOC stocks within the use of mineral and organic soils and land use change.

Thus, the SOC maps developed by the OSS (Fig. 21) use land cover changes based on the aforementioned maps as well as other factors such as climate change and land management to estimate carbon stock change for mineral soils, and emission factors for carbon losses for organic soils (due to drainage or fire).

It appears from the organic carbon stock change analysis that the identified hotspots are mainly linked to change in vegetation cover, in response to climate, land use or management. These factors influence SOC stocks by altering the rates, quality, and location of plant litter inputs to the soils, as well as the rates of output from the soils through microbial and physical decomposition (e.g., leaching).

Combination of the three sub-indicators

The three sub-indicators make it possible to assess the situation of land degradation or restoration, and thus reflect the key processes that underlie terrestrial natural capital.

Any significant reduction or negative change in any of the three sub-indicators is considered land degradation under the "all or nothing" rule. In other words, if any of the sub-indicators shows a significant reduction or negative change

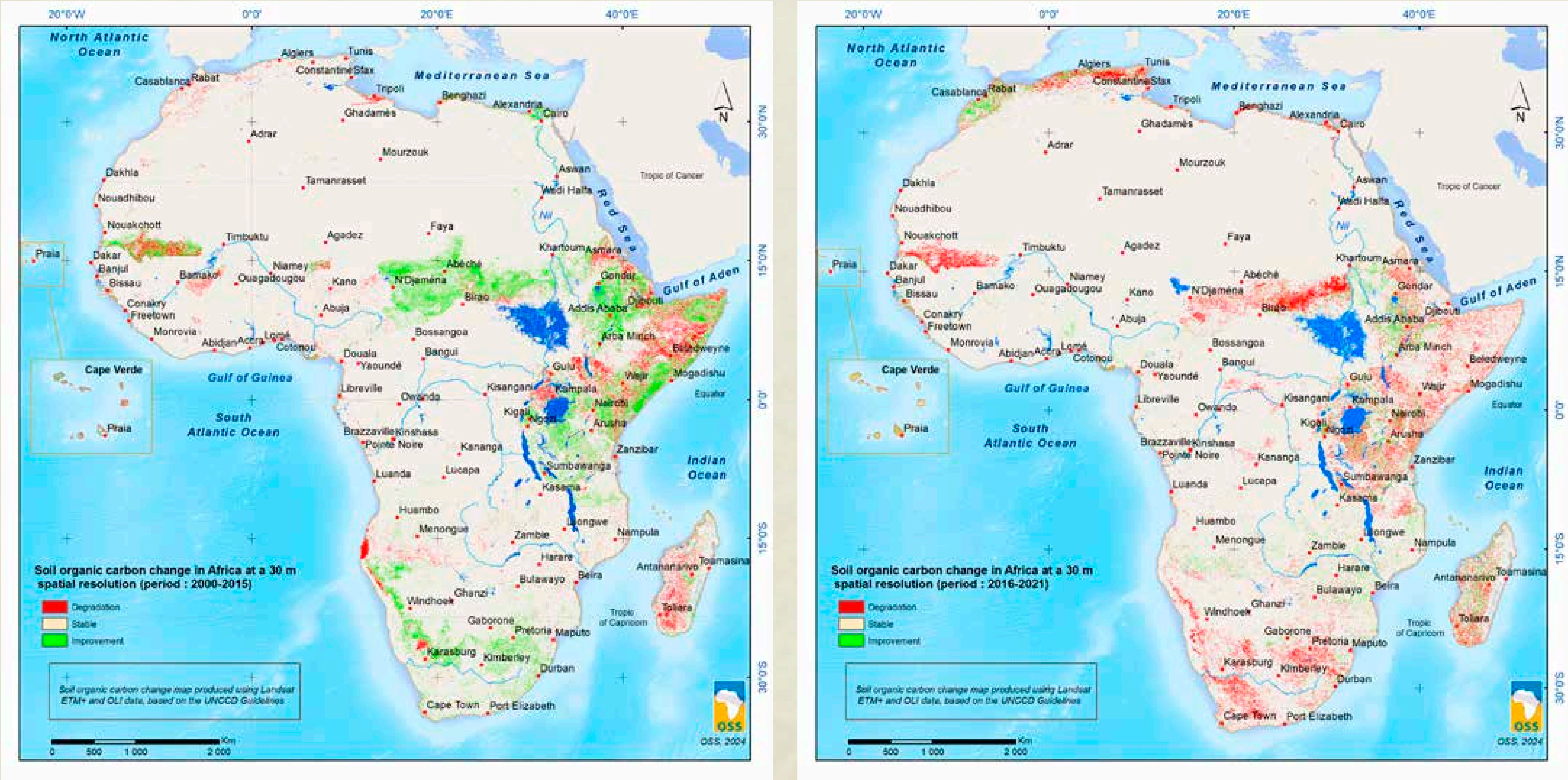


Figure 21: Soil organic carbon stocks maps produced by the OSS from Landsat data (on the left: SOC for the 2000-2015 reference period, on the right: SOC for the 2016-2021 period)

(or is stable when it was degraded in the previous reference or reporting period), the piece of land will be considered degraded subject to validation by the national authorities.

SDG indicator 15.3.1 is ultimately represented by a binary assessment, where a unit of land (pixel) is either degraded or non-degraded (Tab. 10).

Table 10: integration of the SDG 15.3.1 three sub-indicators

Land cover	Land productivity	Organic carbon in the soil	SDG indicator 15.3.1
Degraded	Degraded	Degraded	Degraded
Degraded	Degraded	Non-degraded	Degraded
Degraded	Non-degraded	Degraded	Degraded
Degraded	Non-degraded	Non-degraded	Degraded
Non-degraded	Degraded	Degraded	Degraded
Non-degraded	Degraded	Non-degraded	Degraded
Non-degraded	Non-degraded	Degraded	Degraded
Non-degraded	Non-degraded	Non-degraded	Non-degraded

The aggregation of the three sub-indicators produced by the OSS using the UNCCD guidelines and Landsat data at 30 m spatial resolution made it possible to produce the SDG indicator 15.3.1 map in Figure 22.

The proportion of degraded land over the total land area is produced by combining the three sub-indicators for 2000-2015 as the reference period and 2016-2021 as the reporting period.

Color red is used for degraded areas in 2016-2021 compared to the 2000-2015 reference state. According to the UNCCD guidelines, a pixel is considered "degraded" in a given reporting period compared to a given reference period if it represents either a decrease or a negative change.

As for the current exercise (Fig. 22), the significant extent of degraded areas must be considered taking into account the climate context of the reporting period. The period of study was marked by a particularly disadvantageous climate, with a considerable drop in rainfall and extreme weather events. Indeed, over the past five years, the increased frequency and intensity of droughts and storms have exacerbated soil deterioration, undermining conservation and restoration efforts of the terrestrial ecosystems. 2021 was one of the hottest years that Africa ever experienced. Sub-regions of the continent have all observed an increase in temperatures and North Africa recorded the most significant temperature disruption. In 2021, Africa also experienced 10 days of continental extreme heat, exacerbating land degradation, as reflected in SDG indicator 15.3.1 (IPCC, 2021).

Interpretation and General Summary

Whether caused by land overexploitation or mismanagement, overgrazing, deforestation or inefficient irrigation, land degradation is a complex issue that compromises people's livelihoods, hence the interest in having an accurate and clear image of its extent and severity, state and spatial-temporal evolution.

The assessment and quantification of land degradation are generally specific to the context. Therefore, it is difficult to report the state or condition of land based on one single indicator. Although the approaches, methods and tools for assessing land degradation and the data used are relatively different and no single approach is used to quantifying degraded areas and accurately reflecting their extents, the international community describes land degradation as an insidious scourge and calls for the implementation of immediate and concrete actions considering the lessons learned from past experiences.

Furthermore, although the land degradation monitoring indicator kit remains the conceptual framework for country reporting on SDG indicator 15.3.1, the quality of the data strongly influences the evaluation of the proportion

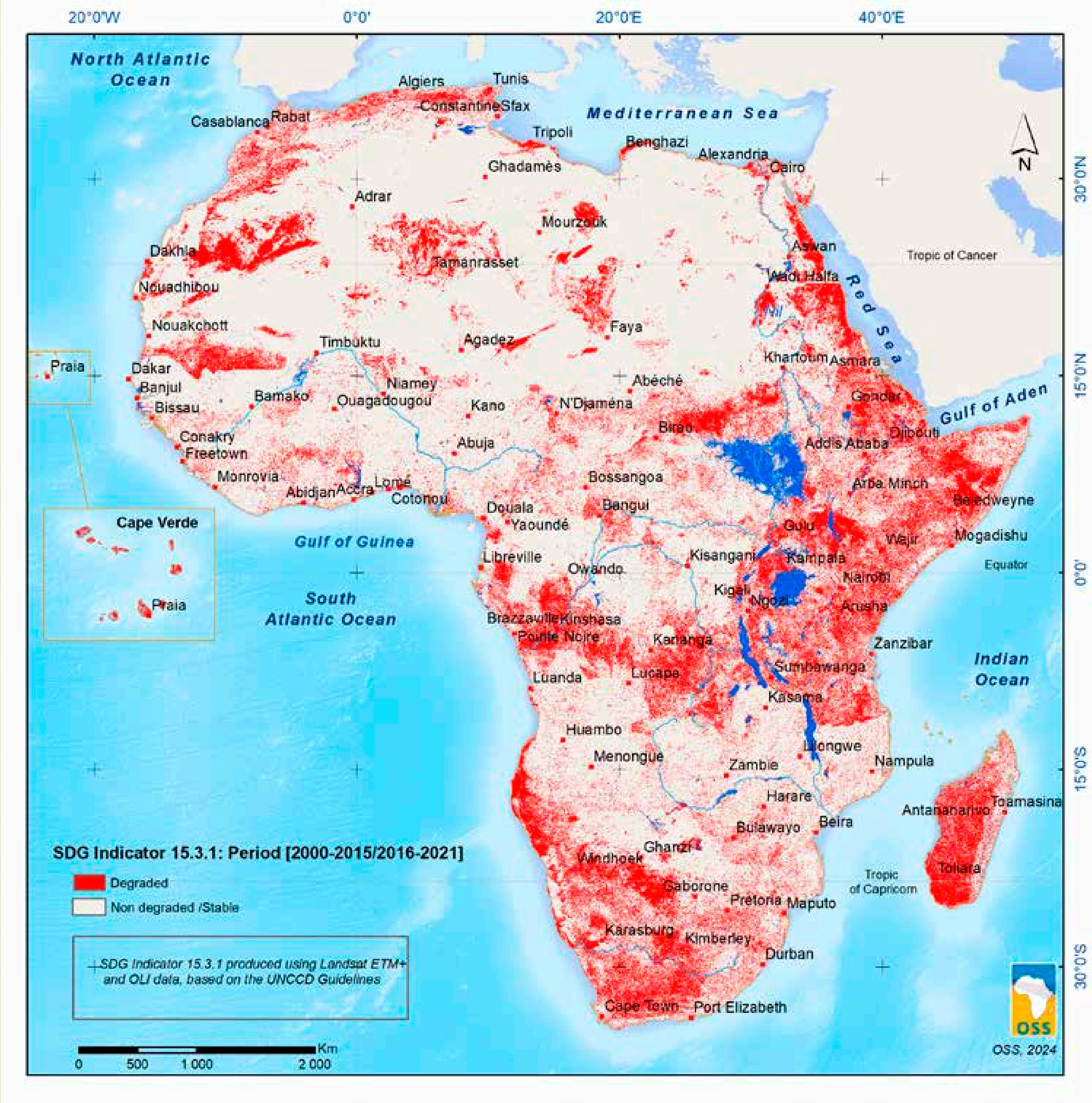


Figure 22: SDG indicator 15.3.1 estimated from Landsat data at 30 m spatial resolution

of degraded land over the total area. High spatial resolution is also required for monitoring an agricultural landscape characterized by fragmentation and multi-tower cultivation. Indeed, the land use change of small plots (1 to 5 ha), which are predominant in Africa, is not adequately identifiable on 300 m satellite data where representable unit area is 9 ha.

The assessment of productivity loss/gain trends is carried out through the combination of three sub-indicators (trend, state and performance) estimated from standardized vegetation indices used as a proxy instead of primary production. However, these indices have shown their limits of use in specific cases, such as areas of sparse vegetation or very low plant cover (arid zones). Furthermore, the Parties to the Convention stipulated that it was hard to validate land productivity gain/decline trend maps, to measure carbon and to validate derived carbon stocks.

Pending replacement of soil organic carbon stock with total Earth system carbon stocks once the methodology is operational, the change in carbon stock is mainly derived from the change in land cover, which implies that the quality of the land cover map used will influence its estimation.

In order to identify priority areas where restoration or awareness-raising actions should be carried out, decision-makers and natural resource managers must have full knowledge of the extent and severity of the degradation; yet, the SDG indicator 15.3.1 is binary (degraded/non-degraded).

Besides, Earth Observation data usually require field calibration and intrinsic validation in order to relate the thresholds used and the results of the different treatments to degradation/restoration. Some of the results are usually counter-intuitive, and this requires validation by experts considering the context of the area. For example, land restoration activities that aim at removing invasive weeds are reflected by a significant reduction in net primary production on satellite data and thus seen and interpreted as degradation. It goes the same way for invasive plants which are described by an increase in greenery and interpreted as land restoration.

Beyond the limits of land degradation monitoring approaches and indicators, the approach that involves Earth Observation data and techniques, local expertise, considering the specific context of the country and the cost of restoration and inaction, remains the most suitable solution for assessing the extent and severity of land degradation and the relevance and impact of sustainable land management measures and policies.

The development of the kit of indicators for monitoring land degradation in Africa must be a continuous process allowing it to be refined and updated through the use of more suitable indicators depending on the degradation and the specificities of the soil, vegetation and climate. Besides, additional relevant indicators such as erosion, areas affected by fires, etc. shall be studied.

In order to have an idea of land degradation in the different regions of Africa, this map gives the root causes in each region.

NORTH AFRICA

Arid, semi-arid and dry sub-humid zones

North Africa is facing climate change resulting in irregular rainfall and drought. The combination of forest fires, agricultural and urban expansion to the detriment of forests and protected areas, water and wind erosion with population growth putting additional pressure on natural resources, human practices and inappropriate agricultural techniques, represents the main causes of land degradation.

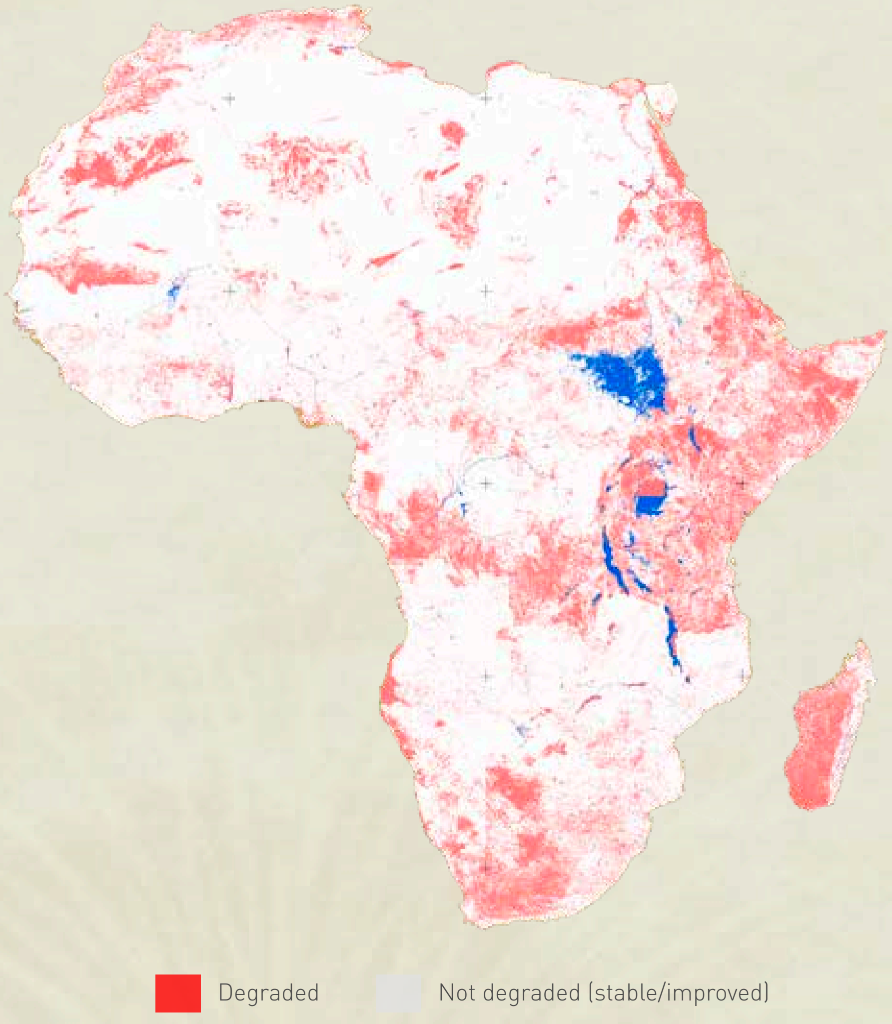
WEST AFRICA

Major river areas

Located in the area of major rivers, the Niger basin faces multiple threats of degradation from climate and anthropogenic origins. One of the major problems of the river is siltation caused, on the one hand, by water and wind erosion (the most frequent forms in the Sahel) and, on the other hand, by drought, desertification and pressure of man and livestock on the environment. Various regions of the area are facing desertification, aridity and heavy torrential rainfall causing erosion and threatening homes and arable land.

SOUTHERN AFRICA

Three major degradation problems are threatening Southern Africa's land: deforestation, invasive species and the encroachment of woody species (in savannahs, grasslands and woodlands). These issues are exacerbated by intersecting factors, namely climate change and anthropogenic activities such as charcoal wood production. South Africa, Angola and Namibia face the risk of sea level rise and coastal erosion.



EAST AFRICA

Horn of Africa

Two major factors are responsible for land degradation in the Horn of Africa: climate change, particularly drought, and human activities, conflicts and migration in particular, having led to changes in land use and coverage. Rapid population growth, which has more than doubled since the 1960s, has contributed significantly to this degradation through increased land clearance for agriculture and deforestation for construction and household energy needs. Additionally, the Horn of Africa is home to the world's largest pastoralist groups, which, combined with a growing population and livestock herd, and longer and more frequent droughts, has led to overgrazing and shortage of quality pastures.

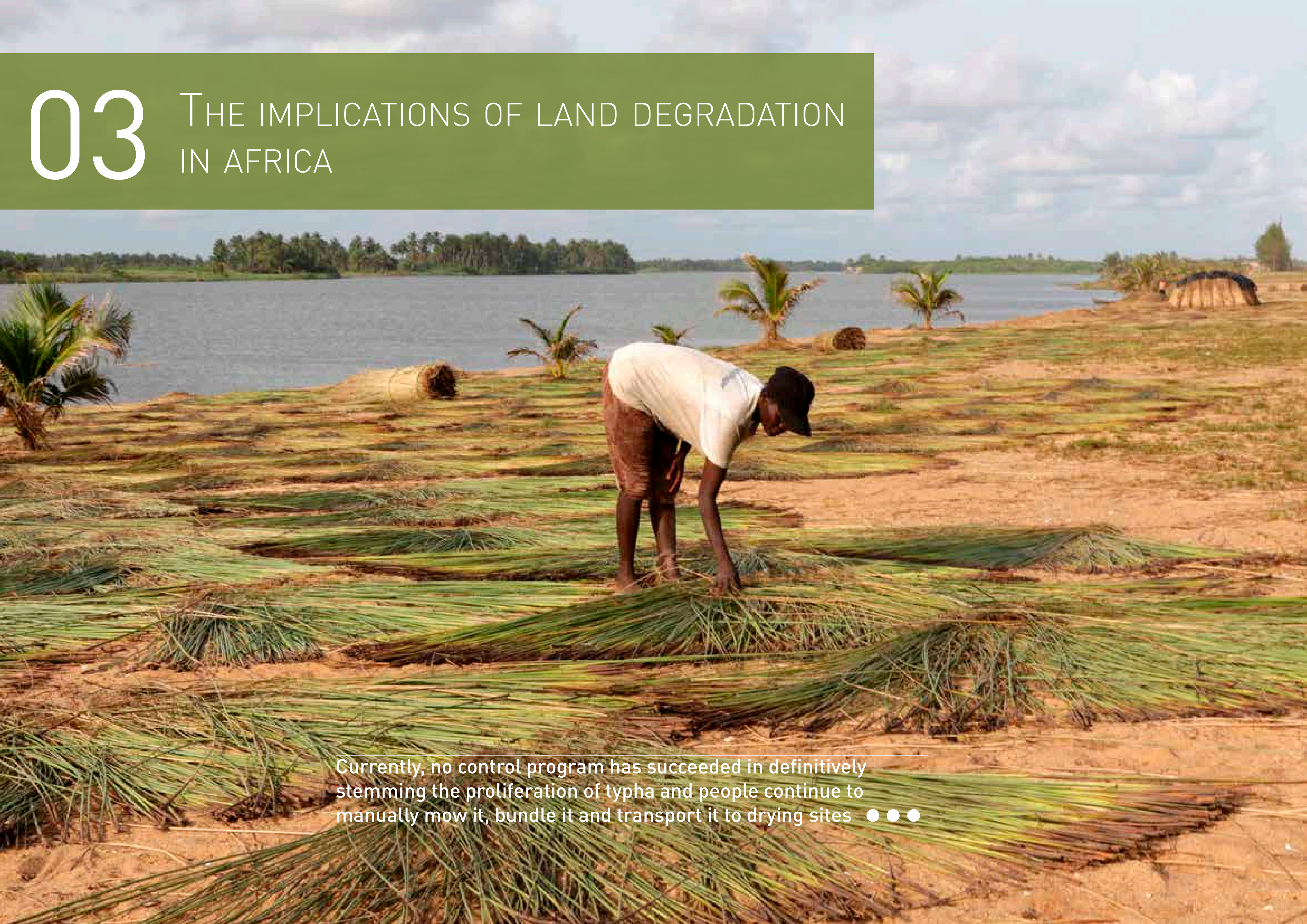
CENTRAL AFRICA

Congo Basin

The Congo Basin is famous with its tropical forests which are undergoing considerable degradation. The deforestation is the consequence of the expansion of subsistence activities (agriculture, charcoal production and the practice of burning) in the first place, followed by population growth and accelerated urbanization.

Mining is also a cause of deforestation in the Congo Basin region, which is home to considerable anthropogenic activities where arable land has replaced forests.

03 The implications of land degradation in Africa



Currently, no control program has succeeded in definitively stemming the proliferation of typha and people continue to manually mow it, bundle it and transport it to drying sites

This section explores the repercussions of land degradation on the well-being of Africans as well as its economic impacts and costs.

I- Implications on quality of life

Human activities are the main driver of land degradation, which goes well beyond simple environmental alteration. Land degradation impacts not only the food security of millions of people but also their health, livelihoods and well-being. This section analyzes the different aspects of this challenge for the future of the continent and its inhabitants, while examining its links with poverty and social instability.

I.1- Food insecurity

Changes in land use, deforestation and unsustainable agricultural practices are leading to reduced arable land and disrupted natural ecosystems, thereby putting food production at risk. Soil erosion and impoverishment reduce agricultural yields, particularly of local crops such as peanuts, while water pollution limits irrigation and alters crop quality. Local food systems, which are based on ancient knowledge and cultural practices adapted to the environment, are strongly affected by land degradation. The loss of heritage knowledge about wild edible plants, animals and specific agricultural techniques leads to a direct decline in the diversity, availability, accessibility and quality of food, with serious implications for the nutrition, health and well-being of affected communities.

Climate change also aggravates land degradation in Africa, especially during periods of prolonged drought in arid zones and forests where the risk of fire is greater.

Land degradation does not affect food security only, it also encompasses agricultural biodiversity, biocultural diversity and essential ecosystem services provided by land.

The repercussions strongly affect the quality of life of communities, endangering essential aspects such as their identity, autonomy, diversity and livelihood options. Indeed, the traditional knowledge of communities, their centuries-old ways of life and their spiritual links with the land end up eroded. The inability to access important sites for food rituals and cultural practices, as well as the replacement of their food resources and their know-how, uproots them from their cultural and identity foundations.

21 **Wild Edible Plants** (PSC) are one of the alternative sources, and play a crucial role in the food supply throughout the world and particularly in sub-Saharan Africa. They contribute to improving the health status of rural poor communities. In Ethiopia, they are used particularly during periods of drought, famine, or other forms of calamity and crisis. Rich in protein, vitamins B2 and C, wild edible plants have a high nutritional content and can be used as alternatives to conventional diets (Duguma, 2020).

I.2- Health risks

Land degradation is also a serious threat to public health. It creates fertile ground for diseases that threaten the lives and well-being of local populations, in the short and long term.

The conversion of forests into agricultural or mining land provides an environment that promotes the proliferation of Anopheles and Aedes mosquitoes, vectors of several serious diseases such as malaria and leishmaniasis. Large-scale projects, such as dams and irrigation, have certain economic benefits, but disrupt natural hydrological flows, favoring the spread of diseases harmful to populations living nearby, such as schistosomiasis (Patz & al., 2004).Furthermore, the spread of contagious diseases from animals to humans, facilitated by hunting and the bushmeat trade, is a complex phenomenon linking both changing land use practices and socio-economic development and the emergence of diseases. In the Congo Basin, for example, deforestation and intensive development are increasing human interactions with wildlife, increasing the risk of diseases such as Ebola and HIV/AIDS, conveyed by bushmeat (Rulli & al., 2017). Moreover, the trade of this meat in West Africa is ground for divide: some call for its ban to reduce health risks, while others emphasize its nutritional importance for disadvantaged populations.

22 Impacts of land degradation on freshwater ecosystem services

Land degradation in Africa has a profound impact on freshwater ecosystem services. Land use changes such as deforestation and drainage of wetlands have directly reduced the availability of freshwater resources, crucial to local communities. The reduction of natural forests, wetlands and riparian zones, which provide around 75% of the world's freshwater, in favor of agricultural land and pastures has significantly increased pressure on these resources. The conversion of wetlands to agricultural land has led to significant losses of biodiversity and affected ecosystem services, such as the availability of fish and other food sources.

Agricultural practices, leading to nutrient and sediment runoff, have caused eutrophication of inland and coastal waters, with adverse consequences for fisheries and recreational services.

Additionally, harmful algal blooms and coastal hypoxic zones, resulting from hydrological changes and pollution, have compromised water quality and limited its use for human consumption.

The degradation of freshwater ecosystem services jeopardizes food security, public health and local economies in Africa, and highlights the need for sustainable land management to preserve these vital resources

Human health is also seriously endangered by pollutants caused by land degradation. This process results in the release of nutrients and toxic products into waterways. For example, intensive mining activities generate runoff rich in heavy metals, and deforestation releases high levels of mercury into the soil. These harmful substances reduce agricultural yields, but also expose populations to serious risks of acute diseases and long-term neurological damage.

Furthermore, by eliminating natural ecosystems which play the role of filters, urbanization aggravates the contamination of water and air by various polluting substances, as evidenced by brown atmospheric clouds (Myers & al., 2009). By affecting ecological functions, namely bioremediation, i.e. the capacity of plants and natural microbes to eliminate toxins from waterways and soils, it seriously compromises the health and living conditions of the populations.

Land use changes can lead to the emergence of new health problems such as anthrax in African desert environments (IPBES, 2018). It is therefore becoming increasingly clear that the impact of these changes on health and disease often outweighs that of climate change in Africa.

The loss of biodiversity is one of the most impactful consequences of land degradation on human health. The decrease in the number of species fosters the spread of diseases, including zoonoses such as Hanta virus, Lyme disease and West Nile virus. This phenomenon is known as the "biodiversity dilution effect". This loss of biodiversity also has significant implications for local healthcare. Indeed, ecosystems provide essential resources such as medicinal plants, essential for traditional medicine but also a source of income, particularly for women. Additionally, the disappearance of plant biodiversity hotspots and species loss threatens future pharmaceutical discoveries. Assessing these losses, however, remains a complex challenge (McCallum, 2015), as affected local communities pay little attention to the cost of this loss of biological prospecting opportunities.

Finally, according to IPBES (2018), several studies have highlighted the complex links between the mental and physical health of individuals and their environment. Thus, by reducing the benefits of mental balance, attention, inspiration and healing, land degradation has the potential to significantly harm psychological well-being. This is particularly being felt among indigenous populations and communities living in rural areas, where social, cultural and traditional structures, as well as belief systems, are often intimately linked to specific environmental elements.

I.3- Aggravated poverty

Land degradation significantly worsens the poverty situation in developing countries. It especially affects the most vulnerable populations who largely depend on agriculture and livestock for their livelihood (Rojas-Downing & al., 2017). In regions where more than 70% of the population lives on fragile land, the rural impoverishment rate reaches 54.7%. This combination is particularly stressed in sub-Saharan Africa, where around half of the total population lives in drylands, and even 75% in some regions.

According to the UNCCD PRAIS 4 report, in Nigeria where more than 40.1% of the population lives below the international poverty line, approximately 23.41% of land was classified as degraded in 2019. The correlation between impoverishment and land degradation highlights the urgent need to adopt effective measures to halt this phenomenon and promote sustainable development.

The poverty-land degradation nexus poses challenges in regions where limited access to markets makes it difficult for small farmers to adopt more efficient land management practices. The livelihoods of poor agricultural households depend heavily on the quality of vegetation and soil fertility and are further weakened by periods of inactivity or seasonal underemployment imposed by work on degraded land. Studies on cassava cultivation, for example, highlight the significant impact of poor soil fertility management on the deterioration of economic conditions and living standards of farming communities (Alene & al., 2018).

A worrying and often underestimated reality, the link between land degradation and poverty arises from various complex factors, such as the level of deprivation, dysfunctional credit and labor markets (Fig. 23). In many regions, these two processes feed into each other, creating a vicious cycle of increasing difficulties (Varghese & Singh, 2016). Thus, the need to put an end to this cycle as soon as possible before it becomes irreversible.

Water pollution poses serious risks to the health of the populations

I.4- HUMAN INSTABILITY

Land degradation can have a significant impact on human security, especially in countries and regions characterized by high poverty and fragile institutions. It acts as a catalyst for violent conflicts, particularly in areas where weakened government mechanisms are unable to peacefully resolve disagreements over limited resources. Land degradation can lead to unwanted migration by limiting agricultural and pastoral productivity in areas of economic insecurity. These involuntary migrations depend on the complex relationships between land degradation, conflicts, social institutions and the capacity of societies to adapt to environmental and social challenges.

• *Conflicts*

Throughout human history, resource scarcity has been a major driver of national or international conflicts, often linked to territorial acquisition or control of natural resources. Recently, the growing risk of violent conflicts due to land and environmental degradation has become more worrying. Indeed, by restricting access to natural resources, land degradation places increased pressure on individual livelihoods and social systems. Worsening levels of poverty and discontent, or the resulting low resilience of social and political structures, can indirectly lead to conflicts.

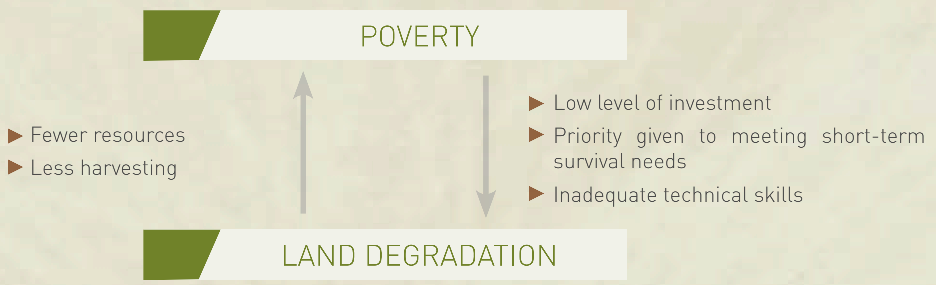


Figure 23: Interrelationship between Land Degradation and Poverty

Although the link between land degradation and increased conflicts is proven, it is less apparent than other factors, particularly poverty. Some researchers therefore recommend in-depth study of indirect causal pathways between land degradation and conflict, with particular emphasis on their impacts, on livelihoods and on institutions.

Data collected in sub-Saharan Africa between 1990 and 2008 showed that periods of extremely low rainfall stood behind a 45% increase of conflicts within the communities, namely: the pastoral communities in East Africa or in Mali, where tensions have emerged between nomadic herders and sedentary farmers.

• *Migration: degraded land, displaced people*

In rural areas, land degradation is often associated with high rates of migration, due to a lack of local economic opportunities. An Intergovernmental Panel on Climate Change (IPCC) report on the human security implications of climate change (Adger & al., 2014) presented ten cases, primarily in Africa, where migration rates have increased due to environmental changes responsible for a decrease in agricultural or pastoral productivity. Two cases related to international migration and eight concerned the internal migration of individuals seeking new land in rural areas or opportunities for paid work. Agricultural exploitation by internal migrants settling in new territories can also contribute to perpetuating and accelerating land degradation.

In Egypt, 70% of internal migrants interviewed as part of the "Where the Rain Falls" project in the Nile Delta and Old Cairo mentioned both land degradation and shortages of water as causes of their migration decision (Warner & Afifi, 2014). Similarly, in the Middle Draa Valley of Morocco, a household survey found that land degradation was a major factor in migration decisions and intentions (Ait Hamza & al., 2009). These examples illustrate how land degradation and drought have a significant impact on migration, particularly in the context of climate change. According to some estimates, by 2050 the combined impact of land degradation and climate change could result in the migration of 50 to 700 million people (Warner & al., 2009).

II- Economic repercussions

Economic repercussions are often underestimated in a context mainly focused on the study of the land degradation biophysical impacts. However, the economic assessment of this issue is essential to fully understand its scale and scope, and evaluate the importance and need to act against this phenomenon (ELD Initiative & UNEP, 2015).

By examining the land degradation costs, this part considers the specificities of Africa. It distinguishes between direct and indirect costs, as well as the methods used to estimate these impacts. Additionally, Africa-specific case studies are presented to illustrate the benefits of adopting sustainable land management (SLM) measures and highlight the economic cost of inaction.

In order to explain the economic aspects of land degradation, this part draws on the data and analyzes presented in "Economics of Land Degradation and Improvement – A Global Assessment for Sustainable Development" (Nkonya & Mirzabaev, 2016) and on the Economics of Land Degradation (ELD) Initiative reports.

II.1- Direct and indirect costs

The economic consequences of land degradation in Africa extend to different levels and directly or indirectly affect a diversity of actors. They impact both producers and consumers, on the microeconomic scale, and the creation of wealth, the employment rate and the trade balance, on the macroeconomic scale.

An olive grove replaced by an urban extension

Immediate direct costs are generally perceptible at the local level, affecting the livelihoods of agricultural populations and natural resources. The loss of soil fertility leads to a significant decrease in crop yields, which directly affects food production and the income of farmers and rural workers. This drop of income significantly reduces the ability of farms to generate stable and sufficient income, compounding the costs associated with land degradation

At the same time, the impacts of this deterioration on human health in Africa lead to a significant increase in healthcare costs, such as the treatment of malnutrition or water-borne diseases. By placing additional financial pressure on households and local health systems, these direct costs have considerable implications for the social and economic well-being of affected communities.

Furthermore, the indirect consequences of land degradation occur at several regional and national scales, through various macroeconomic mechanisms. Decreased agricultural productivity and disruptions in supply chains lead to a reduction in gross domestic product (GDP) and negatively affect employment rates, particularly in industries affiliated with agriculture and natural resources. In addition, this phenomenon causes migratory movements and increase dependence on imports, thus disrupting the trade balance and putting pressure on government expenditures.

Furthermore, the reduction in the recreational value of ecosystems following land degradation has indirect impacts on the economy in Africa, namely: natural tourist sites such as national parks and conservation areas are no longer as attractive as they used to be, particularly in African countries that rely heavily on tourism.

Market gardening, Ghar el Melh, Tunisia

However, estimating these costs faces several challenges due to the lack of data on the biophysical components and pricing of environmental products (Low, 2013). Economic evaluations are certainly useful as governance tools and have marked the major events of the UNCCD by making links with the SDGs in particular. However, they can be excluding due to methodological limitations (hidden values, hidden costs), the evaluation scales used, the actors involved as well as the socio-economic context at the time they were carried out. This highlights the possible disjunction between study scales, which may limit the scope and inclusiveness of the results obtained.

II.2- Cost assessment methodological approaches

Globally speaking, land degradation affects nearly three billion people in affected areas, generating an estimated annual cost of around 300 billion USD. About 78% of this amount is attributable to direct land users, resulting from land use changes and inappropriate management practices on croplands and pastures. Analysis of the cost according to the type of ecosystem services shows that 54% of this cost is due to losses of regulatory, support and cultural services (Nkonya & Mirzabaev, 2016).

The international community needs evidence to act against land degradation and its impacts on human well-being. Research is thus increasingly focused on the development of analytical approaches and the generation of data to regularly assess the costs of land degradation and improvement at local, regional and national levels.

Methodological approaches adopted in the literature are often guided by the emphasis on action and by definitions of land and its degradation. According to the 2005 Millennium Ecosystem Assessment (MEA), land deterioration is a long-term decline in terrestrial ecosystem goods and services, both on-site and off-site. The use of this definition leads to the adoption of a global approach which considers both the direct and indirect benefits, locally and beyond, in the short and long term, of sustainable land management compared to land deterioration related expenses.

On the other hand, it is important to note that losses caused by land degradation are not limited only to environmental deterioration measured directly on the ground, such as nutrient depletion. They also include the costs of indirect and external environmental impacts, such as sedimentation of water bodies, water pollution and reduction of biodiversity. Additionally, several studies have highlighted the importance of not double-counting these ecosystem benefits (Barbier, 2011). For example, it would be possible to consider processes, such as water purification, and the resulting benefits, such as purified drinking water, separately by giving them distinct values. Thus, to avoid double counting, we can value drinking water of different qualities, without including the water purification process (Nkonya & Mirzabaev, 2016).

However, many services provided by ecosystems are not traded in markets. Thus, actors have no incentive to pay for positive or negative effects on these ecosystems. The inconsideration of externalities may be overlooked by farmers when making land use decisions, leading to an undervaluation of their value and contribution to ecosystem services. According to Barbier (2011), it could be advisable to consider ecosystem services as being integrated into natural capital. Failure to consider these values for terrestrial ecosystems leads to an underestimate of the impact of higher rates of land degradation. There are different approaches to valuing ecosystem services (Nkonya & al., 2011), but assigning economic values can be complex due to many uncertainties and real-world measurement constraints. Thus, according to (Daily & al., 2000), the assessment of natural capital should follow three steps: (i) The analysis of alternatives, such as the degradation of soil ecosystem services in relation to their sustainable management, (ii) The assessment and identification of the costs and benefits for each option, and (iii) The comparison of the costs and benefits of each option, including their long-term consequences. However, it is difficult to identify and aggregate individual preferences and values associated with ecosystem services, including over time, for each alternative option. The economic values of ecosystem services are closely linked to the number of human beneficiaries as well as the socio-economic context, which means that these services are influenced by local or regional specificities. Such a reliance contributes to fluctuated values of these services (TEEB, 2010).

It is plain to see that the conceptual framework for economically assessing land degradation and rehabilitation should not be limited only to degradation costs that are more easily measurable on-site and off-site. Such an approach disregards the relationship of ecosystems and might underestimate the costs of land degradation and the benefits of appropriate measures to fight it.

Furthermore, the Total Economic Value (TEV) approach, supported by the Land Valuation Initiative (LDI), is currently the most widely used holistic method for assessing the cost of land degradation. This approach aims to simplify the economic analyzes linked to these phenomena by considering the different forms of degradation present in six distinct biomes, excluding coastal biomes and aquatic wetlands. The selected studies are based on field data, specifying the reference period and the value per hectare. The biomes selected in descending order of TEV are forest (tropical, temperate), grasslands, scrubland, wooded areas, cropland and bare land.

However, it is important to note that despite the holistic aspect of the study, it does not address specific forms of degradation, such as fertilizer overapplication and wetland degradation, due to data limitations. In addition, indirect impacts, such as fluctuations in land prices or migration, are not considered. These omissions are deliberate to simplify study management. Thus, further research might be necessary to obtain a complete perspective.

It is therefore essential that the conceptual framework considers all losses caused by land degradation, thereby providing guidance and a basis for a comprehensive assessment.

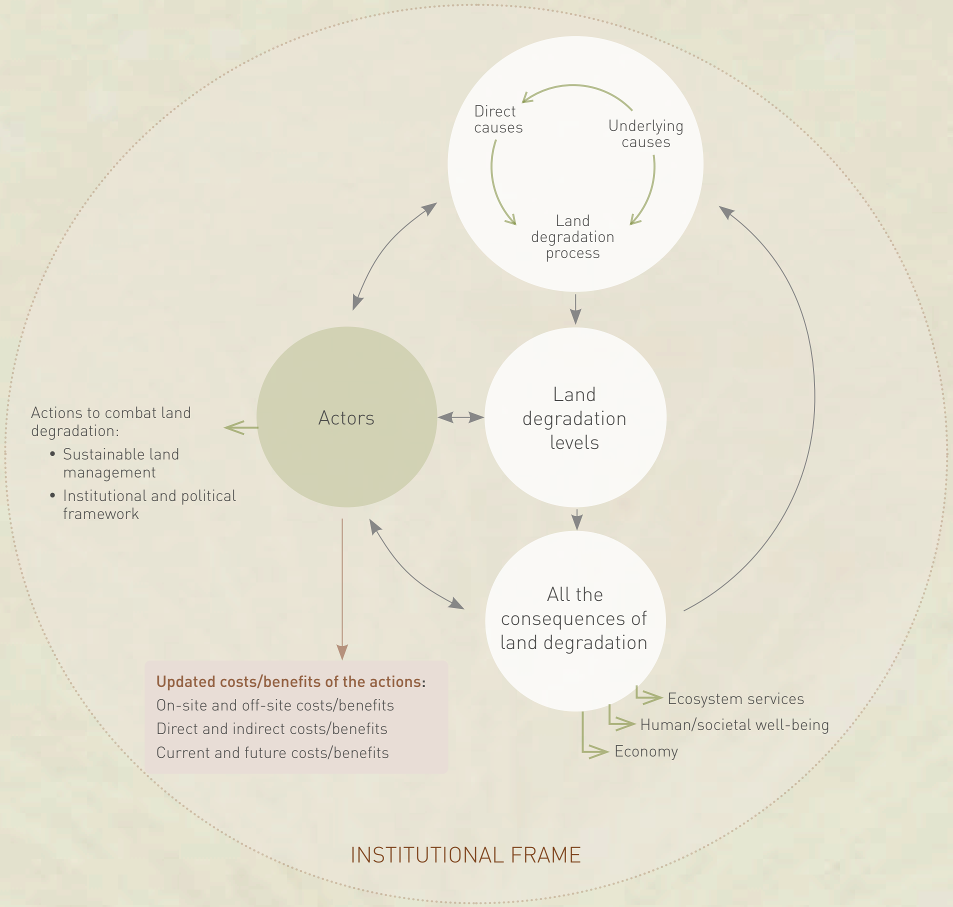


Figure 24: Conceptual framework (figure adapted from Nkonya & al., 2016)

As shown in Figure 24, the IFRI (2016) study suggests that a conceptual framework must first categorize the causes of land degradation into proximal and underlying causes, which interact to result in a different levels degradation. Proximal causes act directly on the terrestrial ecosystem, subdividing into biophysical (natural) causes and unsustainable (anthropogenic) land management practices. The underlying causes indirectly influence the proximal causes, including institutional, socio-economic and political factors. For example, poverty can lead to a lack of investment in sustainable land management practices, thereby resulting in degradation. It is necessary to have a thorough understanding of these causes and their interactions, as well as the socio-economic context of the area to identify effective actions against land degradation, which is complex in the African context. The economic risks are worrying, especially with almost 80% of the population living on less than $11 per day (AFD, 2024). Thirty of the forty most agriculture-dependent economies are in Africa, and more than 750 million people live in unsustainable ecozones, including 157 million in highly degraded areas.

Thus, the end goal of a conceptual framework is primarily to compare the costs and benefits of action against land degradation versus the costs of inaction. The main goal is to assess the impacts of land degradation on ecosystem services and benefits for populations. For this to happen, different methods are used to measure the flow and stock of ecosystem services on-site and off-site. For example, a study was carried out in Burkina Faso, a region where anti-erosion or agroecological developments such as stone cordons, zaï, half-moons, gabions, etc., are implemented. The purpose was to assess the value of the non-market services offered by these infrastructures according to producers. The outcomes of this study are presented in Table 11. Firstly, it reveals that the absence of agroecological infrastructure (business as usual) leads to a considerable loss of utility per hectare for producers, estimated at nearly a year of local minimum income. Collaboration with local producers made it possible to evaluate each priority non-market service in terms of price per hectare based on their perceptions. The non-market supply services of water, additional straw for the animals, trees (for biodiversity) and gain in local solidarity (mutual aid is necessary to maintain these infrastructures) were estimated at 110,000 FCFA (approximately 160 euros) per hectare per year, or more than three months of minimum wage in Burkina Faso in 2020, where the monthly minimum wage amounts to 33,130 FCFA.

Agricultural water body developed by the villagers of Koankin, Burkina Faso

Table 11: Methods for putting a value to land degradation effects (adapted from Traoré & Requiers-Desjardins, 2019)

Service	Calculation method	Value in FCFA/year/ha
Harvest gain	Cost-benefit analysis on a representative sample Cost-benefit analysis (CBA)	52,250 (1)
Straw gain	Method of experimental choices Assessment of producers' willingness to pay (WTP) on a reporting basis	27,400
Water	Method of experimental choices Assessment of producers' willingness to pay (WTP) on a reporting basis	36,100
Biodiversity	Method of experimental choices Assessment of producers' willingness to pay (WTP) on a reporting basis	16,800
Mutual aid	Method of experimental choices Assessment of producers' willingness to pay (WTP) on a reporting basis	29,700
Total		162,250
Situation without development *(business as usual)*		-330,303

*(1) This amount was calculated by multiplying the surplus by the average price of cereals in 2018 (250*209-52250)*

Figure 25 presents a conceptual framework used in the "The economics of land degradation in Africa" report, published in October 2015 by the ELD initiative in collaboration with UNEP. This framework includes three components: i) econometric and biophysical modeling to establish soil nutrient balances and losses of ecosystem services, ii) an assessment of the costs of inaction and action measures, and iii) policy recommendations.

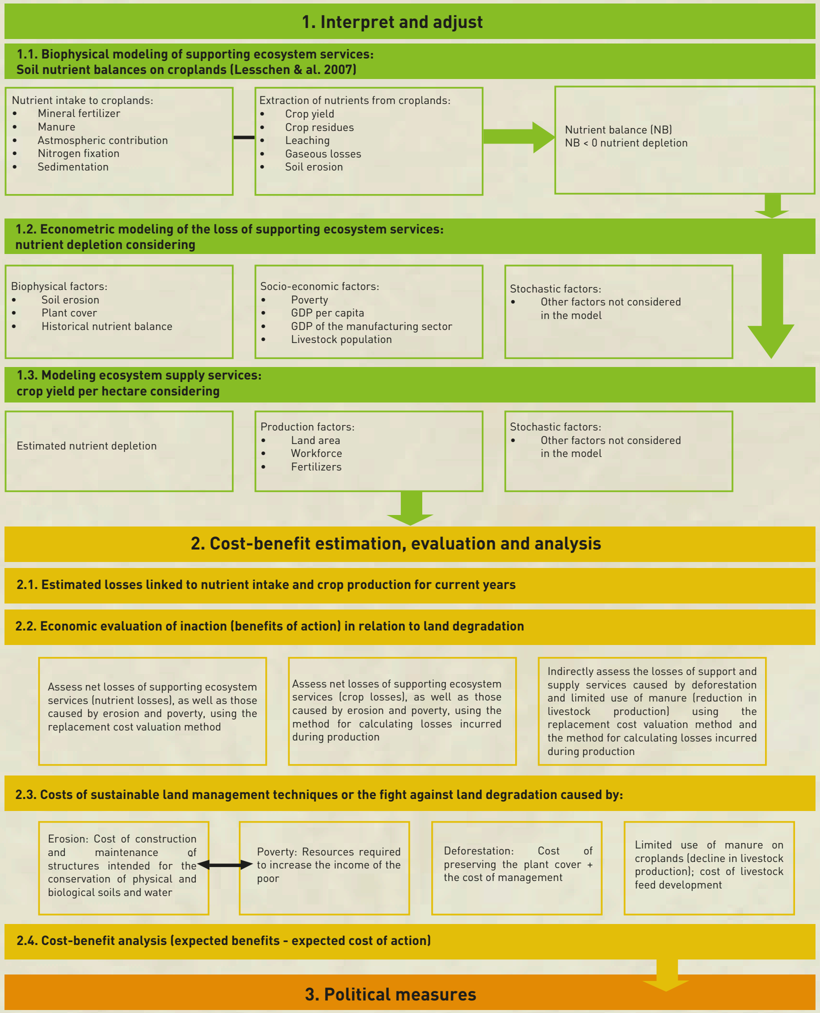


Figure 25: Conceptual frame (ELD, 2015)

II.3- Cost of inaction

Even if land restoration represents a costly challenge for African States and even if remediation costs fluctuate depending on the level of degradation, the economic damage will be greater if no degraded land rehabilitation effort is made. Investments needed to regenerate ecosystems and promote sustainable agricultural practices can place a heavy burden on national budgets, limiting the resources allocated to other development priorities.

Faced with this dilemma between rehabilitation costs and degradation losses, a crucial question arises: is inaction more expensive than action? In other words, what are the benefits that states can reap from land restoration despite the costs involved? The year 1992 brought the answer to this question. At the Rio summit, the first global economic assessment of desertification clearly demonstrated that the costs of inaction far outweigh those of action. This assessment quantified land degradation monetary losses, especially for agricultural activities, estimating annual losses at 42 billion USD (at 1990 exchange rates). This highlights the importance of the economic valuation of natural capital to guide decisions towards sustainability (Bonnet & al., 2024).

As for Africa, the available literature already provides answers to this question, highlighting the numerous advantages of action, particularly highlighted by the study of the ELD initiative.

- The costs of inaction due to nutrient depletion caused by erosion amounted to 95 billion USD in PPP per year for 2002-2004 and 279 billion USD in PPP per year for 2010-2014. For nutrient depletion caused by poverty, the costs were 18 billion USD in PPP and 33 billion USD in PPP for the same periods. The latter occurs when farmers cannot buy enough fertilizers or adopt sustainable agricultural practices due to lack of financial means. This leads to excessive land use without sufficient nutrient supply, thereby depleting soil fertility. These particularly high costs of inaction for the period 2010-2014 compared to 2002-2004 are mainly explained by the increase in global food prices after the 2008 financial and economic crises, leading to what has been called "land confiscation in Africa". Over a 15-year period, a net current benefit of approximately 2.83 trillion USD in Purchasing Power Parity (PPP) would be generated by applying measures against erosion-induced nutrient depletion. This would call the 42 African countries covered by the ELD-initiative study (2015) to invest in sustainable soil management.

- 6.58 would be the average cost-benefit ratio of action to counter erosion-induced nutrient depletion, which means that every dollar invested, would reap approximately 6.58 dollars. Over the period 2016-2030, a benefit of around 440 billion USD in PPP (present value) could be generated from actions against poverty-induced nutrient depletion (ELD-initiative, 2015). For this benefit to be achieved, it is necessary for the 42 African countries covered by the ELD-initiative study (2015) to reduce their poverty gap to zero by 2030. Thus, an average of 6.67% of people would escape poverty each year, and reach the income threshold considered to be the poverty line.
- In the "do nothing" scenario in Ethiopia, production potential would decrease by 10% in 2010 and by 30% in 2030. Agricultural added value per person would fall from $372 in 2000 to $162 in 2030, while the food availability decreases from 1,971 calories per day to 685 calories per day in 2030. This scenario is described as a "disaster". The other scenarios are based on non-agricultural income and preservation and infrastructure measures (Mélanie Requier-Desjardins, 2009).

Fencing, a management and conservation technique, El Mahbess, Tunisia

23 **Case study: Tanzania and Malawi**

A study conducted by Mulinge & al. (2016) examined the causes, extent and impacts of land degradation in Tanzania and Malawi. This degradation constitutes a major obstacle to improving rural living conditions in these countries, where 51% of Tanzanian territory and 41% of Malawian territory are identified as critical areas of degradation. According to the total economic value (TEV) approach, the annual costs of this degradation amount to approximately 244 million USD in Malawi and 2.3 billion USD in Tanzania over the period 2001-2009, representing respectively 6. 8% and 13.7% of the GDP of the two countries. Additionally, degrading agricultural practices have led to significant economic losses. However, to mitigate land degradation and preserve ecosystem services, communities are adopting different measures, such as reforestation and integrated soil fertility management. Investments in degraded land restoration provide a considerable return on investment, with 4.3 dollars for every dollar spent in Malawi and 3.8 dollars in Tanzania.

24 Case study: Tunisia

A comparative economic evaluation between sustainable land management by 2050 and the cost of inaction was initiated by the ELD, as part of the "Protection and Rehabilitation of Degraded Soils (ProSol) Tunisia" project. Its objective was to demonstrate the socio-economic impact of land degradation and the costs of inaction, and to highlight the economic net benefit and return on investment of a sustainable land management approach.

According to this study, investing public resources in improving the resilience of rainfed agriculture in the governorates of Béja, Siliana, Kairouan and Kasserine would generate benefits far greater than the amounts allocated. Net present value was calculated using discount rates of 7% and 15% to reflect social preferences and market interest rates. The outcomes were benefit-cost ratios of 14 and 12. Each TND invested would reap more than 10 of benefits to the State, agricultural producers and society as a whole.

Around 50% of the benefits would benefit to the State in terms of public finances, making it possible to recover 5 TND invested thanks to the reduction in the importation of cereals and the increase in the useful life of the dams. Agricultural producers would earn more than 40% of the profits, thereby contributing to the government's food security and social development objectives. Finally, approximately 5% of the benefits would be associated with carbon sequestration, thereby supporting the national carbon neutrality initiative.

Durum wheat harvest, Kairouan, Tunisia

	Discount rate 7 % (TND)	Discount rate 15 % (TND)
Olive growing productivity	1,001,798,794	382,563,095
Cereal productivity	7,220,446	3,200,643
Erosion control by loss of soil cereal production	1,072,639,502	689,248,059
Erosion control by loss of soil olive production	211,818,899	58,057,539
Carbon storage	97,264,189	14,920,636
Sedimentation Control	5,281,408	810,185
Total updated profits	2,396,023,238	1,148,800,157
Cost premium price Olives	8,385	5,639
Cost premium price Cereals	399	234
Cost of compensatory mechanism for ecological transition	72,492,261	43,054,865
Cost of capital investment aid for farms < 20 ha	90,615,326	53,818,581
Cost of installing CES (tabias and benches)	3,177,806	487,486
Reforestation/rehabilitation (800 TND/ha; 266USD/ha Objective: 40,000	5,510,256	845,291
Total present value of implementation costs	171,804,433	98,212,095
Benefit/Cost Ratio	13.95	11.7

Cost-benefit analysis of a sustainable land management approach

25 **Case study: Niger**

The natural resources management policies implemented in Niger, whether during the colonial period or after its independence, have largely contributed to land degradation. The country experienced prolonged drought episodes that exacerbated the misery of the populations who heavily relied on natural resources. Nevertheless, Niger has learned lessons from its past and came up with new policies and strategies. A study by Moussa and colleagues (2016) found a significant correlation between these policy developments and improved human well-being, demonstrating the potential for low-income countries to achieve sustainable development. Improving government efficiency, namely by giving local communities the responsibility of managing natural resources, while encouraging land users to invest and benefit from their resources. The analytical approach adopted by the Moussa & al. study focuses on estimating the cost of land degradation, ground verification of satellite data, and drivers for the adoption of sustainable land management practices. Analysis of land use/land cover change shows that 6.12 million hectares experienced changes, with the greatest ones observed in shrublands and grasslands. Excluding the desert, 19% of Nigerien territory has undergone changes. Agricultural land expansion accounts for about 57% of deforestation, followed by grassland expansion. Due to these changes, the cost of land degradation in Niger amounted to approximately 0.75 billion USD in 2007, or 11% of that year's GDP and 1% of the value of ecosystem services in 2001. Each dollar invested in corrective measures generates six dollars, pretty attractive isn't it? Field data confirmed a significant correlation between satellite observations indicating land degradation and their condition as perceived by the communities. However, in areas where satellite data indicated land improvement, the correlation with local perceptions was yet to prove.

Farmer weeding his lettuce plot, Niger

26

Case study: Namibia

As part of a bilateral cooperation between Namibia and Germany, a national program to combat bushes and to use biomass, called the Bush Clearing Support Project, has been set up. This project, aligned with the Economic Land Degradation (ELD) Initiative, is led by the Namibia Nature Foundation, which conducted two studies for the assessment of the potential economic benefits of bush thinning programs at national and regional levels. These studies assessed key ecosystem services threatened by shrub encroachment, as well as options for using harvested biomass. Using a cost-benefit model, the researchers estimated the possible aggregate net benefits of brush control compared to an inaction scenario. The national study covered aspects such as groundwater recharge, carrying capacity of grazing land, carbon sequestration and biomass use. The regional study additionally included the production of animal feed and the generation of thermal energy for industrial use. The results showed an estimated potential net profit of almost N$48 billion (approximately 3.8 billion USD) over 25 years, which is approximately N$2 billion (approximately 0.2 billion USD) per year.

Young farmers in Kavango region, Namibia

04 Sustainable land management in Africa to fight against land degradation

Thanks to their ancestral know-how, local populations were able to make the best of Typha. They used it in housing, the development of fishing equipment and the manufacture of handicraft products ●●●

Land degradation hugely impacts the quality of the populations life and is extremely expensive on African economies, thus the importance and the need to confront it. According to the UNCCD, the fight against land degradation refers to activities which fall within the integrated development of land, with a view to sustainable development and which aim to (i) prevent and/or reduce land degradation, (ii) rehabilitate partially degraded land and (iii) restore degraded land. In this fight, sustainable land management (SLM) is emerging as a major solution to reverse land degradation trends. It is today a priority for many governments, international organizations, civil society actors, etc. SLM does not refer to a single method, but rather encompasses a set of methods, strategies and practices adopting integrated, sustainable and participatory approaches.

This part gives pride of place to SLM, including integrated water resources management, which represents a broad concept for avoiding, reducing and/or reversing land degradation (Critchley & al., 2021; Sanz & al., 2017). The definition of SLM includes the restoration of degraded land for degradation reversing.

These key concepts are promoted by the UNCCD and other institutions and initiatives with a view to achieving LDN and thus contribute to all commitments made by the countries.

I- Sustainable land management: explaining the rules

I.1- Basic principles of sustainable land management: a global approach against degradation

SLM is the cure to land degradation and the way to achieve LDN. It could also be the most powerful tool available to achieve the goals of the United Nations Decade on Ecosystem Restoration (UNDER). It is a set of possible SLM practices, technologies and approaches.

The use and scaling of SLM practices in Africa are approaches intended to maintain and improve livelihoods while protecting land resources and ecosystem functions[1]. In addition, SLM can simultaneously generate various associated benefits, in particular the mitigation of climate change (accumulation of materials, organization in the soil and vegetation) and adaptation to it (systems that absorb variability and shocks), resilience and reduction of disaster risks, improved hydrological land function, restoration of biodiversity and increased production (Critchley & al., 2021). Indeed, many SLM practices make it possible to jointly address the causes and consequences of land degradation, desertification and climate change (Sanz & al., 2017).

SLM practices encompass structural measures such as cross barriers, agronomic solutions including soil mulching, plant interventions such as agroforestry and management strategies for grazing and peatland protection. An SLM practice includes an SLM technology and an SLM approach.

The UNCCD Science-Policy Interface report on Sustainable Land Management undertook a review of SLM initiatives, databases and literature (scientific journal articles, research papers, etc.) and has identified more than a hundred individual SLM technologies as well as fourteen global groups of SLM technologies around the world. Specifically, these SLM technology groups were identified based on existing initiatives and databases, namely WOCAT, TerraAfrica, World Bank SLM Source Book, Climate Smart Agriculture FAO, IPCC Assessment Reports, with a wealth of information on how to apply and adapt technologies to meet different needs (Sanz & al., 2017).

27 **SLM technology:** physical land management practice that controls land degradation and improves land productivity and/or other ecosystem services (https://qcat.wocat.net/en/wocat/). A technology consists of one or more measures, such as agronomic, vegetative (biological), structural and management measures (WOCAT, 2016).

SLM approach: defines the ways and means employed to promote and implement one or more SLM technologies, including technical and material support, participation and the role of stakeholders (https://qcat.wocat.net/en/wocat/). An approach can refer to a project/program or to activities initiated by the land users themselves.

1 https://www.eld-initiative.org/en/what-we-do/sustainable-land-management/highlights-of-sustainable-land-management-in-africa/

SLM technology groups [According to the UNCCD Sustainable Land Management Report - Science-Policy Interface (Sanz & al., 2017)] :

1. Integrated soil fertility management
2. Minimal soil disturbance
3. Pest and disease control
4. Soil Erosion Control
5. Vegetation management
6. Water management
7. Reduction of deforestation
8. Afforestation and reforestation
9. Sustainable forest management
10. Forest restoration
11. Management of grazing pressure
12. Animal waste management
13. Agroforestry

SLM technologies illustrate the potential to avoid, reduce and/or to reverse land degradation and desertification for particular land use types. The IPCC has identified many technology clusters as important options for climate change adaptation and mitigation (Sanz & al., 2017). It should be noted that while some SLM practices may specifically target one of the three categories of the "hierarchy of responses": avoid, reduce and reverse, many practices are relevant to two or even all three (Critchley & al., 2021).

The World Overview of Conservation Approaches and Technologies (WOCAT) is the global reference database on SLM. This source of documentation is constantly evolving and its quality is controlled. WOCAT identifies 26 different groups of SLM technologies[2] and 3 groups of SLM approaches including traditional/indigenous approaches, recent local initiatives and projects/programs. As for the African continent, WOCAT describes more than 700 SLM practices in approximately 30 countries in a standardized and consistent manner. The platform also identifies socio-economic and environmental benefits. Many tested and proven best practices are available and ready to be scaled up (Critchley & al., 2021). As part of its mission, WOCAT supports evidence-based decision-making and influences policymaking at different levels aimed at promoting the expansion and intensification of implementation of good SLM practices. It thus contributes to global efforts to prevent, stop and reverse land degradation (Cherlet & al., 2018).

A summary of the SLM technology groups practiced in Africa is presented in Table 12. Proposed by the OSS after having consulted documents produced by institutions such as the UNCCD, WOCAT and FAO, it summarizes the groups of technologies the most significant and most adapted to the needs of Africa.

2 See explanation of the 26 technologies in "Questionnaire on SLM technologies". https://www.wocat.net/library/media/15/

Table 12: General information on the main SLM technology groups in Africa (Liniger & al., 2011 ; Sanz & al., 2017)

Main SLM technology groups	Definition and principles	Applicability
Integrated Soil Fertility Management (ISFM)	ISFM aims to manage soils by combining different methods of amendment and conservation of water and soil (CWS). It is based on the following 3 principles: (1) maximizing the use of different organic sources of fertilizer; (2) minimizing nutrient losses; (3) optimizing the use of mineral fertilizers according to the needs and economic availability.	ISFM is necessary in areas with low or rapidly decreasing soil fertility. Due to the wide variety of ISFM techniques, there are no specific climate restrictions for their application, except in arid areas where water is always a limiting factor. ISFM is particularly appropriate in mixed crop and livestock systems.
Minimal ground disturbance	Minimum soil disturbance refers to no-till or low soil disturbance crops, only in small strips and/or at shallow depth, and direct seeding (WOCAT, 2016). It is an agricultural system that preserves, improves and makes more efficient the use of natural resources. Proven practices preserve the soil, but also its humidity and trap carbon (FAO)[3].	Minimal soil disturbance works for a wide range of food and cash crops. It is suitable for a variety of agroecological zones and farming systems: regions with low or high rainfall; degraded soils; multiple cropping systems and systems with labor shortages or low external inputs. It has good diffusion potential in arid environments due to its ability to save water.
Agroforestry	Agroforestry integrates the use of sustainable woody plants with agricultural crops and/or livestock for a variety of benefits and services, including better use of water and soil resources, multiple fuels, food and forage resources and habitat for associated species.	Agroforestry is suitable for arid areas suffering from strong winds and wind erosion, and for less fertile soils (park systems, intercropping, windbreaks). Multi-stage systems are suitable for areas with excessive rainfall leading to water erosion, soil compaction, expensive inputs (fertilizers), spread of pests and diseases. The extent and forms of agroforestry practiced vary depending on the country.

3 https://www.fao.org/agriculture/crops/plan-thematique-du-site/theme/spi/mecanisation-agricole/technologies-&-equipement-de-mecanisation-agricole/agriculture-de-conservation-ac/fr/

Main SLM technology groups	Definition and principles	Applicability
Management of grazing pressure	This relates to the management of grazing on natural or semi-natural meadows, meadows with trees and/or light forests. Animal owners may have a permanent residence while their livestock move to distant grazing areas, depending on the resource availability. Grazing pressure management practices provide strategies for conserving or enhancing native grass, improving forage production, restoring soil quantity and quality, improving plant communities and reducing overall operating costs. Enclosure, bourgou culture, transhumance are some examples of these practices.	Rangeland management and improvement is a production system for drylands where productivity is relatively low due to aridity, altitude, temperature, or a combination of these factors.
Water Management	It is the management of water resources, including surface, ground and rainwater, to promote their efficient use and protect them from pollution and overexploitation. It also involves the removal of excess water from the soil surface or root/drainage zone, using sustainable irrigation systems and water harvesting. Water management practices can help increase the capacity of the soil to receive, hold, release and deliver water, and can reduce soil erosion. This might include rainwater harvesting and small-scale irrigation management (by small farmers).	Water management can be applied to land use types where water resources are present, such as cropland and forest/woodland, in different ways, depending on the SLM overall objective.

28 **Soil health and fight against land degradation**

Soils are the skin of the "earth". They are an essential resource to preserve for the production of food, fiber, biomass, water filtration, preservation of biodiversity, carbon storage, etc. As carbon reservoirs, they play a vital role in the fight against increased concentration of greenhouse gases.
Thus, soils represent a pillar of the United Nations SDGs, in particular SDGs 2 "Zero hunger", 13 "Fight against climate change", 15 "Life on land", 12 "Responsible consumption and production" or even 1 "No poverty".

Preserving and strengthening soil health is therefore fundamental in the fight against land degradation. The situation in Africa has positively evolved, nevertheless, data provided by Africa Fertilizer indicates that average fertilizer use remains low and ten times less than the global average.

Many solutions can protect and improve soil fertility, based on the substitution of techniques that are harmful to the health of the environment and populations. The objectives would be:

- Increasing good quality arable land as a main strategy for many African countries;
- Building the capacities of farmers in crop management and spreading agricultural extension messages in relation to the needs of farmers, considering the various agroecological systems and the socio-economic conditions of the communities;
- Formulating recommendations for an effective use that correspond to soil types and their current nutrient content as well as the requirements of the intended crops, and which consider local knowledge and practices;
- Collecting recent data and reliable information on levels of soil degradation and fertilizer needs.

Achieving these objectives requires an integrated and sustainable soil management approach that makes sure that soil systems exercise their natural functions and thus provide the ecosystem services essential for sustainable development in Africa, ensuring food and nutritional security, and enable adaptation and mitigation of climate change. Indeed, healthy soils with a high organic matter content, which are well ventilated and having a good structure, can increase the fertilizer absorption efficiency of the plants (Chevallier & al., 2020).

I.2- Implementation of sustainable management/land restoration interventions

Interconnection between sustainable management and land restoration

Generally speaking, SLM and land restoration are two interconnected and inseparable concepts. Land restoration is one of the tools that can be used to achieve SLM, as it can help improve the long-term productivity and sustainability of land use systems. SLM is essential for the restoration of terrestrial ecosystems. It is at the heart of maintaining or restoring life on earth. When applied on productive land, appropriate SLM practices can lead to higher and more stable yields.

The role of SLM in restoration efforts is primarily linked to achieving a land degradation neutral world by 2030. However, SLM can have a significant impact on ecosystems restoration only if it spreads widely, covering a critical mass of land and people, and if the practices introduced are maintained and adapted over time. A combination of SLM practices is necessary to give positive results (Critchley & al., 2021).

Restoration includes a broad range of land management interventions, from reducing societal impacts in production landscapes to full recovery of native ecosystems. Examples of ecosystem restoration include the management of agriculture to reduce soil erosion, installing urban greenways, and remediating land contaminated by mines (UNEP, 2021).

Restoration can be active, through the plantation of native species, or mixtures of native and non-native species, and through assisted natural regeneration. It can also be passive, by removing the causes of degradation to allow or boost natural regeneration. For example, various silvicultural methods and treatments can be applied under the name of restoration, including enrichment planting with desired species, the removal of exotic species to reduce competition, and agroforestry to promote tree cover and food production (Stanturf & al., 2017 ; Mansourian & Berrahmouni, 2021).

The different SLM technology groups are more or less relevant for ecosystem restoration (Critchley & al., 2021), such as:

Closure of areas (stopping all use, setting aside areas, etc.): closure and protection of an area of degraded land against human use and animal interference, in order to allow natural rehabilitation, reinforced by additional practices conservation of plant practices and physical structures (WOCAT).

Rotation systems (crop rotation, fallows, shifting cultivation): rotation of different types of crops/plants in the same area in successive seasons, fallowing of land for a period of time, etc. Shifting cultivation is an agricultural system in which the farmer temporarily cultivates plots, then abandons them so that they return to their natural vegetation, and moves to other plots (WOCAT).

Afforestation and reforestation: Afforestation is the planting of trees or tree cover on land that historically did not contain forests. Reforestation is the planting of trees or tree cover on land that previously contained forests and was later converted to another use. This involves the reclamation of a land to be restored/rehabilitated or converted to forest land to reverse land degradation. The benefits of afforestation/reforestation include increased above-ground and below-ground biomass accumulation and biodiversity, control of soil erosion and enhancement of ecosystem functions and services, and aesthetic and cultural services. Afforestation could lead to a gradual accumulation of soil organic carbon, particularly during the conversion of cropland or during the restoration of severely degraded land (Sanz & al., 2017).

Strategies and assessment of restoration options

The first step in an ecosystem restoration program is the analysis of its initial state, including its state of degradation. At this stage, you need to determine the reference ecosystem that can guide restoration measures. This reference ecosystem (restoration target) is established in particular based on spatial data and participatory techniques (Gann & al., 2019).

Then, before identifying the dynamics of degradation, and detecting and evaluating the extent of degradation and the progress of restoration in a site to be restored, you need to develop a reference model. Indeed, degradation and restoration are relative terms. The questions to ask are: "degraded compared to what? » and "restored for what purpose?" (IPBES, 2018). The reference model makes it possible to describe the ecosystem using measurable indicators which allow a comparison with the site to be restored (Gann & al., 2019).

Here follows the process of a reference model identification (Durbecq, 2020):

- Creating the boundary of a geographic area of habitat types similar to the restoration sites.
- Identifying the environmental factors structuring non-degraded communities in this geographical area.
- Comparing environmental factors between degraded and non-degraded sites.
- Selecting non-degraded sites having the same environmental specificities as restoration sites and use them as reference sites.

29

"A **reference ecosystem** is a representation of a native ecosystem that is the target of ecological restoration, according to the Society for Ecological Restoration (SER). A reference ecosystem generally represents a similar, undegraded version of the designated ecosystem with biotic and abiotic elements, functions, processes and successional states that might have existed at the restoration site if degradation had not taken place and which are adjusted to adapt to changing or expected environmental conditions (Gann & al., 2019)".

"A **reference model** is an estimate of the composition (species), structure (complexity and configuration) and function (processes and dynamics) of the ecosystem as if degradation were not occurring. It is based on multiple reference sites and measurable indicators of ecosystem composition, structure, function and external exchanges (Gann & al., 2019)".

Considerations to take into account for a restoration program (Gann & al., 2019):

- Including a mosaic of ecosystems, for large sites or for sites having a varied topography.
- Using multiple references to reflect ecosystem dynamics or expected changes over time, particularly for ecosystems with complex dynamics that may need multiple models describing different possible restoration outcomes.
- Adjusting the baseline model over time based on the program monitoring results.

Assessing restoration potential involves the identification of the ecological need; the degree of degradation or risk status of the ecosystem, the social need, the types of potential restoration interventions; economic cost and benefits, legal, institutional, political and financial limits and opportunities, etc. (IUCN & WRI, 2014).

Finally, implementing a land restoration plan involves the identification of the most appropriate interventions for the restoration to be carried out. These interventions will be based on stakeholder contributions, ecological relevance, legal, regulatory and governance requirements and constraints, scale and cost-effectiveness (UNEP, 2021; CBD and SER, 2019).

I.3- Importance of local expertise and good practices in SLM

Over the centuries, the people of the African continent have developed local know-how to adapt to different forms of land degradation and ensure the sustainable management of their resources. The wealth of this local know-how and the diversity of Africa's cultural heritage, closely linked to the natural environment, constitute a strategic asset for the sustainable development of the continent.

Traditional practices that contribute to SLM vary from one region to another and change according to ecosystem richness, the diversity of agroecological conditions and according to the specific needs of the area.

30 **Land restoration is a solution, but prevention remains the best option**

Land restoration is certainly a global priority, but conservation is even more important. Indeed, it is easier and less costly to avoid and prevent land degradation than to restore a degraded land. Preventing land degradation requires a holistic approach that involves all stakeholders, from governments to individuals. It involves the adoption of sustainable agricultural and forestry practices, the protection of natural resources and adaptation to climate change. Actions may include crop rotation, water and soil conservation, protection of forests from deforestation and overexploitation of resources, protection of wetlands and mangroves playing an important role in protecting soils from erosion, etc.

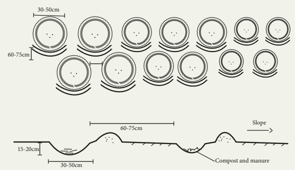
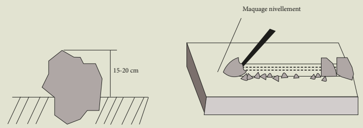
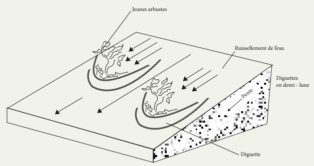
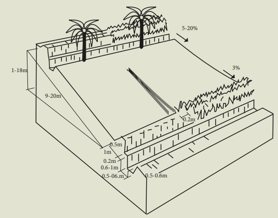
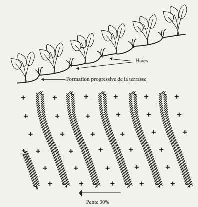
In the Sahel, countries have long adopted relevant local know-how in order to preserve soil fertility, optimize productivity and protect crops. These practices include crop rotation, fallowing, saving good seeds, using goat waste as fertilizer, monitoring seasons and soil types for the proper distribution of the crops, etc. (OSS, 2017).

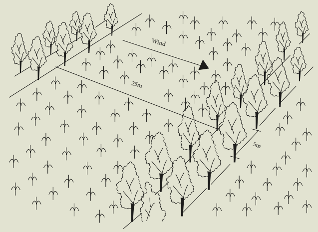
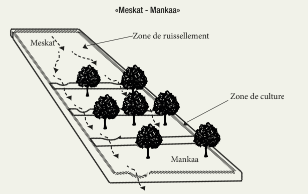
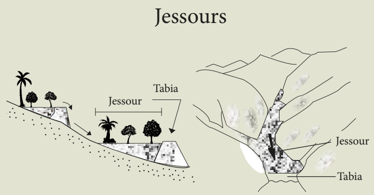
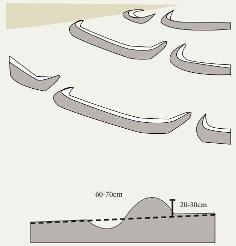
Local populations also use soil rehabilitation techniques developed for dry areas, namely stone bunds, zaï, mulching, yarding, haymaking, crop association/rotation, etc.[4]

Many of these traditional techniques have been successful and proven in Africa and can be important components of the climate change adaptation strategy of smallholder farmers (IIED, 2011).

4 https://www.snrd-africa.net/fr/valorisation-des-savoir-faire-locaux-pour-la-rehabilitation-des-sols-des-zones-seches/

Table 13: Some local SLM techniques and know-how in Africa (Diop & al., 2022 ; OSS, 2017 ; Liniger & al., 2011).

Name	Areas of use	Description	Illustration
Zaï	North, West and East Africa - Native to West Africa	Catchment of runoff water through holes in order to feed a plant planted in the middle and to facilitate infiltration into groundwater. The method consists of digging a hole to receive rainwater, manure and seeds.	
Stone bunds or stone lines	West Africa, Eastern and Southern Africa	Slowing runoff and increasing water infiltration to improve production in semi-arid areas. At the same time, sediments are retained behind these semi-permeable barriers.	
Half Moon	West and East Africa, Morocco	Increased water infiltration, rehabilitation of degraded land, soil stabilization and reduction of water erosion by digging half-moon shaped holes following the slope and contour lines of the land.	
Terraced farming ("Fanya juu" terrace)	East Africa, Togo, Cameroon, Sudan, Morocco, steep areas across Africa	Popular and successful cross-sectional measures in the small-scale agriculture sector. Contour dikes are constructed by projecting earth upward from trenches located just below. This design leads to the gradual formation of terraces with a flat or slightly forward-inclined bed. Reduction of soil and water losses and improvement of plant growth conditions.	
Live hedges	Kenya, Cameroon, Rwanda	Increase in the quality of water conservation and integrated management of soil fertility, and reduction of bank erosion through the plantation of one or more species of trees or shrubs.	

Name	Areas of use	Description	Illustration
Windbreak	Suitable for areas with high wind speed (more than 35km/h)	Tree and shrub barriers that protect against wind damage: reduction of wind speed, protection of plant development (agricultural crops and forages), improvement of microenvironments to increase plant growth, demarcation of field boundaries and increased carbon storage.	
Meskat	North Africa	Increase in the amount of water received by crops by using the uncultivable surface of the hills as an impluvium and by planting trees in the valleys and at the bottom of the slopes.	
Jessour	North Africa	Increasing the retention of runoff water and bedload materials in the soil, as well as reducing water erosion by constructing earthen dykes. The structure is reinforced downstream by a drystone wall with a variable height depending on the flow.	
Soil/earth dykes (or "ridges" in southern Africa)	West and South Africa	Soil conservation by constructing an earth dyke along contour lines by digging a canal and creating a small ridge below. These dykes are built gradually and maintained annually by adding earth to the dyke. Unlike stone lines, they perfectly prevent water runoff by blocking its movement.	

Some SLM good practices in Africa (UNCCD, 2022)

Coordinated land degradation management efforts through SLM must target water scarcity, soil fertility, organic matter and biodiversity. SLM seeks to increase agricultural production through traditional and innovative systems and to improve resilience to various environmental threats (Liniger, 2011). Several SLM practices have proven to be effective in various African countries, thus becoming success stories.

Malawi: Intercropping Gliricidia with maize improves long-term soil fertility thanks to Gliricidia leaf litter which provides inexpensive organic fertilizer. Fields managed this way retain around 50% more water two weeks after a rain than corn monoculture soils.

Tunisia: land consolidation to reduce fragmentation and increase the average size of farms aims to protect fertile agricultural land and contribute to LDN. This practice makes it possible for owners of small, scattered plots to exchange them, within certain limits, with the aim of grouping them together and make them more economically viable plots. Larger plots are more conducive to investments in contour plantations aimed at reducing soil erosion (Mtimet, 2016) and conserving water. The aggregation process includes awareness-raising on economic impacts, peer-to-peer learning, participatory and gender inclusion approaches, and involves farmer associations, public authorities and civil society.

Jessours technique, Tunisia

Dyke technique, Ethiopia

Area closure and reforestation are other examples of practices in Tunisia. They aim at protecting and reforesting degraded areas of the Center and South using native tree species (A. raddiana) that are particularly resilient to extreme droughts and to the Sahara Desert (UN, n.d.).

Kenya: Pastoralism is a type of mobility that makes it possible for pastoralists to manage risk and uncertainty in drylands. However, grazing areas are often neglected in land restoration programs, despite being an important carbon store and offering great potential for achieving environmental and development goals. In Kenya, the Group Representatives Act of 1968 gave Maasai communities collective title to the land where they raise their herds. These "collective ranches" gave breeders security of tenure and control of associated land resources. By forging links with outside communities and adjacent collective ranches, they benefit from greater mobility and better seasonal zoning of pastures, allowing them to dedicate some to recovery and others to emergency land use.

Morocco: The Ait Souab-Ait Mansour agroforestry system is a biodiversity hotspot where argan trees have been cultivated for centuries with more than 50 other plant species. This system is based on agroforestry practices in dry stone terraces and exploits large underground caves that collect and filter water from the land above. These natural tanks collect water so efficiently that local farmers can thrive despite the arid environment and poor soils.

Assisted natural regeneration of cork oak is another practice that contributes to the preservation of ecosystems. It consists of preparing cork oak seed plots from nursery seedlings (UN, n.d.).

31 It is important to underline the importance of traditional agricultural techniques that takes care of the environment, allowing farmers to produce quality local products without harming natural resources or biodiversity. Although these products are generally not very profitable, they present advantages in relation to the costs of degradation, being less harmful. These ingenious techniques are recognized as part of the world's agricultural heritage (Ingenious Systems of World Agricultural Heritage - ISWAH). In Tunisia, we find the hanging gardens of Djebba El Olia-Tibar, located on the plateaux of north-western Tunisia at 600 m, as well as the Ramli cropping system of the Ghar el Melah lagoon -Bizerte. Ramli practices are particularly beneficial in combating dry environmental conditions by reducing water loss through evaporation and increasing the moisture retention capacity of the soils. These two sites illustrate the close links between cropped land, the natural ecosystem and local fauna and flora, while promoting traditional know-how and biodiversity (FAO, 2020b).

32 **Inappropriate techniques that foster different forms of land degradation**

- The lack of anti-erosion farming techniques within the technical itineraries;
- The sloping land plowing following the direction of the slope;
- The use of disc plows on coarse-textured soils which destroy the soil and promote wind and water erosion;
- The absence of an appropriate rotation which would allow, on land sensitive to erosion, to have covered soil in times of heavy rains;
- The lack of integration of livestock breeding which limits the quantities of manure necessary for improving fertility, the organic matter content and the structural stability of the soils;
- The absence of a well-advised management based on rotation and periodic improvement of rangelands to avoid overgrazing and therefore rangeland degradation.

Restrictions to the adoption of sustainable land management practices

Even though SLM proved to have several benefits, practices in Africa are still hard to carry out. The ELD initiative (2019) and TerrAfrica (2009) have defined some of them.

Speaking of knowledge and technology, several SLM practices require significant investments or intensive labor (earthworks, stone walls, spreading sills). In addition to limited access to equipment, inadequate knowledge transfer and management explain the low awareness of farmers on the importance of land degradation and the lack of capacity of farmers, communities, local extension agents and NGOs. In addition, the inadequacy of monitoring and evaluation of land degradation and its impacts hinders the SLM practice.

The evaluation of SLM and its effects also poses challenges due to the poor valuation of field monitoring (Liniger & al., 2019).

At the institutional and political level, the absence of aligned policies and SLM integration into expenditure frameworks, the lack of ownership of management structures Incentives, particularly with regard to land tenure, the unfavorable political environment to stimulate SLM and the scaling up of project successes and community efforts, hamper the successful implementation of SLM.

Besides, sustainable pastoralism in particular is confronted with the weakness of traditional governance over collective natural resources, travel restrictions, sedentary lifestyle, borders and the progression of agriculture.

At the economic and financial level, resources, investment opportunities and loan facilities are desperately short as agricultural service providers give priority to short-term gains.

Sustainable land management and land degradation neutrality: what is the connection?

SLM is the basis of the concepts that promote the preservation, enhancement and restoration of biodiversity, land productivity and the resilience of livelihoods and ecosystems - including "nature-based solutions", "ecosystem-based adaptation" and "ecosystem-based disaster risk reduction" (Critchley & al., 2021).

"SLM is one of the main mechanisms for achieving LDN." Scientific evidence shows that if widely adopted, SLM practices help prevent, reduce or reverse land degradation and achieve LDN; to contribute to climate change adaptation and mitigation; to protect biodiversity; to achieve multiple Sustainable Development Goals and increase human well-being globally (Sanz & al., 2017).

Although SLM principles are well known and widely promoted by many land use projects in different countries, land degradation keeps worsening and becoming a major global threat. According to the UNCCD, the slow adoption of SLM could be resolved by its inclusion as a Sustainable Development Goal. The LDN goal can serve as a target for SLM and an overall indicator for SLM success (Kust & al., 2016). Achieving LDN through SLM underpins and catalyzes the achievement of SDGs 15 and 13 and their related targets (Fig. 26) (Sanz & al., 2017).

II- Efforts in sustainable land management and prerequisites for success

II.1- LDN progress in Africa

In order to monitor progress in achieving LDN by 2030, countries estimated baseline levels of land degradation for the period 2000-2015 against the three agreed sub-indicators of LDN[5] and set their intervention measures. These analyzes were carried out using a combination of global and national data, depending on the resources available in the countries. The sources and data available on these sub-indicators are derived from global observation systems, providing a more accurate and relevant idea of land degradation at the country level. These three sub-indicators could be associated or reinforced by national level indicators.

5 Land cover, land productivity and carbon stocks.

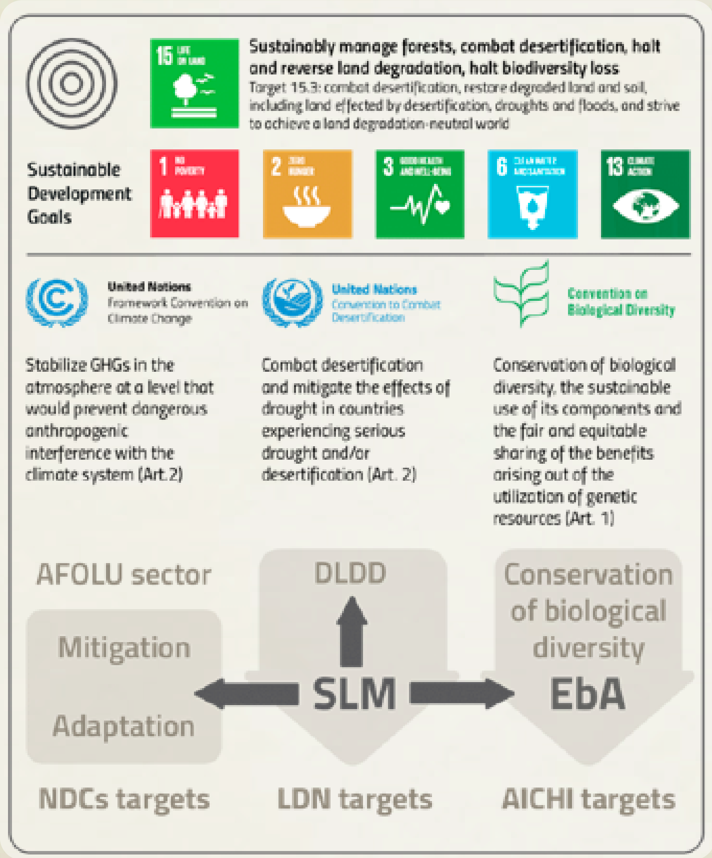


Figure 26: Objectives of the three Rio Conventions, mainly SDG 15 (15.3) and SDG 13 (Sanz & al., 2017).

In African countries and according to national reports, more than 3,432,840 km^2 need to be restored within the framework of LDN objectives. The countries with the largest commitments are located in West Africa. The area promised under the LDN program could be significant, as the African region has almost 2,631,500 km^2 of degraded land.

In this context, it is necessary to consider the connection between the restoration and LDN targets, the National Biodiversity Strategies and Action Plans (NBSAPs) and the Nationally Determined Contributions (NDCs). This allows synergies between the three Rio conventions to be achieved in a cost-effective manner. In most cases, measures aimed at achieving the

Half-moon technique, Niger

LDN objective will also benefit biodiversity conservation and climate change adaptation and mitigation.

Here follow the country commitments:

- Improving the productivity of agricultural areas and crop land;
- Reducing deforestation/increasing forest areas;
- Improving land productivity and soil organic carbon stocks;
- Restoring and sustainably managing pastoral land, grasslands, savannahs and pastures;
- Regenerating bare land;
- Reducing the loss of soil surface through erosion.

LDN commitments need to meet ecological restoration standards, as countries often give priority to cost-effective afforestation measures, which are easy to implement.

However, restoration success should not be assessed solely based on the number of hectares being restored or trees planted, but also in terms of improved terrestrial natural capital and ecosystem services restored.

National LDN targets and objectives

Decision 3/COP 12 (UNCCD, 2015) called upon all Parties to the Convention to formulate LDN national targets based on their specific national specificities and development priorities. Thus, the UNCCD Global Mechanism established the global program to support the LDN objectives (Target Setting Program - TSP) for all countries in order to define the national reference levels, to identify the voluntary objectives and associated measures to achieve LDN by 2030, and to monitor progress in achieving LDN targets.

The voluntary national LDN targets are the same as those established during the baseline. Neutrality is generally the minimum objective: countries are free to set a more ambitious target, namely the improvement of terrestrial natural capital relative to the baseline state to increase the volume of healthy and productive land.

48 countries of the region have engaged in setting LDN targets and have defined and approved voluntary national LDN targets through the working group consultation (National LDN Report - TSP)[6].

However, many countries have neither an LDN implementation and achievement monitoring mechanism, nor accurate local data on relevant national indicators to calculate SDG indicator 15.3.1.

II.2- Scaling-up sustainable land management

SLM scaling up is a significant opportunity to promote the UN 2030 Agenda goals and the UNCCD principles. By promoting soil preservation, responsible management of natural resources and strengthening ecosystem resilience, this approach directly contributes to SDG Goal 15 to protect, restore and promote sustainable use of terrestrial ecosystems. Additionally, by encouraging sustainable agricultural practices, SLM scaling up supports food security (Goal 2), poverty reduction (Goal 1), and sustainable economic growth promotion (goal 8). The SLM expansion in Africa perfectly aligns with the 2030 Agenda aspirations, reinforcing commitments to a more equitable, resilient and environmentally friendly future. This part presents the descriptive approach to scaling and explores the benefits of this process.

Strategic levers and key factors to scaling

The effective SLM extension requires recognition and ownership of its benefits by land users, or access to appropriate incentives. For example, the adoption by poor farmers, of land restoration practices will depend on various factors, including long-term political and financial commitment, to implementing SLM programs. Regulation of the land system, access to land and local governance also play a crucial role, as does the effective participation of beneficiaries in policy development, planning and implementation of strategies.

Alignment with local practices, existing production systems, cultural values, and community aspirations is truly decisive. Adverse biophysical conditions, such as climate and soils, as well as technical challenges, market opportunities, and local social dynamics, represent additional obstacles to consider.

6 https://www.unccd.int/our-work/country-profiles/voluntary-ldn-targets

OSS support to countries in SLM and LDN achievement

Signatory countries to the UNCCD must submit a four-year report on their efforts to fight land degradation, particularly desertification and drought that particularly affect many African countries. It is therefore imperative to provide support to these countries to help them achieve and maintain global environmental conservation goals.

The OSS supports African countries in sustainable land management through several projects. In cooperation with the United Nations Environment Program (UNEP), the OSS focused on improving the reporting systems of African countries to the UNCCD. For this to happen, it has established close collaboration with the Ministries of Agriculture, Climate Change and the Environment in certain countries, by setting up multidisciplinary teams dedicated to reporting. These teams were specially trained to build the capacities of the relevant national key players in monitoring and evaluating the strategic objectives of the Convention. In addition, the OSS actively contributed to mapping degraded land and having them validated by the stakeholders. At the same time, it helped define strategic objectives and additional national indicators, thus making this data ready for submission on the UNCCD PRAIS 4 platform (Performance Review and Implementation Assessment System). These actions aim to ensure better coordination and a more accurate assessment of the African countries' efforts to fight land degradation.

Following its 2030 strategy, the OSS committed to supporting African countries in the production and dissemination of scientific and technical information promoting optimal use and sustainable management of land and natural resources. Technically speaking, the Organization developed monitoring, reporting and capacity building tools in SLM and LDN achievement, in particular, the MISBAR, MISLAND and GUETCROP platforms.

For the land degradation monitoring institutional framework to be reinforced and knowledge and experiences shared in this area, a partnership and collaboration have been established between the OSS and the RCMRD. Furthermore, the OSS officially launched the network of land degradation monitoring experts (Joint Implementation Network - JIN) in February 2023 in Nairobi, currently bringing together 276 experts from 35 African countries.

Capacity building sessions were regularly organized and gathered member institutions, partners and beneficiaries. More than 500 people were trained in the monitoring of seasonal agriculture and land degradation, hosted by the platforms (MISBAR, MISLAND and GUETCROP), and in the use of artificial intelligence and Cloud Computing. Hackathons targeting students, developers and start-ups, were organized and focused on the crop mapping in Africa and the valorization of Earth Observation for the sustainable management of natural resources in the continent, marking the use of project platforms in nearly 40 African countries.

Dialogue with local populations, Djibouti

The expansion of good practices remains a major concern in land management. Land conservation and restoration solutions that have proven effective are not always widely adopted due to contextual variability and region-specific needs. It is imperative to put in place ambitious programs for the co-production of good practices, guaranteeing initial financing conditions, a consolidated and sustainable policy framework, as well as a market that promotes value chains. Capacity building, not only through state technical channels, but also within the communities through exchange and demonstration platforms, should also be a key component. In this context, knowledge management and experience sharing, access to land and mobilization of domestic funds, emerge as essential levers to promote the scaling up of SLM good practices.

- **Knowledge management and experience sharing**

The variety of practices and knowledge acquired over time by various actors, such as researchers, practitioners, and local communities, is a valuable resource. Managing this knowledge involves the collection, organization, dissemination and constant updating of SLM-related information. Experience sharing creates synergy between the different stakeholders through the dissemination of lessons learned, successes and challenges. This collaborative interaction promotes a collective understanding of the best practices, speeds-up the adoption of sustainable methods, and strengthens the resilience of the communities to land management-related challenges. By effectively combining knowledge management and experience sharing, it is possible to create a dynamic network of continuous learning that contributes to the constant improvement of SLM practices. The combination of actions described in the table below can be adopted to boost knowledge management and experience sharing.

Table 14: Concrete knowledge management and experience sharing actions.

WHAT	HOW
Creating digital platforms	A centralized digital platform would make it possible to collect, disseminate and popularize good SLM practices. This platform would be an interactive hub where stakeholders from various sectors, such as agriculture, forestry and water management, could share their experiences and knowledge similar to the WOCAT platform and its popularization by the OSS for the exchange of good practices for sustainable land management in the Sahel-Sahara area[7].
Promoting Inter-institutional collaboration	Fostering collaboration between institutions working on sustainable land management is essential. Strong partnerships between the governments, NGOs, research institutes and the private sector can create a dynamic network for sharing expertise. Regular forums, workshops and conferences could be organized to encourage communication and collaboration.
Developing practical manuals	The creation of practical manuals detailing the best approaches to sustainable land management would allow for more accessible dissemination of knowledge. These manuals could be adapted to local and national contexts, offering practical solutions to specific challenges ahead of Africa.
Using information and communication technologies (ICT)	The integration of ICTs, such as mobile applications and online tools, would facilitate access to information on sustainable land management, even in remote areas. These technologies can be used to deliver educational videos, interactive guides and webinars, increasing awareness and constant learning.
Capacity Building Program	A capacity building program could be established to train key stakeholders, including farmers, land managers and policy makers, in best practices. This would promote faster adoption and effective implementation of sustainable strategies.

7 http://projet.oss-online.org/LCD/)

Fostering collaboration and using new technologies and building capacity would make it possible to create an environment conducive to the widespread adoption of sustainable practices, thereby contributing to the preservation of land and the prosperity of African communities. This approach can be reinforced by the creation and implementation of an appropriate land tenure.

- **Access to land**

Access to land is a fundamental pillar of SLM. It involves securing agricultural land through solid legal frameworks and effective mechanisms aimed at guaranteeing the stability of land rights for farmers. Thus, by ensuring the clarity and legal protection of land property rights, land security promotes an environment conducive to sustainable agricultural investments, and thus contributes to the sustainable development of the region. It allows farmers to trust in the sustainability of their activities, and encourages them to adopt responsible practices and a well-advised use of natural resources. By integrating land security into global SLM strategies, it is possible to prevent land conflicts, stimulate productivity, support long-term prosperity, preserve the ecosystems, food security and the resilience of rural communities to environmental challenges. Table 15 summarizes most of the actions related to access to land.

Table 15: Guidelines for an easier access to land.

WHAT	HOW
Awareness and education	Launching national awareness campaigns to inform farmers, local communities, and decision-makers about the importance of SLM and land security; Establishing continuous training programs for farmers to familiarize them with the SLM best practices, including land security aspects.
Legal and regulatory framework	Evaluating and, if necessary, revising national land laws to ensure effective security of agricultural land. Strengthen legal mechanisms to protect farmers' rights. Clarifying and transparently documenting land rights, particularly those of local communities, to prevent disputes and promote sustainable land use,
Technical support	Establishing technical assistance services to support farmers in the land security process. This may include legal advice, technical training and regular monitoring; Encouraging exchanges of experiences between farmers who have succeeded in securing their land and those who seek to do so, thus promoting mutual learning,
Promoting community participation	Promoting the participation of local communities in land management decision-making processes. Actively involving local stakeholders in the development of policies and programs; Encouraging the creation of agricultural cooperatives, thereby strengthening community solidarity and providing a mutual support mechanism for land security.
Integration into sectoral policies and plans	Making sure that sustainable land management initiatives are aligned with national development goals. The integration of these actions into sectoral policies will make them more relevant and impactful; Promoting the decentralization of policies to consider local realities. Active participation of local authorities and communities in policy formulation and implementation will strengthen local ownership of sustainable practices

Knowledge exchange and awareness in the forest community of Koankin, Burkina Faso

34 How can land tenure represent an obstacle to SLM?

Land tenure governs relations between individuals or groups of individuals for every aspect relating to land, including occupation, holding and management. Land tenure systems have a direct impact on land and livelihood degradation. Legal frameworks and national strategies are designed to promote sustainable land management and sustainable agriculture. Land tenure can be based on written laws (statutory land tenure) or unwritten customs and practices (customary land tenure).

Although tenure security alone cannot end land degradation, its absence often prevents farmers from adopting SLM practices (Chasek & al., 2019). Land security provides sustainable food security and predictable sources of income. It also allows land to be used as collateral to access other opportunities, such as credit markets. Additionally, landowners manage their land better than tenants, thereby reducing land degradation.

The limited availability of suitable soils and quality water hampers the expansion of agricultural and horticultural activities. The majority of arable land is subject to the law on national domain, despite the decentralization of public policies. Local producers are beneficiaries without having formal rights or titles, thus preventing them from accessing agricultural credit to invest. In addition, small farms limit investments and their performance is affected. The rights of access and use of water resources and pastures are not always guaranteed, due to exclusion or grabbing, or real rights to land. In the pastoral sector, land problems and access to water points have a significant impact on the sector's performance. The privatization of rangelands and water points according to national laws and regulations makes them inaccessible without the agreement or contract of the owner(s).

Thus, there is a pressing need to establish equitable land tenure, ensure gender equality, and address the need for national level support and coordination and adequate funding.

- **Mobilization of domestic funds for SLM**

The mobilization of domestic funds is essential to promote SLM scaling up in Africa. This involves the commitment of national governments to allocate substantial financial resources to SLM initiatives in order to boost the implementation of sustainable projects across the continent. This mobilization should not be limited to public financing but include collaboration with the private sector, national financial institutions and development partners. The creation of national funds dedicated to SLM offers an opportunity to guarantee a steady long-term financing. Tax incentives and policies encouraging private investment in sustainable practices also help mobilize additional resources. Furthermore, raising awareness on the SLM economic and environmental benefits can encourage voluntary investments. By consolidating these efforts, domestic resource mobilization becomes an essential catalyst for expanding the SLM impact, thereby promoting ecosystem resilience, food security and the well-being of African communities.

The mobilization of domestic resources is a shared priority, because it demonstrates the commitment of States to the sustainable development of land and communities. Indeed, SLM scaling up is not only an environmental necessity, but it also offers tangible benefits.

Table 16: Guidelines to support the mobilization of domestic funds.

WHAT	HOW
Awareness and education	Informing the public, businesses and policy makers about the importance of SLM. Highlighting the economic, social and environmental benefits of investing in land preservation and restoration
Creating public-private partnerships	Developing collaboration between the public and private sector to develop innovative financing mechanisms. Tax incentives, public-private partnerships and responsible investments can be important levers
Crowdfunding	Leveraging crowdfunding platforms to raise funds from the general public. This will involve the community in preserving its environment and strengthening the sense of ownership
Developing green financial markets	Encouraging the creation of green financial products specific to SLM. Financial instruments such as green bonds and sustainable investment funds can attract capital to promising SLM projects
Building local capacities	Investing in building the capacity of local actors, including farmers, civil society organizations and local governments, to design, implement and manage effective SLM projects
Transparency and accountability	Guaranteeing transparency in the use of funds through the establishment of accountability mechanisms. This will build donor confidence and bring more contributions

Benefits of scaling-up

Scaling up good SLM practices has significant benefits, linked to the SLM environmental services. Each of these services, whether supply, regulation or socio-cultural, has a capital importance in maintaining the ecological balance and the economic and cultural well-being of local populations.

- **Supply services**: SLM practices, such as agroforestry and sustainable crop management, improve agricultural productivity and food security. By promoting a rational use of natural resources, scaling these practices contributes to the continued availability of high-quality raw materials, fuels and agricultural products. This directly supports communities by ensuring a constant supply of essential goods and services.
- **Regulatory services**: Large-scale SLM helps regulate environmental processes and mitigate the negative impacts of climate change. Soil conservation, watershed management and wetland preservation are all practices that help regulate the water cycle, prevent soil erosion and maintain air quality. By protecting ecosystems, SLM provides vital regulating services, such as climate regulation, water purification and natural disaster prevention, which are essential for environmental sustainability.
- **Sociocultural services**: Landscapes and ecosystems preserved through SLM practices promote ecological tourism, generating income and promoting cultural diversity. In addition, SLM supports traditional lifestyles by preserving agricultural practices and local know-how and by marking the cultural identity of the communities. The connection between people and their environment is strengthened, deepening a sense of collective responsibility towards land preservation.

Promoting large-scale SLM in Africa is a crucial step towards a sustainable future, integrating human needs with ecosystem resilience and environmental preservation. This scaling must be wisely adapted to the area and context to achieve optimal results.

Partnerships and initiatives between local and international actors aimed at integrating sustainability into land management at different levels, financing and overall sustainable development policies also play a crucial role.

Research is an engine of growth at several levels, namely, in knowledge development, training and awareness, technological innovation, evaluation of SLM practices (including the identification of the most sustainable practices and better adapted to different regions and contexts), policy development as well as monitoring and evaluation of the impact of SLM initiatives through tools and methodologies. The research also promotes international collaboration by sharing knowledge and experiences between the countries to facilitate the scaling-up of effective and appropriate solutions in different contexts.

However, scaling up good SLM practices in Africa faces financial constraints linked to the importance of the initial financing required and long-term economic viability. To overcome these challenges, innovative models combining technical support from the governments, value chains integrating rural communities and public-private partnerships must be developed. The mobilization of sustainable financing, from national or international sources, public or private, is crucial to achieve African land preservation objectives.

The cultural identity of communities supported by their natural environment

35 The Great Green Wall for the Sahara and the Sahel Initiative (GGWSSI)

African countries have many opportunities to expand their land restoration initiatives continent-wide. The experiences of several countries, including Mauritania, Niger and Tunisia, showcased the benefits of landscape restoration that can be applied to millions of hectares. Restoration practices such as farmer-assisted natural regeneration, dune fixation, reforestation and sustainable land management practices have been documented, with practical implementation steps that can be supported for an easier widespread adoption.

The Great Green Wall initiative, launched in 2010 by the African Union, CEN-SAD and the (PAGGW) Pan-African agency aims to combat desertification, land degradation and drought in the Sahel. It brings together 11 African countries and several technical and financial partners who cooperate to promote nature-based solutions. The objective is to transform the Sahelo-Saharan zones into viable economic hubs by 2025, thanks to a multi-sectoral and ecosystem approach.

The report commissioned by the UNCCD to mark the 15th anniversary of the program was published on September 7, 2020 and revealed that only 4 million hectares of the 100 million hectares target had been achieved. The UNCCD estimates that only 15% of the wall is completed, mainly in Senegal and Ethiopia (PAGGW, 2021).

In 2021, the financial partners who took part in the "One Planet" summit promised 16 billion dollars for the 2020-2025 period. No less than 2.465 billion dollars would be dedicated to land restoration and sustainable ecosystem management. However, the implementation of these important commitments still lags behind.

The Sahara and Sahel Observatory, which actively participated in the conceptualization and definition of the Great Green Wall, never stopped promoting this flagship initiative. It was appointed in 2008 to clarify the concept and the orientations necessary for its implementation and contributed, with the support of numerous scientists from North Africa, West Africa and Europe, to the first definition of what the Great Green Wall concept could be in the Sahelo-Saharan area.

Since then, it has continuously mobilized its expertise to support member countries in the operationalization of the Great Green Wall, whether by building local capacities or identifying financing adapted to the needs of the populations. The OSS, in partnership with its African peers, will keep advocating for compliance with the commitments of Northern partners for the benefit of current and future generations living in one of the most vulnerable regions in the world.

Community forest management in Koankin, Burkina Faso

05 Conclusion and recommendations

In the absence of eradication measures, studies, research and action programs have focused on typha valorization. Its insulating properties make it a construction material that would enhance the energy efficiency of buildings, and its combustion potential makes it a biochar that would contribute to reducing deforestation. The objective is to transform this environmental scourge into opportunities for sustainable development.

Conclusion

Land degradation in Africa represents a major and complex environmental challenge, exacerbated by extreme climate conditions and anthropogenic activities. It compromises agricultural productivity, food security and biodiversity, with particularly severe impacts on vulnerable populations. Biodiversity loss and ecosystem degradation reduce essential ecosystem services. Furthermore, land degradation contributes to the intensification of forced migrations and conflicts over access to natural resources. Economic costs are also high, including land restoration, agricultural losses and impacts on human health.

Indicator 15.3.1 of the Sustainable Development Goals (SDGs) is central to measuring the proportion of degraded land. It is based on three main sub-indicators: land use change, land productivity and soil organic carbon. They make it possible to assess the state of land degradation or restoration and reflect the key processes underlying terrestrial natural capital. Any significant reduction or negative change in any of these sub-indicators is considered land degradation. Therefore, the final assessment of SDG indicator 15.3.1 is binary, describing land as degraded or non-degraded based on the combined data from its sub-indicators.

With this in mind, the OSS started producing a map to assess land degradation in Africa, to provide more accurate information on their state, using finer and free satellite data, namely Landsat images. It has produced several maps, covering the years 2000, 2015 and 2021, to monitor the evolution of the three sub-indicators as well as the SDG indicator 15.3.1 which was estimated from Landsat data at 30 m spatial resolution. The maps produced illustrate significant changes in land use in Africa between 2000 and 2021. They reveal major transitions, such as the conversion of forests to urban areas and cropland, as well as the disappearance of steppes and rangelands. These transformations will have an impact on the availability of water and will thus make the management of agricultural and water resources even harder. Furthermore, the analysis of time series of land productivity reveals two types of areas: those in active degradation, characterized by persistent declines in primary productivity, and those stabilized after past degradation. This separation will help identify priority areas for soil restoration and effective land management.

These maps are currently being validated but have certain limitations, particularly with regard to the spatial resolution of the data, which may not be enough to identify land use changes in mixed agricultural landscapes, characterized by small size plots. Additionally, vegetation indices used to assess land productivity may show limitations in specific areas such as dry or humid zones. It is also difficult to measure and validate carbon stocks derived from land use changes.

This work is an overview and a summary of current knowledge on land degradation and its sustainable management in Africa, and proposes recommendations to stakeholders, emphasizing the importance of following technical, socio-economic and governance guidelines, supported by short and long-term material assistance for a sustainable land management.

Responsible and sustainable management of land resources aims to present realistic solutions to the climate change challenge, while avoiding the impacts of land degradation, through the implementation of well-thought practices adapted to local conditions: agroforestry, minimal soil disturbance, grazing management, reforestation, etc. These SLM practices result in a high rate of carbon sequestration, restore soil fertility and improve ecosystem resilience.

The importance of adopting these practices is underscored by the potential consequences of inaction that would result in significant financial harm. Ignoring these costs can weigh heavily on African national budgets and reduce available resources for other development priorities. According to the 2015 ELD initiative, by controlling soil erosion in 42 African countries, cereal crop production could reach 280 million tons per year, up from the current 104.4 million. This would lead to a significant increase in land productivity.

For this fight against land degradation to succeed, research-backed innovations are necessary in the evaluation of land development projects. The main efforts of African countries should focus on improving diagnostics (evaluation-monitoring) and technical and institutional capacities (land reforms, creation of opportunities for rural youth) in order to help the countries, identify positive pathways for land conservation and restoration, both nationally and intercontinentally. It is also crucial to strengthen the exchange of knowledge and experiences, as well as technology transfer, training through international institutions and popularization by civil society. In addition, the development of partnerships allowing coordinated actions in the territories must be encouraged. This calls for an integrated and collaborative approach, involving governments, local communities, civil society and international Organizations.

The African Continent is home to abundant natural resources and offers opportunities for more adequate and efficient management of its precious resources. Sustainable land management (SLM) is essential to ensure food security, environmental resilience, population well-being and the preservation of biodiversity. In order to address land degradation challenges, it is imperative to implement innovative and proven approaches. Knowledge management and experience sharing, as well as securing agricultural land, are emerging as essential levers to promote the adoption and implementation of sustainable practices. To contribute to the fight against land degradation in Africa, the following perspectives are intended to help target priorities and show the path towards sustainable and equitable management of our land.

Recommendations

Almost all African countries regularly update their national action plans to combat desertification (NAP/CD) and have developed their land degradation neutrality (LDN) strategies, demonstrating their commitments to combating land degradation. Subject to the availability of financing, the implementation of national programs would make it possible to slow down land degradation and restore millions of hectares by 2030.

The Windhoek Declaration on Building Drought Resilience (2016) recommended that all African countries, including drylands, join regional programs and initiatives such as the Great Green Wall, Landscape Resilience Initiative of TerrAfrica (ARLI) and the AFR100 Initiative, while making quantified national commitments to promote their implementation.

Several financing mechanisms have been put in place by the international community to support programs to combat land degradation and promote SLM, such as:

- Global Environment Facility (GEF) which finances the implementation of the three Rio conventions. This fund is subject to country quotas per cycle (via the Transparent Resource Allocation System "STAR") and requires increasingly substantial co-financing.
- LDN Fund, which is an investment fund, combining resources from the public, private and philanthropic sectors, aims to restore degraded land in developing countries and promote sustainable methods of exploitation in the agricultural and forest. This is done in conjunction with local communities, small producers and private investors in these sectors with strong environmental and social impacts. The LDN Fund reached its final closing at $208 million in March 2021.
- Climate funds, such as the Adaptation Fund and the Green Climate Fund (GCF), are mechanisms that provide support to countries in their fight against the effects of climate change through adaptation and mitigation initiatives and programs. These funds make it possible to integrate actions to combat land degradation and drought into national or regional projects on climate change.

After reading this book, these might be relevant recommendations to think of:

1. Implementing NAPs/CD and LDN action plans

African countries must follow up on their commitments relating to the consolidation of their sustainable land management policies by building the capacities of local and national institutions in terms of planning and management of natural resources, and by adopting specific measures for the soil conservation, restoration of degraded land and promotion of sustainable agriculture.

However, these commitments depend on the mobilization of the necessary funds, whether from own resources or from international and bilateral cooperation agreements.

2. Easier access to financing

Access to financing is complex and most countries need to mobilize international expertise to support them in developing bankable initiatives, implying the need to resort to equity capital. These efforts allow the implementation of pilot actions that can be scaled up and act as levers for national policies.

The initiatives implemented through these funds have several advantages, in particular through:

- The scope of their impact: covering vast areas. The GGW, for example, extends over an 8,000 km strip of land across Africa, making a stand against desertification.
- Coordinated action and resource mobilization: attracting greater international attention and financial support, thereby calling for significant public and private investment.
- Knowledge creation and sharing: serving as platforms for collecting and disseminating information, data and best practices.

3. Increasing public and private partnerships (PPP)

Mobilization of funds sometimes requires the engagement of the private sector in agroforestry, sustainable forestry and regenerative agriculture investment projects.

The private sector can thus contribute to land restoration in Africa through various mechanisms, such as investing in reforestation, sustainable management of forest resources and agroforestry practices. Investments in these areas can generate triple gains in terms of increased income and yields, adaptation to climate change and reduced greenhouse gas emissions.

4. Promoting local know-how

Several olden-time land conservation techniques have proven to be efficient in all sub-regions of Africa, for the fight against land degradation and adaptation to climate change. Given their direct impacts on local populations, these nature-based solutions, could be integrated into the LDN strategies of African countries. Economic incentives would encourage environmentally friendly agricultural practices and discourage intensive land use.

5. Empowering local communities

Considering gender and vulnerable groups, empowerment at the community and local level would promote global approaches. Stakeholder mobilization and participatory planning would promote collective action, which is essential for the enforcement of integrated approaches.

6. Ensuring synergy between the three RIO conventions

The three Rio conventions (UNCCD, UNFCCC, CBD) are closely linked and their coordinated implementation would lay the foundation for sustainable development.

Strengthening synergies between these conventions would help achieve their overall objectives. As such, SLM is at the heart of this synergy through:

- Land degradation and desertification reduction and LDN achievement,
- Carbon sequestration and mitigation of greenhouse gas emissions and climate change adaptation,
- Preservation of biodiversity and ecosystem services.

This also helps avoid scattered efforts and material, human and financial resources, while facilitating access to more substantial joint funding.

On the other hand, this synergy is likely to contribute to promoting the adequacy between natural resources management and economic and social development, by establishing more ecologically sustainable management bases. It requires stronger consultation frameworks at national and regional levels, better exchange of information and stronger capacities of the stakeholders.

The synergy should, moreover, go beyond the framework of the RIO conventions to integrate other agreements and strategies such as the Revised African Convention for the Conservation of Nature and Natural Resources (Maputo Convention), the Algiers Convention on the Conservation of Nature and Natural Resources, the Abuja Declaration on Fertilizers and Agenda 2063 "the Africa we want".

7. Promoting technology transfer and capacity building

Faced with the challenges of land degradation, it is imperative to implement innovative and proven approaches aimed at facilitating access to good practices and innovative conservation techniques. In this context, the development of knowledge and the exchange of experience constitute essential levers to promote the adoption and implementation of sustainable practices.

African countries should invest in scientific research to develop and adapt sustainable land management techniques to their context, which is significantly different from the context of Northern countries, both on a natural and socio-economic level.

It is also necessary to put in place monitoring and evaluation systems to assess the impact of agricultural practices on the environment and land productivity.

8. Implementing targeted awareness and communication programs

The development of awareness and communication programs aims to promote the adoption of sustainable agricultural practices. This has proven to be very useful in using soil conservation techniques and crop diversification to improve the resilience of agricultural systems to climate change and to diseases.

9. Developing the role of civil society

Civil society must play an important role in land degradation initiatives. As a central actor and beneficiary, it promotes cooperation between the governments, NGOs, local communities and international institutions. Through actions such as reforestation and the promotion of ancestral techniques, it actively participates in the preservation of land.

GLOSSARY

Land: designates, according to the UNCCD, the terrestrial bio-productive system which includes the soil, plants, other living beings and all ecological and hydrological phenomena of this system.

Sustainable land management (SLM) is the adoption of land use systems that enhance their ecological supporting functions through appropriate management practices and thereby enable users to derive economic and social benefits while preserving those of future generations. This usually implies the integration of socio-economic principles with environmental concerns in order to: (i) maintain or improve production, (ii) reduce the level of production risk, (iii) protect the potential of natural resources, (iv) avoid soil and water degradation, (v) be economically viable and socially acceptable (ELD, 2019).

The United Nations defines sustainable land management as the use of land resources, including soil, water, animals and plants, for the production of goods that meet changing human needs, while ensuring the long-term productive potential of these resources and the maintenance of their environmental functions (Earth Summit, United Nations, 1992).

Natural regeneration is the gradual process of recovering ecosystem structure, function and composition prior to disturbance (Chazdon & Guariguata, 2016).

Assisted natural regeneration is the deliberate human protection and preservation of naturally regenerating woody vegetation on abandoned forest or agricultural land or exclosures (Chomba & al., 2020).

Farmer-managed natural regeneration is an agroforestry practice consisting of the deliberate protection and management by farmers of woody vegetation regenerating naturally on agricultural land (Chomba & al., 2020).

Prevention involves the use of conservation measures that maintain productive natural resources as well as their environment such as afforestation, water and soil conservation work, fallowing, etc.

Ecosystem restoration is, according to UNEP, a process of reversing the degradation of ecosystems in order to recover their ecological functionality and improve the productivity and capacity of ecosystems to meet the needs of society. This can be done by allowing the natural regeneration of overexploited ecosystems or by planting trees and other plants. This definition is used by the United Nations Decade on Ecosystem Restoration (IUCN, 2019).

Ecological restoration is the process that helps recover an ecosystem that has been degraded, damaged or destroyed. Ecological restoration aims to find back the state of the ecosystem if degradation had not occurred, while considering anticipated changes. Simply put, ecological restoration is a specific type of ecosystem restoration practice that provides the highest level of ecosystem repair. This practice can be referred to as ecological restoration (Gann & al., 2019).

Rehabilitation management actions that aim to restore a level of ecosystem functioning to degraded sites, where the purpose is the renewed and continued provision of ecosystem services rather than the biodiversity and integrity of a designated native reference ecosystem. The rehabilitation of an ecosystem relies on restoration activities that may not completely restore the biotic community to its original state (Gann & al., 2019).

P.N. Ecosystem restoration encompasses the "ecological restoration" and "rehabilitation".

Land degradation is defined as a change in the health of the soil that results in a reduced capacity of the ecosystem to provide goods and services for its beneficiaries. Degraded soils are in no condition to provide the usual quality and quantity of goods and services.

Soil erosion is a common term that is often confused with soil degradation, but in fact only refers to the loss of topsoil and nutrients. This is the most visible effect of land degradation. Soil erosion is a natural process in sloping areas, but it is often amplified by poor agricultural practices (plowing in the direction of the slope, annual crop, deforestation, etc.).

Land degradation: the scope of this alteration is broader than soil erosion and land degradation together because it covers all negative changes in the capacity of the ecosystem to provide biological goods and services as well as socio-economic factors linked to land production.

Desertification is, according to the UNCCD, the degradation of land in dry arid and sub-humid zones. It also refers to the irreversible change in the function of land and its incapacity to recover its functions and thus its original uses.

Biodiversity hotspots are regions of the world that are home to large numbers of unique and threatened species. The term biodiversity hotspot emerged to identify high priority areas for species protection, habitat and conservation. These hotspots are located in different parts of the world and are home to a wide variety of plants and animals, many of which are found nowhere else on Earth.

Encroachment of woody species: refers to shrubs and other woody plants gradually invading areas where they were not previously dominant, such as grasslands, savannahs or agricultural land. This process can result in significant ecosystem modification, often to the detriment of local herbaceous species, and can contribute to land degradation by reducing biodiversity, agricultural and pastoral productivity, and increasing fire risks (Kebe & al., 2020).

Specific decline refers to the gradual decrease in the population of a particular species in a given ecosystem. This decline can be caused by various factors such as habitat loss, pollution, climate change, disease, overexploitation, or competition with invasive species. Specific decline can result in a reduction in genetic diversity and, in extreme cases, lead to local or global extinction of the affected species.

Specific drift, also known as "genetic drift", is an evolutionary process by which the frequency of alleles (gene variants) in a population changes randomly from one generation to the next. This occurs particularly in small populations and can lead to a reduced genetic diversity. Specific drift can result from factors such as random fluctuations in reproduction, catastrophic events that drastically reduce population size, or random migrations of individuals.

Phenological asynchrony refers to the temporal shift between phenological events (i.e. development phases or seasonal activities) of different species or between individuals of the same species, which are normally synchronized. This phenomenon can be caused by environmental factors such as climate change, which modifies seasonal conditions (temperature, rainfall) and thus disrupts the natural cycles of organisms.

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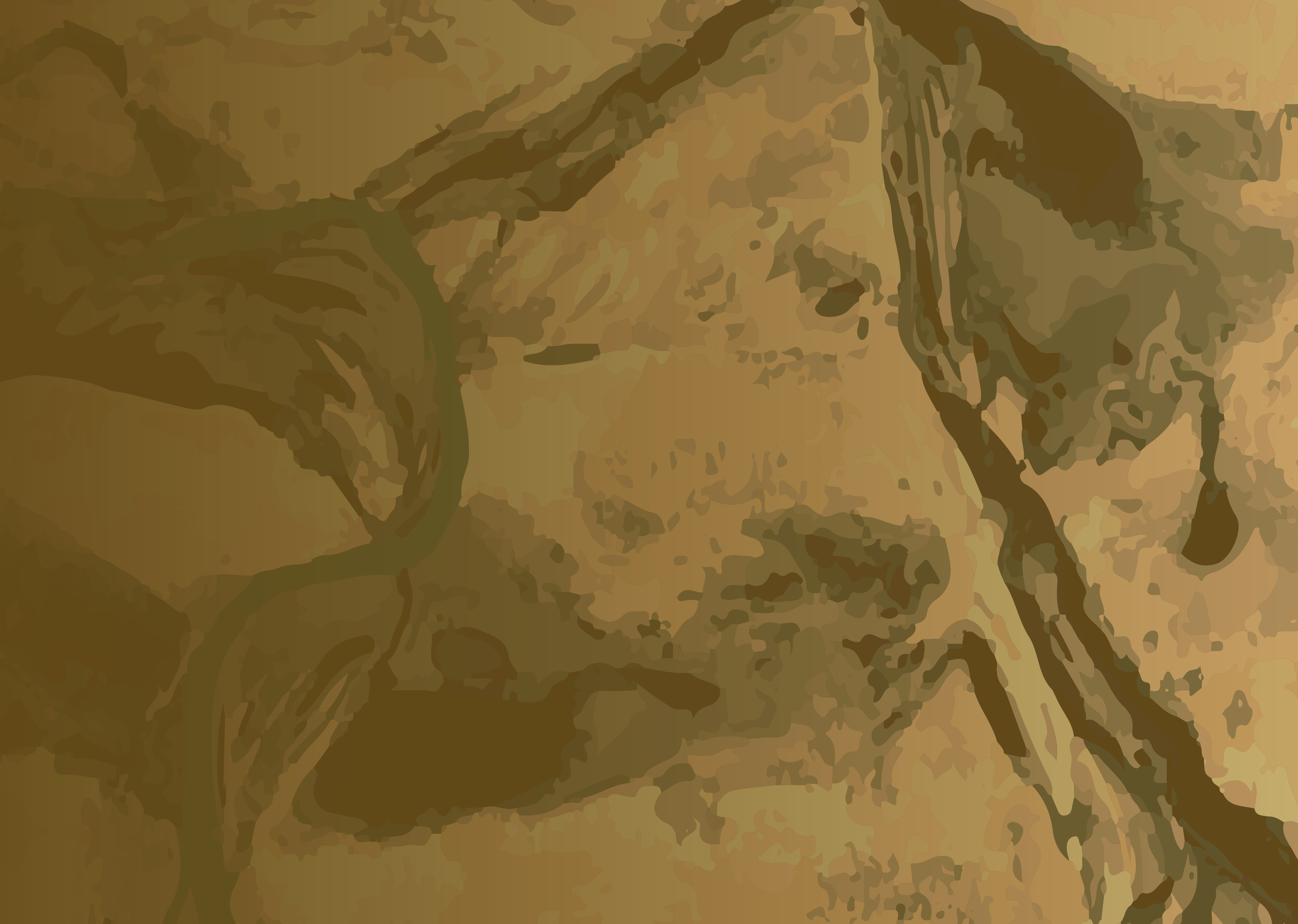
Abbreviations & acronyms

AGNES	Support Group for Experts of the African Group of Negotiators
ARLI	TerrAfrica Landscape Resilience
CAR	Central African Republic
CBD	Convention on Biological Diversity
CBZs	Critical Biodiversity Zones
COP	Conference of the Parties
COS	Strategic Orientation Committee
CRIC	Committee for the Review of the Implementation of the Convention
FAO	Food and Agriculture Organization of the United Nations
GCF	Green Climate Fund
GDP	Gross domestic product
GEF	Global Environment Fund
GHG	Greenhouse gas
IFDC	International Center for Soil Fertility and Agricultural Development
IOM	International Organization for Migration
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
JRC	Joint Research Center
LDN	Land Degradation Neutrality
NAP/CD	National action plan to combat desertification
OSS	Sahara and Sahel Observatory
SDGs	Sustainable Development Goals

SOC	Soil organic carbon
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
UNPF	United Nations Population Fund
WMO	World Meteorological Organization
WOCAT	Global overview of conservation approaches and technologies
WRI	World Resources Institute



The accelerating land degradation in Africa is compromising the economic and social development of the countries and food security of a growing population. It is the result of multiple causes including climate change which brings extreme phenomena such as droughts and flooding. In addition, it is aggravated by anthropogenic factors, such as agricultural practices, urban pressures, pollution, deforestation and overexploitation of natural resources. According to the United Nations Convention to Combat Desertification (UNCCD), 90% of land will bear the mark of Man by 2050.

This documentary book, produced on a bibliographic basis and mobilizing regional and international expertise, provides an overview of the factors and the state of land degradation in Africa, using a kit of indicators developed according to the methodology recommended by the UNCCD, namely land use change, primary productivity and soil organic carbon stock. It also presents internationally recognized prevention and rehabilitation tools that are relevant to the African continent.

Stakeholders in charge of or working on sustainable land management and the implementation of rehabilitation initiatives and prevention measures can find some of the answers they seek in this book.

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