



Regional assessment on Ecosystem-based Disaster Risk Reduction and Biodiversity in West and Central Africa

A report for the Resilience through Investing in Ecosystems – knowledge, innovation and transformation of risk management (RELIEF Kit) project



CENTRAL AND WEST AFRICA PROGRAMME



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Abbreviations

ACMAD	African Centre of Meteorological Application for Development	LDCF	Least Developed Countries Fund
AfDB	African Development Bank	NADMO	National Disaster Management Organisation (Ghana)
AMCC	Alliance mondiale contre le changement climatique	NAP	National adaptation plans
ANR	Assisted natural regeneration	NAPA	National Adaptation Programme of Action
CAF	Cancun Adaptation Framework	NBSAPs	National Biodiversity Strategy and Action Plans
CBCA	Communauté Baptiste au centre de l'Afrique	NCCAS	National Climate Change Adaptation Strategy (Ghana)
CC	Climate Change	NCF	Nigerian Conservation Foundation
CCA	Climate Change Adaptation	NEMA	National Emergency Management Agency (Nigeria)
CCAP	Climate Change Action Plan	NEWMAP	Nigeria Erosion and Watershed Management Project
CILSS	The International Standing Committee on Combating Drought in the Sahel	NGO	Non-Governmental Organisation
CPGRC	Commission en charge de la prévention et de la gestion des risques de catastrophe/ Commission in charge of preventing and managing disaster risks (Senegal)	NTPF	Non Timber Forest Product
DNEF	Direction Nationale des Eaux et Forêts (Mali)	PA	Protected area
DRC	The Democratic Republic of Congo	PARCC	Protected Areas Resilient to Climate Change (project)
DRM	Disaster Risk Management	PDD-DIN	Programme de Développement Durable du Delta Intérieur du Niger
DRR	Disaster Risk Reduction	REC	Restauration de l'Environnement au Congo
EbA	Ecosystem-based Adaptation	REDD	Reduction of emissions due to deforestation and land degradation
ECA	Economic Commission for Africa	ROC	Republic of Congo
ECCAS	Economic Community of Central African States	SAWAP	Sahel and West Africa Programme
Eco-DRR	Ecosystem-based Disaster Risk Reduction	SCCF	Special Climate Change Fund
ECOWAS	Economic Community of West African States	TEEB	The Economics of Ecosystems and Biodiversity
EM-DAT	The International Disasters Database	UNESCO-MAB	United Nations Education, Science and Culture Organisation-Man and the Biosphere Programme
EPIC	Projet Ecosystèmes pour la Protection des Infrastructures et des Communautés	UNISDR	United Nations Office for Disaster Risk Reduction
FLR	Forests and Landscape Restoration	VS	Vetiver System
GEF	Global Environment Fund	WAP	W-Arly-Pendjari Complex
GGW	Great Green Wall	WCMC	World Conservation Monitoring Centre
GIEC	Groupe d'experts intergouvernemental sur l'évolution du Climat		
GLR	Great Lakes region		
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics		
IPCC	Intergovernmental Panel on Climate Change		
ITCZ	Intertropical Convergence Zone		
IUCN	International Union for Conservation of Nature		
IWRM	Integrated Water Resources Management		
KBA	Key Biodiversity Area		

Executive summary

This assessment is being conducted as part of the RELIEF-Kit (Resilience through Investing in Ecosystems-knowledge, innovation and transformation of risk management) project implemented by IUCN. The project aims to contribute to knowledge dissemination and capacity development for the effective implementation of ecosystem-based disaster risk reduction Eco-DRR, with a focus on the role of biodiversity conservation.

The current assessment focuses on the following countries in West and Central Africa: Burkina Faso, Togo, Senegal, Mali, Ghana, Nigeria, Cameroon and Democratic Republic of the Congo (DRC). Several hazards especially droughts and floods have been recorded for many decades in the region. The Sahel is the most affected and vulnerable part of the region as it depends on rainfall patterns. The hazards have caused significant damages to people and infrastructure. In 2007, West Africa experienced the worst floods over the past 30 years with 33 deaths in Burkina Faso, 23 in North Togo, 46,000 displaced people including 26,000 in Burkina Faso and 14,000 in Togo. In the same year, 17,689 ha of flooded crops and a production loss of about 13,500 tonnes were recorded in Burkina Faso. It is worth noting that most flood-related damages have occurred in areas where natural ecosystems have been destroyed by human settlement and activities.

There is increasing recognition that ecosystems can play an important role in disaster risk reduction. The reforestation of degraded forest or woodland ecosystems with specific species screened for particular capacities/abilities (i.e. drought tolerant, flood resistant, salinity tolerant), or the management of mangroves to reduce the impacts of floods can reduce the risk of disaster. However, these Eco-DRR activities are not well known and implemented in the region. Policies are not integrated and disaster risk management (DRM) strategies do not include ecosystem and biodiversity management schemes, or vice versa. In addition to counting damages, more data should also be collected to better monitor disaster risks and develop and implement preparedness activities.

The assessment therefore suggests the following:

1. Regional and national institutions should be strengthened to better plan and implement climatic resilience for both ecosystems and people, and also climate risk management;
2. Joint capacity building initiatives for ecosystem, DRM managers and other actors should be implemented in order to help them better understand the links between DRM and ecosystem management;
3. Ecosystem managers should collaborate with all stakeholders including researchers, NGOs, communities and decision makers to effectively implement a long term strategy on resilience, disaster risk reduction that integrate ecosystem and biodiversity aspects;
4. Researchers should develop the appropriate tools (including maps) for collecting and analysing data on damages and Eco-DRR to highlight the links between DRM and ecosystem management;
5. Government institutions should develop and facilitate the implementation of integrated disaster risk management and environment/ biodiversity conservation management policies.

1. Introduction

The West and Central Africa region faces several hazards especially droughts and floods since many decades. The Sahel is the most affected part of the region, and this is exacerbated by the climate change threat (Boko et al., 2007). In the past, these hazards have affected people and ecosystems, and continue to do so as extreme weather events become more frequent due to the complexity of climate change and variability. During 2005–2015, West Africa counted not less than 17 drought events with almost 32 million affected people. Flood events have been more severe during the same period with a total of 132 events, with more than 14 million people affected, 2,000 dead and almost 400,000 homeless. Economies were also affected as it caused US\$ 830 million of economic losses (EM-DAT, 2016).

There is a need for effective solutions to such hazards and disasters. It is also important as a means to contribute to sustainable development: indeed 85 percent of people exposed to hazards such as cyclones, earthquake, floods and droughts live in developing countries, including African countries; the direct costs of damages from disasters have multiplied by 13 between 1960 and the last decade; and reducing disaster risks will guarantee the availability of enough food (UNDP, 2004). Some of the recommended approaches to address these issues include ecosystem-based adaptation (EbA) and Ecosystem-based disaster risk reduction (Eco-DRR) approaches as well as nature-based solutions. Such solutions use the benefits that nature can provide to mitigate the negative effects of natural hazards on people and ecosystems. These solutions therefore imply that ecosystems are healthy enough to cope and resist to natural hazards and other environmental disturbances, including climate change. Solutions based on ecosystem and species diversity, through mangrove or forest rehabilitation, exist in the region even though they are not directly linked to disaster risk management.

At the international level, policies and programmes support and promote the implementation of ecosystem-based approaches to adaptation and disaster risk reduction; at the regional level, the implementation of such approaches and related programmes remains low; as a result, people continue to be affected through the loss in income

generated from the ecosystems and ecosystem services that have become exposed, sensitive and unable to adapt to extreme weather events. In this regard, protecting livelihoods is crucial. By restoring degraded land or forests, we can restore and strengthen the ecological foundation for food security.

In order to reduce the gap in implementing Eco-DRR initiatives in the region and worldwide, IUCN is implementing the RELIEF-Kit (Resilience through Investing in Ecosystems – knowledge, innovation and transformation of risk management) project, which aims to contribute to knowledge dissemination and capacity development for the effective implementation of Eco-DRR. This will be achieved by, among others, assessing biodiversity and ecosystem-based disaster risk reduction (Eco-DRR).

The current assessment covers the West and Central Africa region with eight focal countries namely: Burkina Faso, Togo, Senegal, Mali, Ghana, Nigeria, Cameroon and Democratic Republic of Congo (DRC). The main objective of this regional assessment is to collect and review regional information and experience on ecosystem-based disaster risk reduction and its linkages with biodiversity. The assessment will help respond to the following questions: how Eco-DRR can contribute to biodiversity conservation? How biodiversity contributes to Eco-DRR outcomes? What are the trade-offs between biodiversity conservation and Eco-DRR. Specific examples, where they exist, will be provided to illustrate responses to the different questions.

The results of the assessment will help design programmes and plans to better take into account ecosystems when implementing adaptation and disaster risk reduction strategies in the region, and with the ambition to inform future policy decisions.

2. Methodology

A desk review was carried out to compile and analyse published and grey literature from expert institutions, scientists, practitioners, decision makers and ecosystem managers, in the specific area of ecosystem-based adaptation and ecosystem disaster risk reduction. The document includes: scientific articles, technical papers, policy documents, selected national examples/case studies, project documents and other information sources such as newspapers and web information.

Furthermore, the literature was searched and analysed using the following key words: adaptation, resilience, hazards, disasters, droughts and floods (which are the main hazards in the region), risk management, risk reduction, ecosystem-based adaptation (EbA). Most of the documents consulted can only be accessed online.

The assessment includes information from the sources below:

- Fifth National Reports to the Convention on Biological Diversity (CBD)
- National Biodiversity Strategies and Action Plans (NBSAPs)
- Review of EbA and Eco-DRR projects funded by international, regional or national donors
- National Disaster Management Plans
- National Adaptation Programmes of Actions
- Africa Environment Outlook
- Case studies from a broader literature review
- Project documents and reports/case studies
- Published articles on ecosystem-based adaptation related issues.

The desk review was complemented by structured interviews based on a questionnaire targeting stakeholders from the focal countries in order to gain more information on experiences on the ground and on ecosystem-based related activities. Stakeholders included government agencies, (mainly from the environment sector), international organisations, non-governmental organisations, research institutes, and other stakeholders involved in Eco-DRR and biodiversity activities. A total of 28 questionnaires were sent with 14 responses received from the following

countries: Mali, DRC, Senegal, Nigeria, Togo and Ghana (six countries out of eight focal countries). The list of institutions contacted is available in annex 1.

While the topic is relevant to all countries in the region, an assessment for all countries is beyond the scope of this project. Therefore, countries were selected based on the following criteria:

- Availability of information on DRR and Eco-DRR for the country
- Countries where there is an EPIC project i.e. Burkina Faso and Senegal
- Experience and/or current or past projects in DRR or Eco-DRR in the countries
- French/English speaking countries and West/Central African countries

In order to expand on the theoretical concepts, the report contains examples and case studies from the above-mentioned focal countries, some of which have been compiled from questionnaire responses. For countries where data is lacking or not accessible, regional information has been used to elaborate.

3. Regional overview

Central and West Africa has a variety of ecosystems (savannas, forests, deserts, mangroves, oceans, wetlands...), which confers its great biodiversity. The forest ecosystems of Upper Guinea, the Congo Basin, the Afromontane forests between Nigeria and Cameroon and of the Albertine Rift are considered areas of high biodiversity. These ecosystems and the associated ecosystem services, which the population depend on for their subsistence, are facing many pressures and threats including poaching, bush fires, land conversion for agriculture, as well as climate change. The Sahel region and its population, is especially exposed and vulnerable to natural hazards because of the climate conditions, its location and its social, economic and demographic characteristics. It has to cope with the increase, over the last decade, in the frequency and intensity of extreme climatic events such as droughts and floods. In West Africa, between 1900 and 2015, 170,012 people were killed as a result of drought (EM-DAT, 2016).

3.1. Climate, ecosystems and biodiversity in West and Central Africa

Climate

West Africa covers a climatic gradient characterised by annual precipitation varying from 250 mm to 3,000 mm. West Africa has wet and dry seasons resulting from the interaction of two migrating air masses: (i) hot, dry tropical continental air mass of the northern high pressure system, which gives rise to the Harmattan winds (dry and dusty) which blow from the Sahara over most of West Africa from November to February; (ii) the moisture-laden, tropical maritime or equatorial air mass which produces southwest winds. These two air masses meet at the Intertropical Convergence Zone (ITCZ). The north and south migration of this ITCZ controls the climate of the region.

The decrease in annual rainfall is seen in the shift about 200 km to the south of the isohyets (figure 1), during the last century.

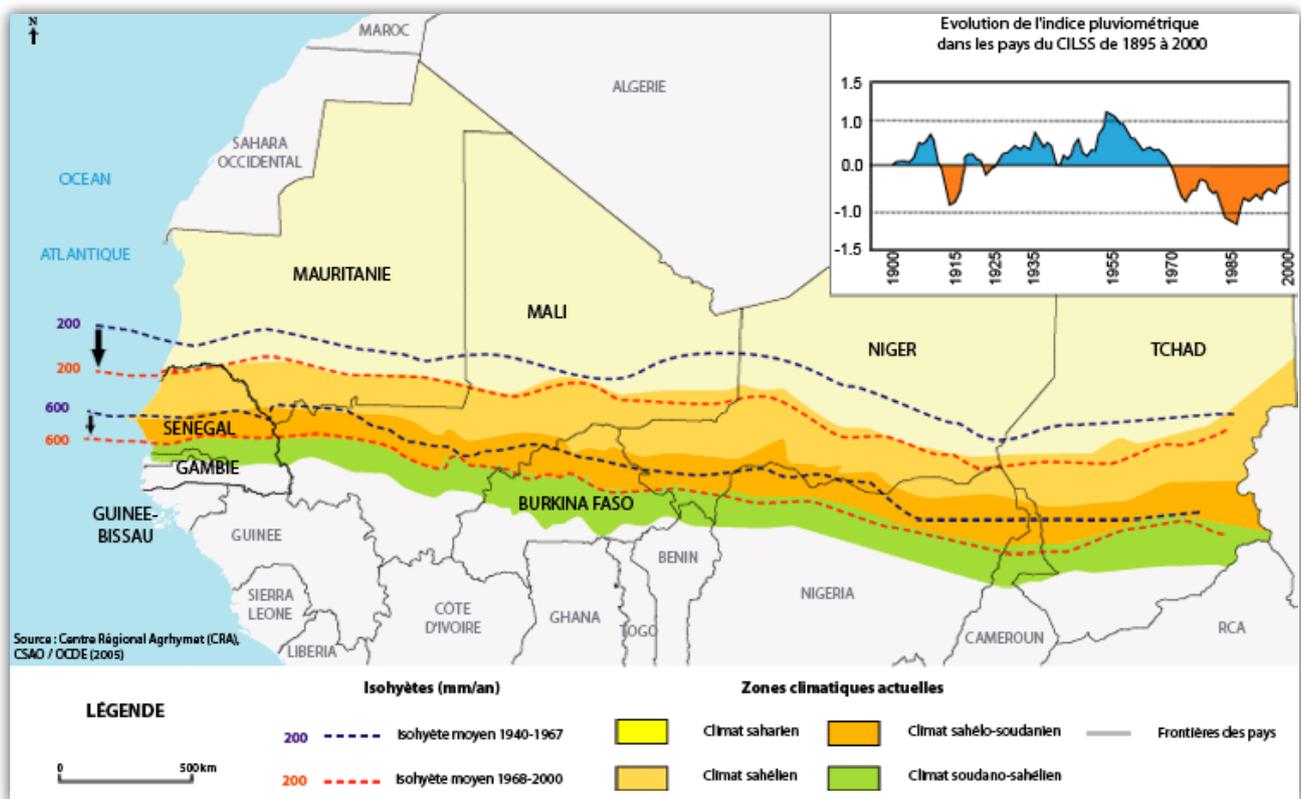


Figure 1: Rainfall and climatic zones in Sahel countries (CEDEAO, 2009)

3. Regional overview (cont.)

In West Africa and especially the Sahel region, surface temperatures increased over the last 50 years, with warming of between 0.5°C and 0.8°C from 1970 to 2010. According to the last IPCC report, temperatures could increase by 3°C to 6°C in several African regions, including the Sahel region, by the end of the century (IPCC, 2014), which is expected to lead to increased disasters. West Africa is projected to experience unprecedented and increasingly variable climates with respect to current climate conditions much earlier in the century (Janes and al., 2015).

Central Africa's climate varies from tropical-dry to humid equatorial (UNEP, 2013). Rainfall is relatively high and reliable over the central and coastal parts of the subregion but tends to diminish and become more variable towards the north. The city of Douala in coastal Cameroon, for example, has an average rainfall of 3,850 mm/year while the city of N'Djamena in Chad only receives 500 mm/year, and suffers periodic drought. Temperatures in the low-lying coastal forests vary little because persistent cloud keeps mean annual temperatures between 26°C and 28°C. In the high-relief mountainous areas, mean annual temperatures are low, between 19°C and 24°C (UNEP, 2002).

The variability of rainfall patterns confers a great diversity of ecosystems, fauna and flora species.

Expected changes in climate

Scientists have performed high-resolution regional climate modelling experiments to assess the potential changes in temperature and rainfall across West Africa. These experiments all suggest a general warming trend, in agreement with wider global climate experiments. There is also an increase in variability within the regional climate results, which could result in a greater frequency of unusually hot events. The high level of agreement across global and regional climate models for West Africa strongly suggests that a projected increase in temperature is very likely to occur. The projections of rainfall patterns with both regional and global climate modelling experiments are highly variable, and contain little to no consensus on either the direction or magnitude of potential changes in rainfall. (Janes et al., 2015).

The greater frequency of hot events may also lead to an increase in the frequency of droughts,

The ecosystems in West Africa are:

- The tropical rainforest (1,500 mm to 3,000 mm of rain), with a diversity of habitats, including mangroves, as well as a diversity of fauna and flora
- The savanna forest ecotone (1,300 mm to 1,500 mm of rain) houses a savanna and forest species mosaic as well as unique habitats for the numerous migratory species
- The savanna (800 mm to 1,500 mm of rain) is characterised by the coexistence of tree and grass species and is the area favoured by the large African mammals
- The Sahel (200 mm to 500 mm of rain), a vast area with a large variability of biological forms adapted to xeric conditions with an impressive diversity of Acacia
- The desert (less than 200 mm of rain), representing the driest part of the subregion, which holds fewer species; however, due to the extreme conditions of life, it possesses potentially significant genetic diversity
- Coastal and marine ecosystems (including islands and estuaries) that host part of the most remarkable biodiversity of the region, including coral reefs of Cape Verde
- Aquatic ecosystems (coastal and continental) with its main watercourses (Niger River, Senegal River, Gambia River, Lake Chad network), which host many plant and animal species and play an important role in flood control.

(Thiombiano & Kampmann, 2010; Diop, 2007)

with impacts on ecosystems and livelihoods in the region, with low levels of productivity of ecosystems and crops (UNFCCC, 2007).

Ecosystems and biodiversity

The Central and West Africa region is endowed with a great diversity of landscapes, including savannas, forest, mangroves, flood plains, deserts, lakes and

3. Regional overview (cont.)

oceans. These ecosystems are very rich in animal and plant species. For instance, the ecosystem of Upper Guinea, the afro-montane forests on the frontier between Nigeria, Cameroon and the Albertine Rift, and the rainforests of the Congo basin, are considered areas with high biodiversity values including high endemism. The Guinean forest ecosystem includes the Upper Guinea Region that stretches over five countries (Liberia, Côte d'Ivoire, Ghana, Togo and Benin) and the forests of the south of Nigeria and part of those of Cameroon. It is a priority zone for the conservation of biodiversity (“hotspots”) at the international level due to the significance of its specific richness, the high rate of endemic species and also due to threats to its biological diversity (Conservation International, 2011). The tropical forest of Gola in Sierra Leone, which is part of this area, was declared to be a national park by the Government of Sierra Leone in 2011, because it represents one of the last vestiges of the forests of Upper Guinea in the country and is home to a large number of rare and endangered species both locally and worldwide, including the White-necked Picathartes. In Mali, the inland delta of the Niger River (Ramsar site) extends across more 30,000 km² and constitutes one of the most remarkable ecological features of the country (DNEF, 2014).

The forest of the Congo basin stretches from the coast of the Atlantic Ocean in the west, to the Albertine Rift mountains in the east, and is the second largest contiguous block of tropical forest in the world. Of the 400 million hectares constituting the Congo basin, nearly 200 million are covered by the forest, including 90% of dense tropical forest. More than 99% of the forest surface consists of primary or naturally regenerated forests. The distribution of the various types of forests is strongly correlated with annual precipitations.



Figure 2: Hotspots of West and Central Africa (Conservation International, 2011)

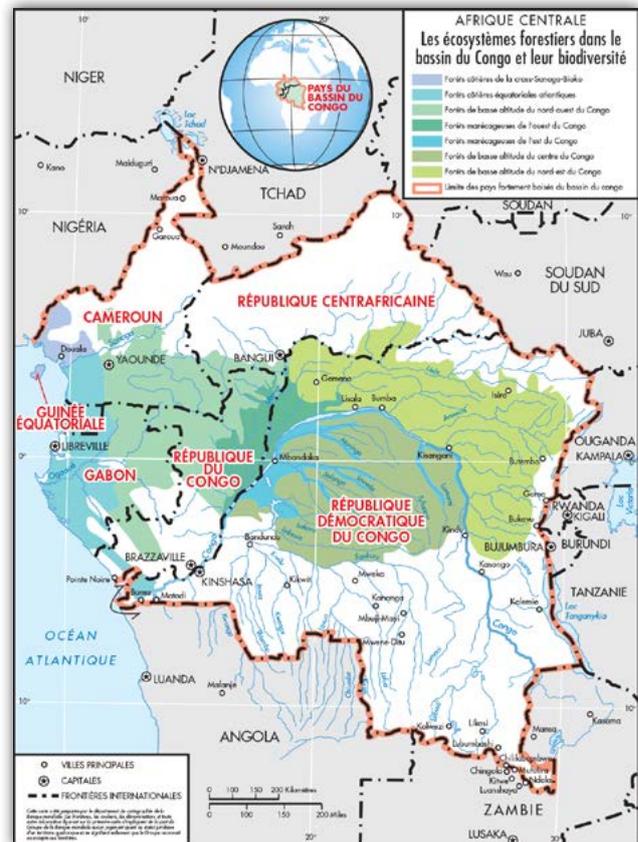


Figure 3: Forest ecosystems in the Congo Basin and their biodiversity (Megevand, 2013).

The forests of the north are subject to a severe, hot dry season while the rest, in particular the forests of the west, experience milder dry seasons (Megevand, 2013).

African wetlands are among the most diversified habitats in the world in terms of animal and plant species, including endemic species, and migratory species such as the West African manatee and many waterbird species that depend on this important ecosystem for their survival. They also play an important role in the regulation of greenhouse gases as they store carbon, thus contributing to climate change adaptation as an important carbon reservoir. West Africa alone contains 30% (80 sites out of a total of 275) of the wetlands of international importance present on the African continent (Ramsar, 2007).

Mangroves are coastal forests particularly found in tropical and subtropical regions; these areas are frequently inundated with salt water. They are among the most productive ecosystems on the planet. African mangroves are home to very diverse

3. Regional overview (cont.)

fauna. Their roots and mud are home to molluscs, such as bivalves and oysters, and crustaceans. Live and decaying mangrove leaves and roots provide nutrients that nourish plankton, which in turn are food for many of these species. With this abundance of food, mangroves function as nurseries for many fish species; many commercially caught fish have spent part of their lives in mangroves.

Their capacity to protect against storms and sea level rise make them indispensable for coastal communities in their fight against climate change. The African country with the largest mangrove area is Nigeria with 1 million ha¹.

The forests of the Congo basin host a rich biodiversity with a very high level of endemic species. Forests of low altitude consist of more than 10,000 species of higher plants, of which 3,000 are endemic. The forests are also home to elephants and buffaloes, as well as endemic species such as the okapi, the bongo, the bonobo, the gorilla, and many endemic bird species. The flora and fauna are, however, unequally distributed, so that the wealth in species varies from one area to another. The areas that are home to the largest variety of species are the forests of Low Guinea to the west (Cameroon, Equatorial Guinea and Gabon) and those of the Albertine Rift in the eastern part of the Democratic Republic of Congo (Megevand, 2013). The Democratic Republic of Congo is part of the Great Lakes region (GLR); the lakes of this region host a great diversity of fish fauna with at least 1,419 freshwater fish species recorded. Most of these species are endemic; they are also globally threatened (40% of the African total of fishes mentioned in the IUCN Red List of Threatened SpeciesTM). The GLR also hosts an important number of terrestrial (168) and freshwater (108) Key Biodiversity Areas (KBAs) (Birdlife, 2016).

Protected areas are one of the approaches recognised to protect this important biodiversity. They are defined by the IUCN as “A protected area is a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values”. According to the world database on protected areas (IUCN and UNEP WCMC, 2013), there are more than 2,500 protected

areas in West and Central Africa. Terrestrial protected areas in West Africa represent around 8% of all protected land worldwide, and marine protected areas only 2.5%. This situation is far from Aichi Biodiversity Target 11, which aims to ensure at least 17% of terrestrial and inland water areas and 10% of marine and coastal areas are effectively conserved.

Certain sites in the subregion are recognised internationally (Ramsar, UNESCO-MAB, World Heritage). For instance Nimba Hills Natural Reserve (Guinea), Oiseaux du Djoudj National Park and Niokolo Koba National Park (Senegal) or Virunga National Park in DRC are on the UNESCO World Heritage List, although some of them like Virunga are inscribed on the List of World Heritage in Danger.

Protected areas play an important role in carbon regulation. It is estimated that approximately 15% of carbon is stored in the world's protected areas (IUCN/WCPA, 2007).

Ecosystem services and livelihoods

The goods and services provided by the ecosystems can be classified in four main categories:

- Provisioning services such as food, water, wood, fibre.
- Providing services such as climate regulation, water flow, disease control, waste decomposition, and water purification.
- Cultural services such as spiritual benefits, recreational and aesthetic values.
- Supporting services such as photosynthesis, soil formation and nutrient cycling.

(Millennium Ecosystem Assessment, 2005).

West and Central Africa ecosystems, including those that are in protected areas, provide such goods and services and the population benefit from them. In West Africa, cereals and tubers constitute the staple diet of the rural communities. The small wild game also often constitutes an important source of animal protein. Other resources, particularly non-timber forest products (NTFP), are a source of income for people and their families; they include for instance honey, shea butter and wild fruits. Culturally, certain species of animal are used during ancestral rites in villages or during ceremonies (weddings, funerals).

¹ <http://africa.wetlands.org/Africanwetlands/Mangroves/tabid/2938/language/fr-FR/Default.aspx>

3. Regional overview (cont.)

The majority of the population living in the Congo basin forest is still indigenous, and directly depends on the forest products. The non-timber forest products include the products of the hive (honey, wax, propolis), wild mango, the pygeum, gum arabic, nuts, fruits, larvae, mushrooms, raffia and bamboo. Their use varies according to the culture, socio-economic status, access to the forest, markets and prices and, to a certain extent (in particular for bush meat), on whether the harvest is legal or not (Megevand, 2013).

The ecosystems also provide other services such as regulation of rainfall, protection against strong winds and flood control especially in Central Africa where rainfall is important, and providing raw materials such as timber for construction and firewood, fruit, seeds, animal fodder and medicinal substances. Other additional advantages include climate regulation at the regional level, which increases climate change resilience. Indeed, the forests of the Congo basin have the ability to sequester great quantities of carbon. The tropical forests store a quarter of the world's terrestrial carbon stock present in the vegetation and ground (Megevand, 2013). Even if the figures vary, total carbon stored in the Congo basin is estimated at approximately 60 billion tonnes, the greatest part being in the Democratic Republic of Congo. But deforestation and degradation of the forests constitute a major source of carbon emissions. It is estimated that 10% to 25% of global anthropogenic emissions result from the loss of natural forests (Megevand, 2013).

In terms of socio-economic importance, protected areas constitute a source of employment for local communities as they may find jobs as tour guides for instance or trackers.

Threats to biodiversity, ecosystems and ecosystem functions

African ecosystems and the associated ecosystem services, which have significance for the people living in the countries of the region, are unfortunately facing many pressures and threats including: poaching, illegal fishing, uncontrolled bush fires, illegal grazing, over-use of timber, mining, land conversion for agriculture, and climate change. Wildlife biodiversity is declining, including in protected areas. Craigie et al. (2010) have reported a decline in the large mammal population in West African protected areas. Another research study quantified the extinction of three large carnivore species (*Panthera leo* (lion), *Acinonyx jubatus* (cheetah) and *Lycaon pictus* (wild dog) in 41 West and Central African Protected Areas, and they found 63%, 73% and 90% of site extinction respectively (Brugière et al., 2015).

The populations of large mammals living in West Africa such as elephants have become vulnerable due to the destruction of their habitat and poaching. Now, the largest populations of elephants (around 4,500 individuals) are found within the W-Arly-Pendjari (WAP) complex of protected areas between Niger, Burkina Faso and Benin (European Commission, 2010). As for lions, a recent study shows that their numbers in West Africa are constantly decreasing and are now estimated at 406 individuals (Henschel et al., 2014). Other species, such as the Western black rhino (*Diceros bicornis longipes*) have already disappeared from the subregion (Emslie, 2011).

In Africa, even if the annual loss of forests in 2010–2015 remains high (2.8 million hectares), the FAO assessment report for 2016 reports that the rate of loss has decreased from the previous five-year period (FAO, 2015). The main causes of biodiversity loss in the African countries are essentially the destruction of natural habitats, which leads to their fragmentation, erosion and the impoverishment of soils. Other indirect causes include: poverty, rapid population increase, uncontrolled urbanisation, pollution, and the introduction of non-native species that have become invasive, causing harm to the environment. The Guinean forest is an important sanctuary of West African biodiversity but is also one of the most vulnerable regions of the planet

3. Regional overview (cont.)

because it is critically fragmented. In 2010, only 15% of the original forest cover of this hotspot remained intact (Thiombiano & Kampmann, 2010).

In particular, climate change is considered as the main threat to biodiversity (IPCC, 2002). The rise in air temperature, change in rainfall patterns and increase in the frequency and intensity of extreme climatic events such as droughts and floods are some of the manifestations of climate change. In the Sahel region, for example, average rainfall has decreased by 25% (UNFCCC, 2006) in the past 30 years. Wetlands can be negatively affected by climate change through rising sea level, and the intrusion of salt water into freshwater resources. Likewise, climate change has negative impacts on the composition, diversity and functioning of freshwater ecosystems. Warming and hence the increase in water temperature will alter communities' composition including the composition of fungi, with a direct consequence on rates of organic matter decomposition. This has impacts on food webs; as a result, some species on the trophic chain may no longer be available (migration or death) with changes in prey and predator distribution, composition and diversity (Woodward et al., 2010).

Increasing demographic pressure, poor knowledge of the law and poor law enforcement, poverty as well as climate change exacerbate these threats.

With the many threats affecting biodiversity and ecosystems, resilience becomes an important concept as it concerns the ability of ecosystems to resist and recover from these disturbances. There are different sorts of environmental changes that should be considered: they may be rapid-onset (e.g. disease), chronic (e.g. habitat loss), or transitory (e.g. drought) perturbations. Of course, the impacts of environmental perturbations on ecosystem functions will depend on the presence of ecosystem characteristics that confer resilience. Oliver et al. (2015) described some of the mechanisms that characterise an ecosystem as resilient including: species sensitivity to environmental change, adaptive phenotypic plasticity, genetic variability, local environmental heterogeneity and landscape connectivity.

3.2. Hazards in West and Central Africa and most vulnerable countries

In sub-Saharan Africa, the number of disasters has considerably increased in frequency and intensity especially regarding extreme climate events such as droughts and floods. During the last four decades, more than 1,000 disasters occurred in sub-Saharan Africa, among which 300 disasters between 2005 and 2010 affected more than 330 million people. Drought and floods together account for 80 percent of loss of life and 70 percent of economic losses linked to natural hazards in Sub-Saharan Africa (World Bank, 2010).

Main hazards in West and Central Africa include: floods, droughts, landslides, sea level rise, invasive species and locust invasion, extreme temperature (heat waves), windstorms (violent winds) and gullies erosion. In addition to the above, there is strong coastal erosion along the whole West Africa coastline, from Mauritania to Nigeria. At the same time, soil erosion and desertification, which also threaten food security, continue to develop due to these extreme weather events. These hazards are a consequence of climate change, and they sometimes lead to disasters. Geological disasters, such as earthquakes and volcanoes, occur to a lesser extent (World Bank, 2010).

The most vulnerable and poor people are more severely affected, especially people that depend on agriculture for their livelihoods. Indeed the climatic risks lead to deficits in production, loss of cattle, and reduced availability of fisheries and forest resources (FAO, 2011).

Droughts have particularly become more frequent since the late 1960s in the Central African Sahelian zone, leading to food insecurity and crisis, particularly among the poor (UNEP, 2002). Flooding is common in the more humid areas of Central Africa, especially where forests and natural vegetation have been cleared for cultivation or human settlements. Indeed, forests, including forest protected areas, play a very important role in protecting the ecosystem from floods because they provide space for water to disperse (Dudley et al., 2010). Almost bare soils without proper vegetation cover will therefore become more vulnerable to floods. In Central Africa, in the

3. Regional overview (cont.)

past 30 years, commercial logging, commercial or subsistence agriculture, and collection of firewood have led to extensive clearing of forests. Reduction of vegetation cover exposes the soil and worsens the impacts of drought and flooding (UNEP, 2002).

The figure below shows the number of reported disasters in West Africa, from the EM-DAT Database (2016), from 1900 to 2015.

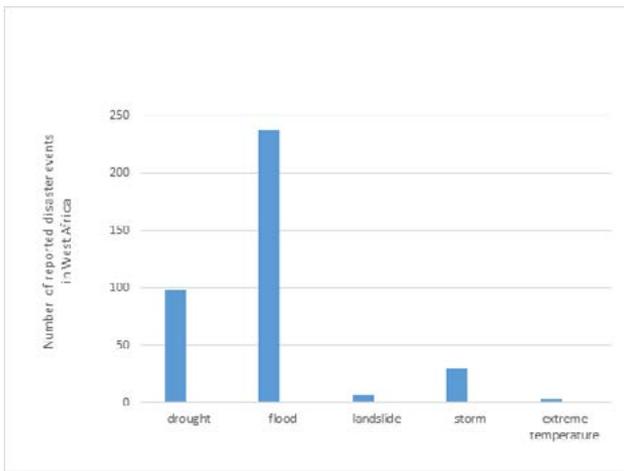


Figure 4: Number of reported disaster events in West Africa, 1900–2015*
Source: EM-DAT Database (2016)

**Note: the database does not include the Central Africa region, but includes individual Central African countries.*

The graph above shows that the two main hazards in West Africa are droughts and floods. Droughts are particularly important in the Sahel region because rainfall tends to be reduced in this region (see section 3.1 above).

From a recent study which analysed the links between climate change, protected areas and communities in different sites in West Africa, the main climate hazards identified by the local communities interviewed and in the literature review are: drought, flooding, strong winds, heatwaves, irregular rainfall, and sea level rises for coastal areas (Masumbuko & Somda, 2014). West Africa has experienced droughts since the 1970s. This is due to climate variability. Rainfall variability, for instance, is considerable and often reaches 40–80% (African Studies Center, 1999).

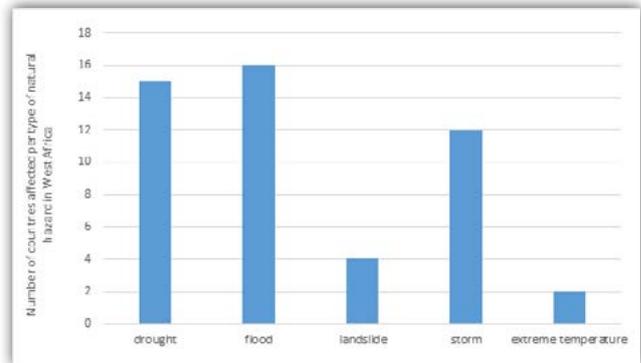


Figure 5: Number of countries affected per type of natural hazard in West Africa, 1900–2015
Source: EM-DAT Database (2016)

The region is also exposed to rising sea levels in the coastal countries. In West Africa, the areas that are most vulnerable to sea level rise or extreme oceanic events (extremely high tides) are the most populated areas, sometimes the most urbanised given that the capital cities and greatest urban centres of countries like Senegal, Guinea Bissau, Liberia, Togo, Benin, Cote d'Ivoire, etc., are located on the coast. In the Gulf of Guinea, sea level rise could submerge (even destroy) immersed land in coastal lagoons, whereas changing precipitation patterns could affect the flow of rivers which supply them (UNEP, 2002). This situation also affects many rural communities on the coast that rely on land and water resources for their subsistence: in particular, increased salinisation due to sea level rise will affect the ability of the surrounding land to produce, for instance, vegetable products.

The region experiences the risk of landslides, which is high in countries with hilly terrain, high levels of rainfall, soil erosion and deforestation due to unsustainable land management (World Bank, 2010). Soil erosion, especially gully erosion, an advanced level of land degradation that can irreversibly affect the soil's productivity is seen in northern Cameroon as well as in southern Nigeria. In this part of Nigeria, there are an estimated 3,000 gullies, which can be up to 10 km long with multiple fingers spreading through the rural or urban landscape. In southeastern states, gullies and areas exposed to erosion tripled; the total area affected by rill, sheet or gully erosion has increased from about 1.33% (1,021 km²) in 1976 to about 3.7% (2,820 km²) in 2006 (World Bank, 2011).

3. Regional overview (cont.)

In West Africa there are important areas of seasonal breeding sites of pests such as the desert locust, the Senegalese locust, seed-eating birds and rodents; these areas are vulnerable to epidemics and to invasions on a large scale in favourable ecological conditions. The seasonal breeding sites in the subregion are mainly in Chad, Mali, Mauritania and Niger. The presence of these devastating pests, as well as their distribution depends on the climate. For example, increased rainfall, especially beyond the usual season, and consequently the expansion of the wetlands, can be favourable to the development of the desert locust and the red bug of the cotton plant. Regular surveillance in the breeding zones allows control at an early stage before these zones grow wider and are difficult to contain.

The graph below shows the number of countries of West Africa affected per type of natural hazard from 1900 to 2015.

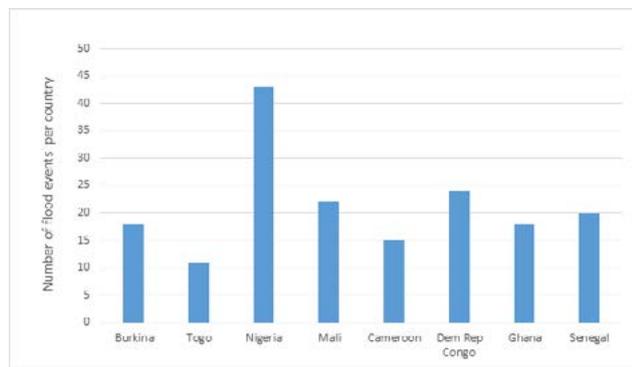


Figure 6: Vulnerability of countries to floods in West and Central Africa, 1900-2015

Source: EM-DAT (2016)

Here again, drought and floods are the most important hazards affecting the countries of West Africa. All the countries of the subregion have been affected by floods, and almost all of them have been affected by droughts. So these events occur everywhere in West Africa; this probably explains the great number of programmes directed towards minimising the incidence of, and increasing the resilience to, droughts and floods.

The graphs below show the number of flood and drought events in the focal countries, and therefore give information on the most vulnerable

countries to these hazards. The countries most vulnerable to droughts are the Sahel countries.

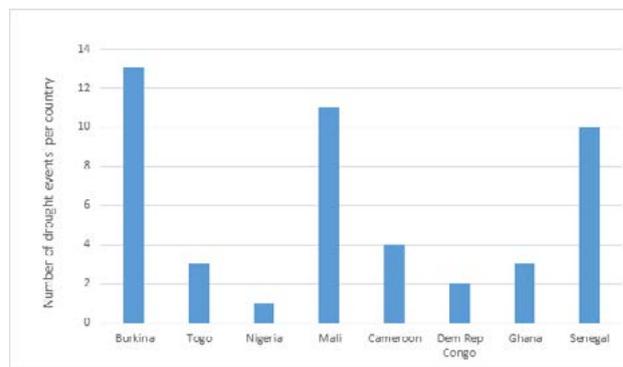


Figure 7: Vulnerability of countries to droughts in West and Central Africa, 1900-2015

Source: EM-DAT (2016)

Volcanic eruptions have been recorded in DRC. The Nyiragongo volcano is one of eight volcanoes in the Virunga Mountains. The volcano is located near the town of Goma in the eastern Democratic Republic of Congo and is one of the most active volcanoes in Africa. Major eruptions occurred in 1977 and in 2002; in 2002 the lava flows reached the city of Goma. The 2002 eruption of Nyiragongo displaced 500,000 people. The Nyiragongo volcano contains an active lava lake; this activity is regularly monitored at Rusayo seismic station <http://www.volcanolive.com/nyiragongo.html> (5 April 2016).

Africa is considered the most vulnerable region to the effects of climate change in the world (Boko and al., 2007). This vulnerability is aggravated by the high dependence of large populations on natural

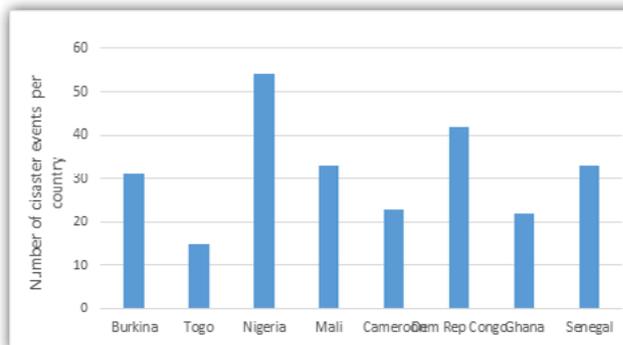


Figure 8: Vulnerability of countries to disasters, 1900-2015 (EM-DAT, 2016)

3. Regional overview (cont.)

resources, including marginalised communities, who are affected through reductions in income and unavailability of food from agricultural production. The fact that agriculture in Africa is mainly dependent on rainfall means that small changes in rainfall patterns can significantly jeopardise the livelihoods of most producers (UNEP, 2013).

Countries located in the Sahel are the most vulnerable: among the countries selected for this study, Mali for instance has a Sahelian climate, characterised by great inter-annual rainfall variability, leading to recurrent dry years which have become increasingly frequent since 1968 (Masumbuko and Somda, 2014).

The figure below shows the vulnerability of the focal countries to natural disasters by showing the number of disaster events during the period 1900–2015.

All focal countries are almost equally affected by natural hazards, but not necessarily the same ones. For instance, countries like Burkina Faso and Mali will mainly suffer from droughts, whereas Nigeria, Togo and Senegal will be affected by sea level rise or erosion. Cameroon and DRC have to face other hazards (geological) related to volcanoes.

Wildfire is not considered a natural hazard in West and Central Africa because it is managed by people for agropastoral activities and hunting activities. Wildfire becomes uncontrolled in this region when it spreads due to environmental conditions that increase the risks of uncontrolled fire and stimulate its spreading. For instance, extreme temperature, strong winds and drought conditions are the triggers of uncontrolled wildfire, which can destroy large areas of forest. Drought periods (due to climate variability), especially if they are severe and successive can exacerbate the risks and occurrence of wildfire. This was the case in Chad that experienced two great droughts in 1984/1985 and in 1993/1994, and which caused drying of ecosystems making it more vulnerable to wildfire. As a result, it caused widespread wildfire and destroying the habitat of certain wildlife species (Boulanodji, 2014).

3.3. Overview of impacts of disasters in the region

Natural hazards are a consequence of climate change and variability. It is projected (likelihood >90%) that heavy rains, floods and heat wave events

Some of the hazards and their consequences in West Africa since 2005.

2005: between the 16 and 22 August, Dakar recorded 367 mm of rain, which is more than half of the annual average cumulated rainfall. Many dwellings in the suburbs and along the main road were flooded.

2007: The worst floods in West Africa over the past 30 years with 33 deaths in Burkina Faso, 23 in north Togo, and 46,000 displaced people including 26,000 in Burkina Faso and 14,000 in Togo. In Burkina Faso, 17,689 ha of flooded productive land, with production losses of about 13,500 tonnes, 55 dams destroyed.

2008: Strong rains in the region of the High Plateaus in the centre of Togo destroyed thousands of hectares of arable land, as well as more than 30,000 houses and 6 dams, more than 10,000 displaced people, 20 dead, 68 bridges

collapsed including the bridge of Main road 1 in Amakpapé. In Benin, this resulted in the destruction of 25,000 ha of food crops and 1,204 ha of cotton fields, approximately 53,674 producers affected. Damage estimated at CFA 9.4 billion.

2009: strong rains and floods in Burkina Faso: Ouagadougou and its surroundings, which recorded a cumulated rainfall of 263 mm between 1 and 2 September 2009. These rains were 130% higher than the 90th percentile (extreme rains) causing more than 150,000 victims and 8 dead, the destruction of several bridges; more than 9,300 ha of productive land were flooded in the whole country, destruction of 30% of the national water supply system.

Adapted from Sarr, 2009. Source: DPC, Senegal, 2009 (data for Cap Vert and Chad not available)

3. Regional overview (cont.)

will become more and more frequent and intense in the world (OMM, 2007). In Africa, food is highly dependent on rain-fed agriculture; the variation in rainfall patterns therefore has an impact on people's livelihoods and well-being. In addition to the decline in animal and plant biodiversity used by people, the reduction in grazing land, drop in crop yields and animal production may lead to decreased household income, food insecurity, health problems and increased poverty in general. This has been reported in West Africa (Masumbuko & Somda, 2014).

During the past ten years in West Africa, several extreme climatic events have caused major damages that have affected infrastructure, people and biodiversity. In the Gambia, for instance, most affected by flooding were houses, communications (roads and telephone lines) and crops. More than 18,000 people were affected by food insecurity due to flooding, violent winds and forest fires in 2009. In 2010, 34,990 people were affected by flooding, the most affected areas being those with the highest population densities (Tanji, Tanbi and the area of Banjul) (Sonko, 2013).

In West Africa, in 2009 the irregularity of the rains in Niger and Chad, and in the north-east of Mali, the north of Burkina Faso and the extreme north of Nigeria, caused severe shortages in food production, and fodder and water for cattle. This situation directly contributed to the food and nutrition crisis of which more than 10 million people were victims in 2010.

Table 1: Number of people killed in West Africa as a result of disasters, 1900-2015 (EM-DAT, 2016)

Number of people killed (West Africa)	Natural hazards
170,012	drought
3,319	flood
82	landslide
540	storm
78	extreme temperature

In 2010 with the abundant rainfall, food availability was improved but the rain also caused serious floods that caused severe damages to crops. In total 1.8 million people were affected and more than

141,000 hectares of food and cash crops were destroyed, in particular in Benin (more than 73,000 hectares), Chad (52,600 hectares), Burkina Faso (6,500 hectares), Niger (5,000 hectares) and to a lesser extent in other countries like Ghana, Mali, Gambia, Guinea, Senegal and Sierra Leone. Livestock were also affected by the floods that caused the death of many cattle by drowning or because of water-related diseases (more than 70,000 heads of cattle lost in Niger and 3,000 in Mali) (FAO, 2011).

In 2010, floods in the White Volta River Basin in Ghana affected hundreds of thousands of people and destroyed many of their livelihoods. Major cities in the country are regularly affected by urban floods².

The graph below gives an idea of the economic damage of natural hazards. Here, floods are the most costly hazards, followed by droughts. Given the different data presented in the graphs we can easily state that droughts and floods in West Africa are: the most common hazards found, the hazards affecting more people and countries, and the hazards that cost the most in terms of economic damage. There is therefore an urgent need to enhance and optimise the resilience and recovery (including restoration of ecosystems affected) of both people and the ecosystems.

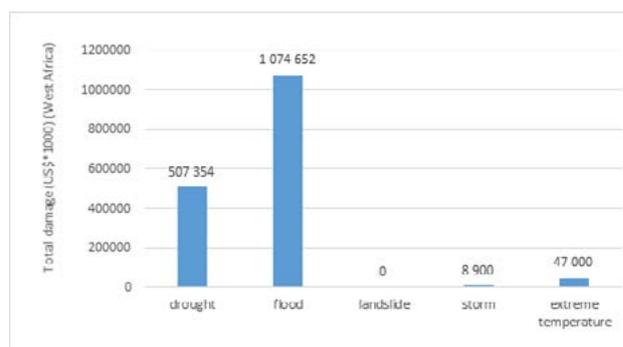


Figure 9: Total damage in West Africa as a result of disaster (in US\$). (EM-DAT, 2016)

In south-east Nigeria, gullies create damage to infrastructure including roads, highways and pipelines, houses and buildings that collapse, and silted waterways, reservoirs and the Calabar (major city) port. Damage to natural resources includes loss of productive farmland and forest. Forest and farmland

² <https://www.gfdr.org/sites/gfdr/files/region/GH.pdf>.

3. Regional overview (cont.)

The impact of gully erosion on one rural community in Nigeria

In 1986, the Agbaja-Ngwo reservoir was built to supply water to Enugu township. According to the Imeama-Ngwo community, the drainage channel for the reservoir should have been directed into the stream running down the hill, but was not. Instead, the channel ended close to the reservoir, resulting first in rill and sheet erosion, but which quickly grew into a large and expanding gully. Since the erosion occurred, this has affected the community sacred forest, and the trees of several families where many residents have their cashew and oil palm trees as well as other cash crops. This land is now cut off from them, requiring them to travel long distances to reach their farms. The community is also cut off from other communities, affecting their social linkages. To address erosion, the community has planted cashew trees and grasses along one gully finger, but the gully continues to expand. An additional problem has been the silting of the stream where residents used to get their water. The residents complained that although the reservoir is on their land so that other people can have a good water supply, the community itself does not have adequate drinking water. To overcome this, the residents practise water harvesting during the rainy season or now have to buy their water. The situation continues to worsen (World Bank, 2011).

exclusively based on rainfed agriculture, women are therefore vulnerable because they depend on climate conditions and environmental factors. The vulnerability of women is also related to the fact that their access to the means of production, in particular to credit, inputs (seeds, manure, plant health products) and to farm equipment, is limited. Furthermore women do not have easy access to the officially acknowledged property rights, as well as the usual land tenure systems, which increases their vulnerability to the effects of natural hazards such as drought. It is therefore important that gender consideration, especially the vulnerability of women, be better integrated in all policies related to disaster risk management (FAO, 2011).

degradation also compromise watershed functions. This process exacerbates erosion downstream and siltation, compromises biodiversity important for livelihoods, and weakens natural buffers against climate and erosion risk.

It is important to note that in West Africa, women are particularly affected by disasters, and therefore are more vulnerable than the men to the crises and impacts. Women represent more than 43 percent of the employed population of the agricultural sector in the subregion. Given that agricultural production dedicated to subsistence in this subregion is almost

3. Regional overview (cont.)

3.4. Country profiles

Burkina Faso



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Key indicators	Unit	in % of region (West and Central Africa)
Land area (km ²)	274,200	2.3%
Forest area (km ²)	56,490 ³	1.98%
Volta River Basin (km ²)	400,000 ⁴	43% of river in Burkina
Niger River Basin (km ²)	2,262,000	Extends across 10 countries ⁵
Total population	16,934,839	3.86%
Urban (% of total population)	28.1	
Rural (% of total population)	71.8	
GDP (million US\$)	11,582.556	

Period 1975–2015	Unit	in % of region (West and Central Africa)
Registered hazards	49	4.9%
Deaths	16,822	15.5%
Affected people	12,246,261	10.2%
Economic losses ('000 US\$)	181,176	12%

Source: elaborated based on World Bank (2016), EM-DAT (2016), FAO (2015), https://fr.wikipedia.org/wiki/Bassin_du_Niger, and Prevention web

Natural hazards

Burkina Faso reported 49 natural hazard events during the period 1975–2015. The figure below shows that drought, floods and epidemic were responsible for 18%, 37% and 45% of the total occurrence of natural hazards, respectively. The impacts of these events resulted in more than 16,000 deaths and affected more than 12 million people.

Table 2: Natural hazards in Burkina Faso, 1975-2015 (EM-DAT, 2016)

Disaster type	Number	Total deaths	Total affected
Drought	9	0	11,438,290
Epidemic	22	16,667	193,789
Flood	18	155	614,182
Total	49	16,822	12,246,261

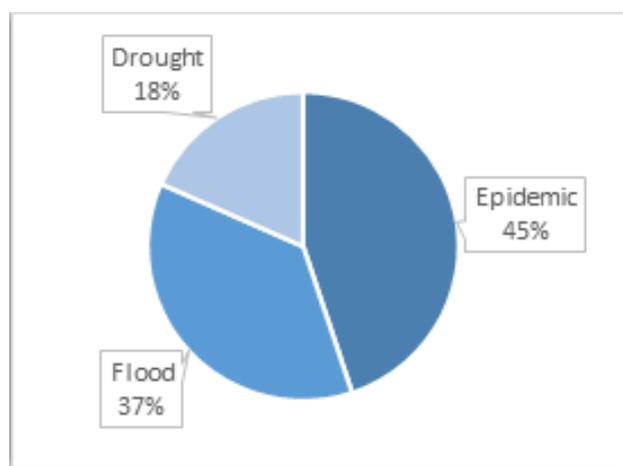


Figure 10: Most common hazards in Burkina Faso, 1975–2015

Source: elaborated based on EM-DAT (2016)

Among all the selected countries, Burkina Faso had the highest number of drought events (9) during the period 1975–2015, which represents 10.9% of the total occurrence of droughts in West Africa and Central Africa (82). They did not cause any deaths but affected almost 11,500,000 people. Flood events caused economic damages to the country with US\$ 181 million losses, US\$ 150 million for the year 2009

³In 2010

⁴IWMI, 2005

⁵Algeria, Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Guinea, Mali, Niger, Nigeria, Chad

3. Regional overview (cont.)

alone. The highest number of people affected was also reported during this year (151,000).

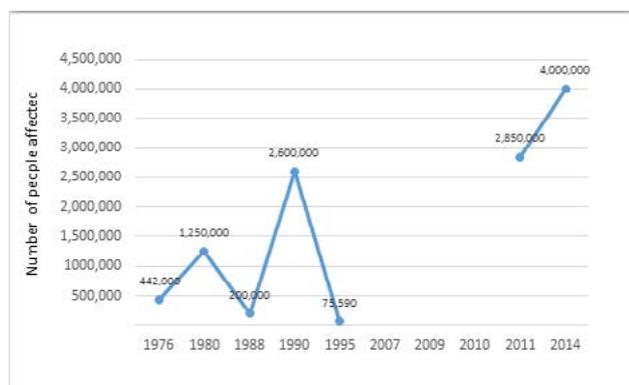


Figure 11: Number of people affected by droughts in Burkina Faso, 1975–2015

Source: elaborated based on EM-DAT (2016)

Burkina Faso represented one of the countries with the highest occurrence of droughts in West and Central Africa (11%) and also in the West Africa region (15%). However, flood events represent twice (36% of total) the occurrence of drought events (18% of total) in the region, and there were reported mortalities for floods, whereas for drought only affected people were reported.

Mali



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Key indicators	Unit	in % of region (West and Central Africa)
Land area (km ²)	1,220,190	10.6%
Forest area (km ²)	47,150	1.65%
Volta River Basin (km ²)	400,000	15% of river shared between Mali, Togo, Benin, and Cote D'Ivoire
Niger River Basin (km ²)	2,262,000	Extends across 10 countries
Senegal River Basin (km ²)	289,000	53.6% in Mali
Total population	15,301,650	3.5%
<i>Urban (% of total population)</i>	38,363	
<i>Rural (% of total population)</i>	61,637	
GDP (million US\$)	10,942.727	

Period 1975–2015	Unit	in % of region (West and Central Africa)
Registered hazards	47	4.7%
Deaths	3,541	3.27%
Affected people	7,230,500	6.04%
Economic losses (000 US\$)	0	

Source: elaborated based on World Bank (2016), EM-DAT natural hazards (2016), FAO (2015), UNESCO (2003), https://fr.wikipedia.org/wiki/Bassin_du_Niger, and Prevention web

3. Regional overview (cont.)

Natural hazards

Mali reported 47 natural hazard events during the period 1975–2015. The figure below shows that drought, floods and epidemic were responsible for 17%, 47% and 36% of the total occurrence of natural hazards, respectively. The impacts of these events resulted in more than 3,000 deaths and affected more than 7 million people.

Table 3: Natural hazards in Mali, 1975–2015 (EM-DAT, 2016)

Disaster type	Number	Total deaths	Total affected
Drought	8		6,927,000
Epidemic	17	3,412	24,173
Flood	22	129	279,327
Total	47	3,541	7,230,500

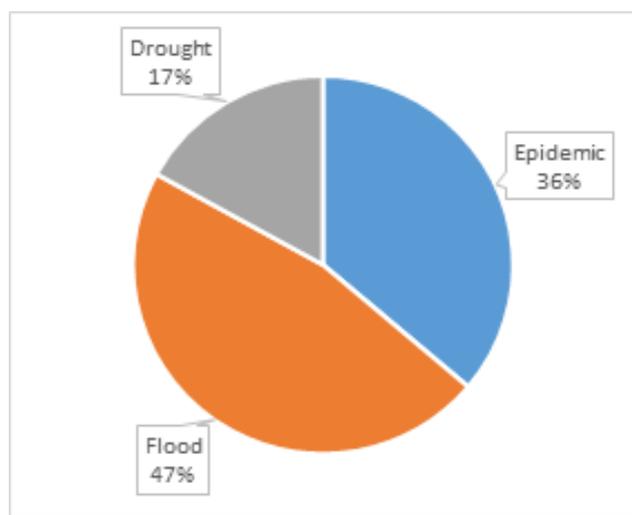


Figure 12: Most common hazards in Mali, 1975–2015
Source: elaborated based on EM-DAT (2016)

Among all the selected countries and after Burkina Faso, Mali had the highest number of drought events (8) during the period 1975–2015, which represents 9.75% of the total occurrence of droughts in West and Central Africa (82). Floods and drought are important hazards. Floods, the most important hazard in Mali affected 279,000 people since 1975; mortalities recorded from floods were 129. The highest number of people affected by drought was reported in 2011 (3,500,000).

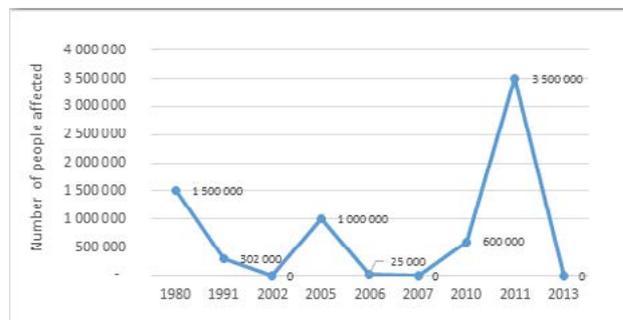


Figure 13: People affected by droughts in Mali, 1975–2015
Source: elaborated based on EM-DAT (2016)

Mali represented one of the countries with the highest occurrence of droughts in West and Central Africa (10%) and also in the West Africa region (13%). Drought events were only reported to affect people whereas flood events were reported to cause 129 deaths.

3. Regional overview (cont.)

Ghana



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Key indicators	Unit	in % of region (West and Central Africa)
Land area (km ²)	239,460	2.08%
Forest area (km ²)	93,370	3.3%
Volta River Basin (km ²)	400,000	42% of river in Burkina
Total population	25,904,598	5.91%
Urban (% of total population)	52.735	
Rural (% of total population)	47.265	
GDP (million US\$)	47,928.718	

Period 1975-2015	Unit	in % of region (West and Central Africa)
Registered hazards	40	4%
Deaths	1,708	1.5%
Affected people	16,456,289	13.74%
Economic losses ('000 US\$)	45,500	2.98%

Source: elaborated based on World Bank (2016), EM-DAT (2016), FAO (2015) and Prevention web

Natural hazards

Ghana reported 40 natural hazard events during the period 1975–2015. The graph below shows that drought, floods and epidemic were responsible for 5%, 40% and 55% of the total occurrence of natural hazards, respectively. The impacts of these events resulted in more than 1,500 deaths and affected more than 16 million people.

Table 4: Natural hazards in Ghana, 1975-2015 (EM-DAT, 2016)

Disaster type	Number	Total deaths	Total affected
Epidemic	22	1,299	96,299
Flood	16	409	3,859,990
Drought	2	-	12,500,000
Total	40	1,708	16,456,289

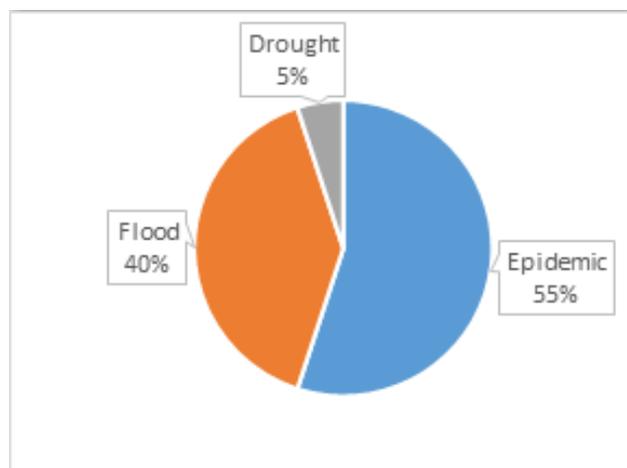


Figure 14: Most common hazards in Ghana, 1975–2015
Source: elaborated based on EM-DAT (2016)

Ghana does not contribute significantly to the main hazards in the region (only 5%) but many people were affected by drought events (12,500,000); this was recorded in only one year, 1980, and corresponds to the severe drought of the 1980s. As shown in the figure below, the number of people affected by floods decreased gradually, while the occurrence of floods over the years remained the same (one a year on average).

3. Regional overview (cont.)

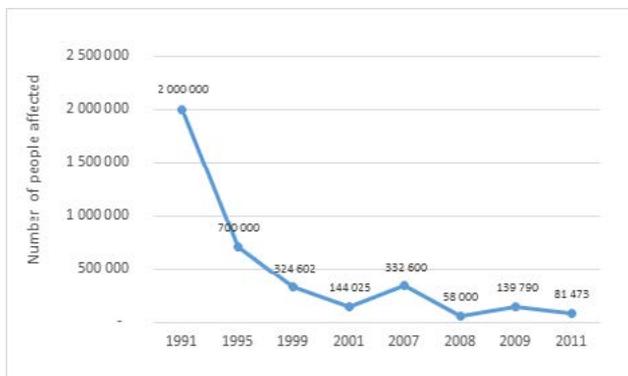


Figure 15: Number of people affected by floods in Ghana, 1975-2015

Source: elaborated based on EM-DAT (2016)

Compared to the other countries of this study, Ghana has the most people affected by both floods and droughts if considered together (more than a quarter – 26%).

Togo



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Key indicators	Unit	in % of region (West and Central Africa)
Land area (km ²)	56,785	0.49%
Forest area (km ²)	1,880	0.06%
Volta River Basin (km ²)	400,000	15% of river shared between Mali, Togo, Benin, and Cote D'Ivoire
Total population	6,816,982	1.55%
<i>Urban (% of total population)</i>	38,979	
<i>Rural (% of total population)</i>	61,021	
GDP (million US\$)	4,338.576	
Period 1975–2015	Unit	in % of region (West and Central Africa)
Registered hazards	25	2.5%
Deaths	1,188	0.01%
Affected people	1,003,770	0.008%
Economic losses ('000 US\$)	0	0

Source: elaborated based on World Bank (2016), EM-DAT (2016), FAO (2015) and Prevention web

3. Regional overview (cont.)

Natural hazards

Togo reported 25 natural hazard events during the period 1975–2015. The figure below shows that drought, floods and epidemic were responsible for 8%, 44% and 48% of the total occurrence of natural hazards, respectively. The impacts of these events resulted in more than 1,000 deaths and affected more than 1 million people.

Table 5: Natural hazards in Togo (1975–2015) (EM-DAT, 2016)

Disaster type	Number	Total deaths	Total affected
Epidemic	12	1,116	12,170
Flood	11	72	591,600
Drought	2	-	400,000
Total	25	1,188	1,003,770

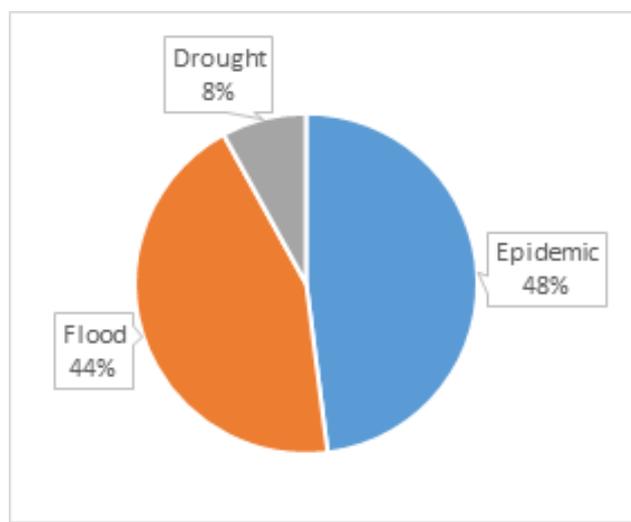


Figure 16: Most common hazards in Togo, 1975–2015

Source: elaborated based on EM-DAT (2016)

The main hazard affecting people in Togo is flood, with an irregular evolution of the number of people affected as shown in the graph below. The first peak (1995) and the last one (2010) are related to flood events that occurred twice in the country.

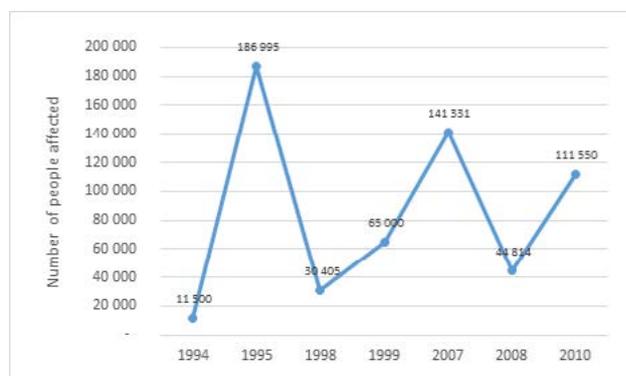


Figure 17: People affected by floods in Togo
Source: elaborated based on EM-DAT (2016)

Compared to the other countries of this study, Togo is the country with the smallest number of natural hazard events (5.38% of the total events of the countries selected) and the smallest number of drought and floods together in the whole West and Central Africa region (5.6%).

3. Regional overview (cont.)

Democratic Republic of Congo



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Key indicators	Unit	in % of region (West and Central Africa)
Land area (km ²)	2,345,410	20.38%
Forest area (km ²)	1,525,780	53.5%
Congo River Basin	3,700,000	
Total population	77,267,000	17.6%
<i>Urban (% of total population)</i>		
<i>Rural (% of total population)</i>		
GDP (million US\$)	33,121	
Period 1975–2015	Unit	in % of region (West and Central Africa)
Registered hazards	110	11.08%
Deaths	10,475	9.67%
Affected people	2,266,106	1.89%
Economic losses ('000 US\$)	31,000	2.03%

Source: elaborated based on World Bank (2016), EM-DAT (2016), IRD (2001), FAO (2015) and Prevention web

Natural hazards

The Democratic Republic of Congo (DRC) reported 110 natural hazard events during the period 1975–2015. The figure below shows that floods and epidemic were responsible for 27% and 58% of the total occurrence of natural hazards, respectively. The impacts of all events resulted in more than 10,000 deaths and affected more than 2 million people.

Table 6: Natural hazards in DRC (1975–2015) (EM-DAT, 2015)

Disaster type	Number	Total deaths	Total affected
Epidemic	64	9,352	711,231
Flood	30	640	466,342
Drought	2	-	800,000
Landslide	4	69	1,315
Storm	4	41	97,647
Volcanic activity	3	347	170,400
Earthquake	3	26	19,171
Total	110	10,475	2,266,106

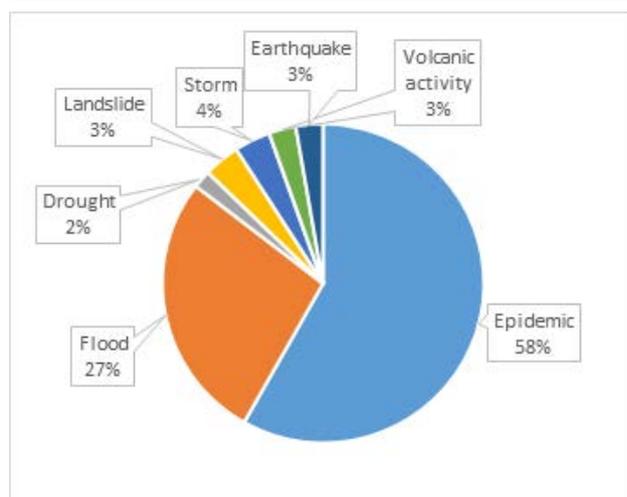


Figure 18: Most common hazards in DRC, 1975–2015
Source: elaborated based on EM-DAT (2016)

The main hazards that have affected people in DRC are droughts, floods and epidemic. The graph below

3. Regional overview (cont.)

shows that the last drought event that affected people occurred in 1983. Flood events are increasingly affecting people, with more than twice the number of people affected between 2010 and 2015.

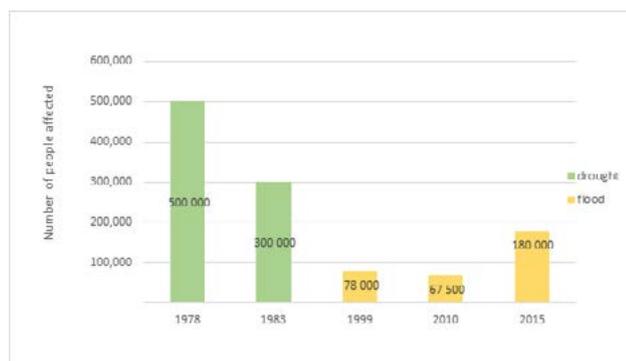


Figure 19: Number of people affected by floods and drought in DRC

Source: elaborated based on EM-DAT (2016)

Compared to the other countries of this study, DRC reported 9% of flood events in the West and Central Africa region, and only 2% of drought events.

Nigeria



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Key indicators	Unit	in % of region (West and Central Africa)
Land area (km ²)	910,770	
Forest area (km ²)	90,410 ⁶	3.17%
Niger River Basin (km ²)	2,262,000	Extends across 10 countries ⁷
Lake Chad Basin	2,434,000	Extends across 8 countries ⁸
Total population	173,615,345	
Urban (% of total population)	46.094	
Rural (% of total population)	53.906	
GDP (million US\$)	522,637.872	
Period 1975–2015	Unit	in % of region (West and Central Africa)
Registered hazards	109	11%
Deaths	24,699	22.8%
Affected people	13,639,484	11.4%
Economic losses ('000 US\$)	718,525	47.17%

Source: elaborated based on World Bank (2016), EM-DAT (2016), https://fr.wikipedia.org/wiki/Bassin_du_Niger, CBLT (2016), FAO (2015) and Prevention web

⁶ In 2010

⁷ Algeria, Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Guinea, Mali, Niger, Nigeria, Chad

⁸ Algeria, Cameroon, Libya, Niger, Nigeria, Central African Republic, Sudan, Chad

3. Regional overview (cont.)

Natural hazards

Nigeria reported 109 natural hazard events during the period 1975–2015. The figure below shows that floods and epidemic were responsible for 30% and 38% of the total occurrence of natural hazards, respectively. The impacts of all events resulted in more than 24,500 deaths and affected more than 13 million people.

Table 7: Natural hazards in Nigeria (1975–2015) (EM-DAT, 2016)

Disaster type	Number	Total deaths	Total affected
Drought	1	-	3,000,000
Epidemic	41	21,978	224,436
Extreme temperature	2	78	-
Flood	33	1,422	10,372,229
Landslide	3	32	1,800
Storm	29	1,189	41,019
Total	109	24,699	13,639,484

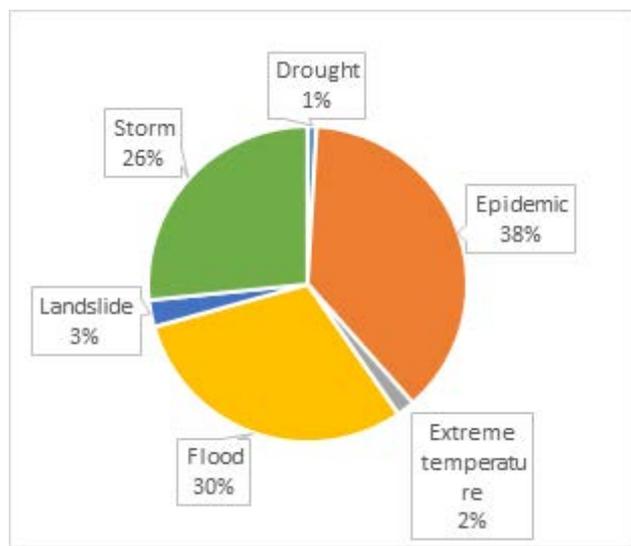


Figure 20: Most common hazards in Nigeria, 1975–2015
Source: elaborated based on EM-DAT (2016)

The main hazard affecting people in Nigeria is flood, representing 76% of all people affected by disaster in

this country. As shown in the graph below, people affected by flood reached an important peak in 2012 during the exceptional rainy season.

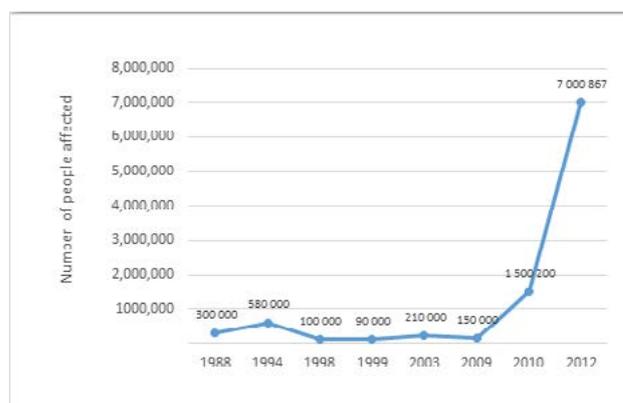


Figure 21: Number of people affected by floods in Nigeria
Source: elaborated based on EM-DAT (2016)

Compared to the other countries of this study, Nigeria has the highest occurrence of floods, and has the second highest occurrence of all events together after DRC; Nigeria represents 23% of all hazard events, and 20% of all flood events. If we consider the whole West and Central Africa region, Nigeria contributes the highest percentage to main hazards in the region (10%).

⁹Data from 2010

¹⁰Data from 2010

3. Regional overview (cont.)

Cameroon



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Key indicators	Unit	in % of region (West and Central Africa)
Land area (km ²)	472,710 ⁹	4.10%
Forest area (km ²)	199,160 ¹⁰	7%
Lake Chad Basin	2,434,000	Extends across 8 countries
Total population	22,253,959	5.07%
<i>Urban (% of total population)</i>	53.250	
<i>Rural (% of total population)</i>	46.750	
GDP (million US\$)	29,274.957	
Period 1975–2015	Unit	in % of region (West and Central Africa)
Registered hazards	47	4.73%
Deaths	6,003	5.54%
Affected people	629,605	0.52%
Economic losses ('000 US\$)	1,700	0.1%

Source: elaborated based on World Bank (2016), EM-DAT (2016), CBLT (2016), FAO (2015) and Prevention web

Natural hazards

Cameroon reported 47 natural hazards events during the period 1975–2015. The figure below shows that floods and epidemic were responsible for 26% and 60% of the total occurrence of natural hazards, respectively. The impacts of all events resulted in more than 6,000 deaths and affected more than 620,000 people.

Table 8: Natural hazards in Cameroon (1975–2015) (EM-DAT, 2016)

Disaster type	Number	Total deaths	Total affected
Epidemic	28	4,108	95,078
Flood	12	92	334,080
Drought	3	-	186,900
Landslide	1	20	100
Volcanic activity	3	1,783	13,447
Total	47	6,003	629,605

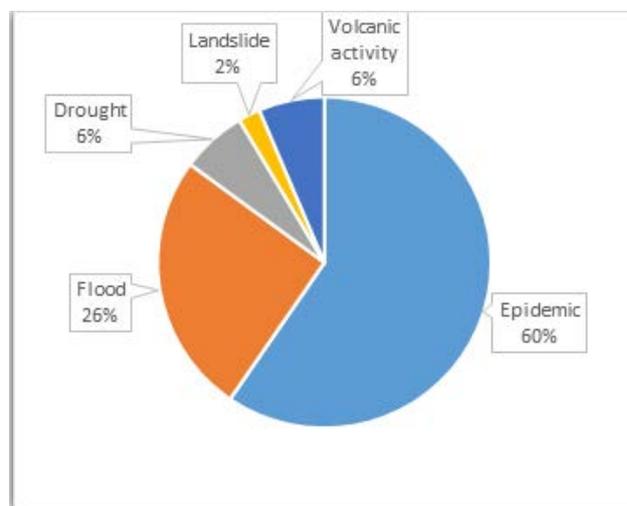


Figure 22: Most common hazards in Cameroon, 1975–2015

Source: elaborated based on EM-DAT (2016)

The main hazard affecting people in Cameroon is flood, followed by drought. As shown in the graph below, more than half of the people (68%) were

3. Regional overview (cont.)

affected in only one year (2014). In the same year, heavy rainfall caused severe flooding.

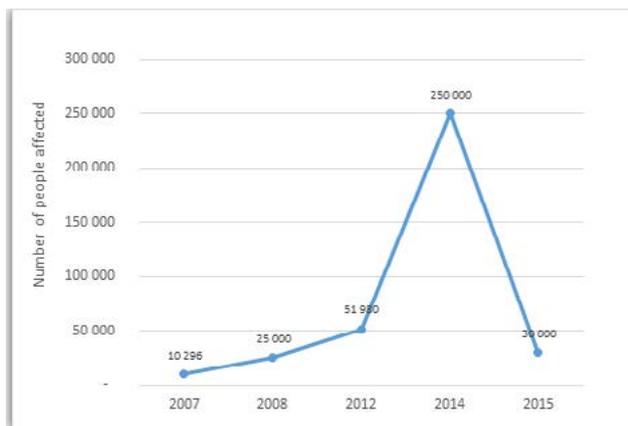


Figure 23: Number of people affected by floods in Cameroon

Source: elaborated based on EM-DAT (2016)

Compared to the other countries of this study, Cameroon contributes only 4% to the main hazards in West and Central Africa.

Senegal



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Key indicators	Unit	in % of region (West and Central Africa)
Land area (km ²)	192,530 ¹¹	1.67%
Forest area (km ²)	84,730 ¹²	2.97%
Senegal River Basin (km ²)	289,000	9.5% in Senegal
Total population	14,133,280	3.2%
Urban (% of total population)	43.079	
Rural (% of total population)	56.921	
GDP (million US\$)	15,149.709	
Period 1975–2015	Unit	in % of region (West and Central Africa)
Registered hazards	39	3.9%
Deaths	1,477	1.36%
Affected people	8,969,794	7.5%
Economic losses ('000 US\$)	354,385	23.2%

Source: elaborated based on World Bank (2016), EM-DAT (2016), FAO (2015), UNESCO (2003), and Prevention web

¹¹ 2014

¹² 2010

3. Regional overview (cont.)

Natural hazards

Senegal reported 39 natural hazard events during the period 1975–2015. The figure below shows that floods, drought and epidemic were responsible for 51%, 16% and 28% of the total occurrence of natural hazards, respectively. The impacts of all events resulted in almost 1,500 deaths and affected almost 9 million people.

Table 9: Natural hazards in Senegal (1975–2015) (EM-DAT, 2016)

Disaster type	Number	Total deaths	Total affected
Epidemic	11	1,208	36,028
Flood	20	82	1,199,211
Drought	6	-	7,638,702
Storm	2	187	95,853
Total	39	1,477	8,969,794

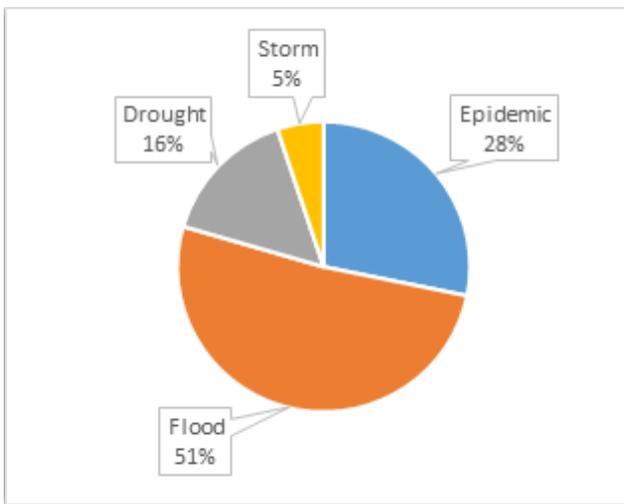


Figure 24: Most common hazards in Senegal, 1975–2015
Source: elaborated based on EM-DAT (2016)

The main hazard affecting people in Senegal is flood. As shown in the graph below, the number of people affected by flood tends to decrease. However, it is important to highlight that in the floods that occurred in 2002 and in 2012, there were recorded deaths of 28 and 19 people respectively.

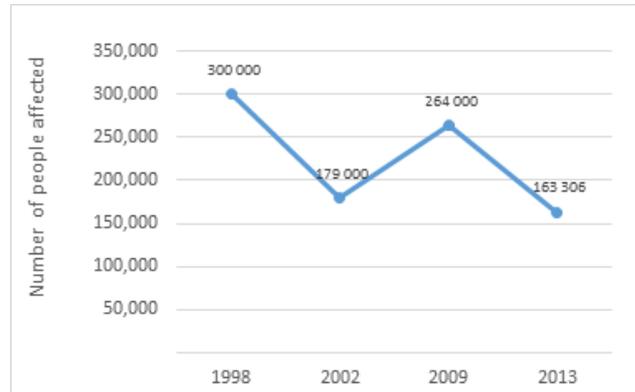


Figure 25: Number of people affected by floods in Senegal
Source: elaborated based on EM-DAT (2016)

Compared to the other countries of this study, Senegal contributes 8.4% to the main hazards. In the whole West and Central Africa region, the country contributes 6% to flood events.

4. Eco-DRR experiences in the region

This section provides an overview of Eco-DRR-related initiatives in the region and an analysis of their role in conserving biodiversity, and inversely it analyses how biodiversity conservation can contribute to Eco-DRR.

4.1. Implementation of Eco-DRR in the region

Vulnerability to disasters and to climate change depends on three factors, namely: exposure, sensitivity and adaptability (GIEC, 2001; GIEC, 2014). Therefore, in the context of disasters, reducing vulnerability involves looking for solutions to reduce exposure and sensitivity and increase adaptability.

Reducing exposure to disasters will consist of trying to relocate human settlements and economic activities out of the high risk-prone areas (i.e. coastal areas, areas that are subject to flooding and landslides, or areas exposed to strong winds). Other nature-based options are, for instance, the rehabilitation of mangroves to reduce coastal flooding, thus reducing their impacts on ecosystems and people, or tree plantation to increase infiltration rates and reduce runoff, especially in urban areas. Indeed trees have the ability to intercept rainfall with their leaves, reducing at the same time the volume of runoff. Trees (tree root growth) play an important role in stormwater management: in urban areas, where subsoils are often impermeable and compact, tree roots can penetrate compacted subsoils and increase infiltration rates and improve groundwater recharge (Kazemi & Sepaskhah, 2016; Bartens et al., 2008).

An example of actions to reduce sensitivity is the support for the development of alternatives to sand harvesting along the beaches of the West African coastland, such as in Senegal. Indeed, in such a situation, a coastland where the sand has not been harvested is less sensitive to erosion for a certain degree of exposure to sea level rise, than one where sand has been harvested (Diop et al., 2014). Several tools and methodologies as well as several activities have been developed over the years to mitigate and reduce vulnerability to natural hazards, by strengthening adaptive capacity. They include activities that promote access to information and technologies, natural infrastructure building, natural resources and ecosystem management, and strengthening institutional capacities.

Restoration is one of these tools. It is about “assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed” (Keenleyside et al., 2012; Dudley et al., 2010). It is therefore an intervention to re-establish the structure (e.g. species composition), and functionalities of the ecosystem (e.g. productivity). Restoration also contributes in responding to climate change challenges, especially adaptation, by strengthening/enhancing resilience to climate change, and climate change mitigation through increased carbon storage by ecosystems. Restoration of habitats or of populations of particular species in a landscape restoration approach provides the opportunity to prevent and/or recover from damage, and enhance ecological and social resilience to environmental change.

Forest landscape restoration may reduce the risk of floods and erosion by increasing the ability of forest to control floods. Likewise, mangrove restoration may reduce the risks of floods in coastal areas. Mangrove restoration has been implemented in many parts of the region as a management strategy to improve the capacity of mangrove to mitigate and adapt to climate change effects and to protect coastal zones from strong winds and floods (serve as windbreak and buffer zone). These areas are also host to many edible species, thus they help fight hunger and malnutrition.

It is important to note that all initiatives described below are not necessarily being implemented from a DRR perspective, but they may show clear links with and contributions to Eco-DRR outcomes.

4.1.1 West Africa

In Nigeria, the Living on the Edge Project implemented by the Nigerian Conservation Foundation (NCF) is a four-year project covering the Jigawa, Yobe and Sokoto States in the northern part of Nigeria. The objective is to restore and conserve natural dryland and wetland habitats and improve peoples' livelihoods. In this area, the proliferation of Typha weeds has negative impacts on water resources. The project will, among others, reduce the negative impact of this weed on water resource use by the fishers and farming communities. Clearing of invasive typha weeds will improve habitats for fishes and enhance fishing navigation on the extensive water system. It will also improve the water resource for

community use and avifauna use, and rehabilitate the desert prone communities in the semi-arid villages outside the wetland. This should improve the use of this area for people, and for birds.

In Nigeria, the NEWMAP¹³ project aims at preventing and reversing land degradation, focusing on major gully erosion that threatens human safety, infrastructure, livelihoods and environmental assets. The project will use an integrated approach to landscape and watershed management issues, and will use the following concepts: Ecosystem Approach, Integrated Water Resources Management (IWRM), and the Forests and Landscape Restoration (FLR) approach endorsed by the Bonn Challenge¹⁴ and developed to engage and build capacity of multiple stakeholders to restore ecosystem functionalities at the landscape level. This project will contribute to Eco-DRR outcomes as it will address the issue of a natural hazard (erosion) by looking at an ecosystem approach (FLR approach).

In Senegal and Burkina Faso, the Ecosystems Protecting Infrastructure and Communities (EPIC) project, implemented by IUCN is documenting the role of and improving ecosystem management for disaster risk reduction. Since its inception in 2013, the project is working with local communities to respond to climate change impacts and restore arable lands that have been degraded by droughts, salinisation, floods and soil erosion. Community resilience is being built through two main activities: 1) strengthening of local capacities to understand vulnerabilities and taking action by using best practices and 2) promoting effective policies for integrated approaches to disasters, climate change and environment management. Endogenous land practices to restore the land and increase agricultural output are implemented in six villages in each country. For example, anti-salt bunds that reduce salt intrusion and contribute to retain freshwater have been installed to recover more than 180 ha of cultivated land in villages in Senegal. In Burkina Faso, traditional practices like stone lines and Zai that conserve water resources have been established to restore 150 ha of land. In both countries, assisted natural regeneration and reforestation is also carried out to increase tree cover and improve soil quality.

One of the species that is used in Burkina Faso to improve soil quality is *Faidherbia albida*, also used in Mali and Niger. In these countries, this species planted through assisted natural regeneration has improved yields of millet and sorghum (Raffaello & Morris, 2015).

In Benin, the Alliance mondiale contre le changement climatique (AMCC) is implementing since 2012, an 8 million euros project targeting forests. The project has promoted the conservation and sustainable use of open forests in the lower Ouémé River Valley, to reduce the effects of floods in downstream areas, thus contributing to Eco-DRR outcome. The project also supported the collection of new GIS data and new maps covering the whole country in order to, among others, improve capacities in land management and disaster risk reduction. The project further recognised the importance of mapping and of early warning systems to improve the capacity to respond to disasters, the involvement of communities, and the promotion of local forest management based on forests to ensure their sustainable management.

In Mali, the Programme de Développement Durable du Delta Intérieur du Niger (PDD-DIN) (Programme for the sustainable development of the Inner Niger Delta), was implemented between 2013 and 2015 in three regions of Mali (Mopti, Tombouctou, Segou), with the objective of improving the resilience of beneficiaries through increasing awareness about the integrated management of natural resources, including the root causes of climate change, and their implications and adaptation measures. As a wetland, the Inner Niger Delta, will be severely affected by the impacts of climate change given that climate change affects water resources and water cycles (IEPF/UICN, 2008); these effects will include: the modification of breeding periods, the modification of species migratory periods, the modification of the duration of the growth season, and the modification of species distribution and population density. Therefore, the protection of this ecosystem remains a priority. Here, the activities related to Eco-DRR included restoring forests and the protection of forest areas to protect the landscape that supports the whole ecosystem from natural hazards such as floods, which can occur in the flood-prone areas.

In Ghana, the Wildlife Division is implementing a project titled "Rehabilitation and conservation of

¹³ Nigeria Erosion and Watershed management project

¹⁴ The Bonn Challenge is a global aspiration to restore 150 million hectares of the world's deforested and degraded lands by 2020 and 350 million hectares by 2030

4. Eco-DRR experiences in the region (cont.)

degraded mangroves". The objective is to restore ecological functions of mangroves (spawning grounds of fish, shrimp, flood control, shoreline stabilisation, sustainable supply of fuelwood to local fisher communities, and enhancement of carbon stocks) and improve local well-being. Main activities related to Eco-DRR include:

- enrichment planting, and
- habitat manipulation: an alternative woodlot is planted using "Matching planting" of woodlot (i.e. a unit area of mangrove planted is matched with the same unit areas of woodlot with fast growing species).

Restoration of mangroves contributes to Eco-DRR as it stabilises the shorelines, prevents erosion and supports soil health. Furthermore, many soil fauna are conserved to maintain their ecological function. This leads to the improved health and ecological integrity of the mangrove ecosystem and hence its biodiversity.

The PARCC project (Protected areas resilient to climate change in West Africa) was implemented between 2010 and 2015 in five¹⁵ pilot countries of West Africa with the main objective to develop strategies and tools to increase the resilience of protected areas to climate change, and build capacity in the region to implement these new approaches <http://parcc.protectedplanet.net/en/general-project-information/project-background>. For instance, the project developed management plans for protected areas that consider the possible effects of climate change, and activities under these plans are implemented taking into account the changing climate. Therefore, with such management plans, protected areas will be better prepared to cope with erosion, floods and droughts, provided that adequate species (resistant to these hazards) are also protected within the protected area system.

4.1.2 Central Africa

The five-year project entitled "Réduction des risques des catastrophes et liées aux conflits" (Reducing disaster risks and conflict related risks) is being implemented in the Eastern DRC (North and South Kivu). Its objective is to enhance the resilience of the communities to disasters and conflicts. Some of the activities related to Eco-DRR include

the plantation of trees and installation of devices to protect against soil erosion. The project has produced community-based disaster risk reduction action plans in some localities (Kibumba, Mutaho, Kingi, Luhonga, Bweremana, Minova and Kalungu) and a contingency plan for Nyiragongo volcano.

The capacity of forest to cope in a changing climate is important when we conduct forest restoration activities for disaster risk reduction; risk reduction depends on the coping capacity of the forest if the climate changes in the future. Therefore, management plans for such ecosystems, including protected areas, that are used for DRR must take into account climate change and future climate scenarios and projections, to make sure that they will effectively continue to reduce the risk if the climate changes.

The PARCC project mentioned above could be replicated in the Central Africa region, and the tools adapted to be used in this subregion.

4.2. Eco-DRR for biodiversity

Eco-DRR activities also contribute to biodiversity conservation, even if it is not specifically mentioned as a project primary objective. The protection and/or rehabilitation of mangroves to protect the whole ecosystems from floods and salt intrusion, for instance, will also provide habitats for wildlife species biodiversity especially migratory birds and their nesting areas. Mangroves are very productive ecosystems that might suffer from climate change effects unless they are sustainably managed; that way, they will conserve their ability to host specific bird habitat including that of endemic bird species. When Eco-DRR activities are implemented to combat invasive species (biological techniques), this protects both the biodiversity of the plant species already present in the ecosystem and the other organisms (mutualistic partners and predators) they interact with to determine their competitive performance: by reducing the competition from the invasive species, the native species can therefore survive.

4.2.1 West Africa

The Living on the Edge Project is implemented in Burkina Faso, Nigeria, Senegal and Mauritania. It aims to restore and protect the habitats of birds

¹⁵ Mali, Togo, Chad, Gambia, Sierra Leone. www.parcc.protectedplanet.net

4. Eco-DRR experiences in the region (cont.)

and provide benefits to local people. In Nigeria, the project (see above) is contributing to biodiversity through the improvement of habitats for both fish and waterfowls. Also the project has generated a database of the bird population and it serves as a policy and advocacy tool in conserving the bird population in the area. There is also improvement in the vegetation cover as a result of establishing community plantations. The trees were planted to reduce the incursion of sand dunes and create a suitable habitat for birds. All these results therefore contribute to biodiversity conservation¹⁶. In Burkina Faso, the project restored the natural landscape along the birds' flyway. They used local seeds to naturally regenerate the landscape. This indirectly protects the riparian forests around lake Oursi.

In Senegal, the project *Renforcement de la résilience des écosystèmes et des communautés par la restauration des bases productives des terres salées* (Département de Fatick et de Foundiougne) is a four-year project that will run until 2019. It involves the following ecosystems: salted areas, mangrove, forests. The project addresses climate change adaptation issues. Some of the expected results include: reducing the salinisation of agricultural, pastoral, and forest lands, which are the productivity basis for local and national economies, and strengthening the resilience of communities to the impacts of salinisation on their livelihoods. On the other hand, the project will greatly contribute to biodiversity conservation with the restoration of the ecosystem productive base (mangrove, crop areas, etc.).

Some of the restoration activities include:

- forest reserve of 4,280 ha under protection
- assisted natural regeneration of 4,008 ha
- restoration of 315 ha of mangrove
- restoration of 11 ha of palm trees
- 200 ha of sand dune fixation,
- reforestation of more than 4,000 ha of mangrove in 2013

In Togo, the Integrated disaster and land management project, will implement community-based activities in watersheds and flood-prone areas to strengthen resilience to flooding through targeted pilot activities

at the local level that will enable communities to better manage disaster risk and land degradation. Interventions will include: community improvement of drainage canals in the city of Tchamba (Central Region); community works for the clearing and maintenance of Lac Boko canal and consolidation of the banks (Maritime Region); and stabilisation of Bombouaka reservoir¹⁷ through de-silting and reforestation of the surrounding area (Savanna Region). The reservoir is continually threatened by soil erosion in the surrounding area, so trees will be planted around the reservoir to help reduce the soil erosion. By reducing soil erosion, the project will protect and restore the whole landscape and watershed management system (World Bank, 2011).

In Togo, another project is being implemented by an NGO (Agbo Zegue) to contribute to the resilience of three communities in the face of climate change through community planning. Some of the results contributing to biodiversity conservation include:

- The establishment and management of conservation areas around Oti-Keran National Park in the north of Togo
- The management of a sacred forest (Godjin-Godjè) within the Biosphere reserve of Delta du Mono
- The management of fisheries resources and the conservation of the manatee (threatened) in lake Togo
- The conservation of marine turtles and marine mammals in Togo with full participation of fisher communities living on the coast and creation of an MPA.

While working on improving the resilience of communities by putting in place community-based management planning, the project will at the same time conserve the biodiversity of the ecosystem.

4.2.2 Central Africa

In DRC, a project entitled "Aménagement du Bassin versant par le reboisement des espèces antiérosives et agro-forestières à Mwenda-Ruwenzori", implemented in the province of North Kivu in the Virunga area, for the protection of the watershed system will also reduce logging in the

¹⁶ <http://www.ncfnigeria.org/projects/the-living-on-the-edge-project>

¹⁷ Bombouaka reservoir is a small reservoir primarily for supplying drinking water to Bombouaka and nearby villages. It is approximately 100 m in length, 35 m wide and 4 m high

4. Eco-DRR experiences in the region (cont.)

park and combat deforestation, thus contributing to biodiversity conservation by protecting the forest.

4.3. Biodiversity case for Eco-DRR

4.3.1. Ecosystem and ecosystem services

Ecosystems play an important role in DRR measures provided they are maintained in good conservation status, healthy and functioning. Mangroves and other coastal vegetation stabilise shorelines, thus reducing the impacts of storms. Lakes and marshes reduce peak flooding, and in arid regions wetlands provide relief from droughts (Dudley et al., 2015). Mangrove forests provide protection and shelter against extreme weather events, such as storm winds and floods, as well as tsunamis. Mangroves absorb and disperse tidal surges associated with these events. Mangroves can reduce wave height by 66% over 100 m of forest, and a mangrove stand of 30 trees per 0.01 hectare with a depth of 100 m can reduce the destructive force of a tsunami by up to 90%¹⁸.

Conserving forests to reduce greenhouse gas emissions and increase carbon sequestration can reduce the risks of soil erosion or landslides by stabilising slopes.

Protected areas are one of the tools to conserve biodiversity (a means of conservation). The Biosphere reserve of Delta du Saloum in Senegal is managed to provide resilience against climate change. Indeed communities themselves are involved in restoration activities of the degraded lands of the reserve in order to increase their resilience in the face of climate change. Restoring the capacity of the protected area to fight against climate change will also enhance its capacity to be fully functional and act as a buffer against coastal erosion and flood risks. It will also improve its capacity to provide ecosystem goods and services for people's livelihood. It has also been noted that the wetlands, marine and estuarine areas, lakes and marshes of the reserve also play an important role in protecting neighbouring villages from natural hazards, including floods (Dudley et al., 2015).

A sound management of protected areas can also reduce the risk of wildfires. Some countries have indeed adopted management strategies and policies to address the issue of wildfire. In Ghana

for example, the National Wildfire Management Policy adopted in 2006 promotes the following strategies that are linked to EbA to combat wildfires:

- inclusion of wildfire prevention and control resources;
- management planning at all levels by relevant institutions;
- integration of indigenous knowledge and international best practices in developing systems of wildfire prevention and control; and
- promotion of alternative sustainable resource management systems that will minimise the occurrence of wildfire such as: agro-forestry, enhanced natural regeneration and reforestation.

4.3.2. Biodiversity

Likewise, biodiversity can play an important role in Eco-DRR measures, including enhancing the resilience of farming systems to natural hazards such as drought. Oliver et al. (2015) have described some of the mechanisms underpinning the resistance and recovery of ecosystem functions to environmental perturbation. They include species-level mechanisms, community-level mechanisms and landscape-level mechanisms. The contribution of biodiversity to Eco-DRR concerns species-level mechanisms; they relate to the specific biological or ecological traits of a species that might confer a resistance to environmental changes. The authors provide hypotheses for the effects of these mechanisms on the resilience of ecosystem functions. These hypotheses are as follows:

- Sensitivity to environmental change: such species possess traits that increase or reduce their capacity to persist in the face of environmental perturbation. Species with reduced sensitivity to environmental change will provide higher resistance of ecosystem functions. As an example, trees and plants vary in their sensitivity to drought depending on nonstructural carbohydrate levels, which will in turn affect the resistance of the ecosystem functions that they provide.
- Intrinsic rate of population increase: capacity of species populations to grow rapidly. Species with a high intrinsic rate of increase will recover more quickly from environmental perturbations.

¹⁸ <http://africa.wetlands.org/Africanwetlands/Mangroves/tabid/2938/language/fr-FR/Default.aspx>

4. Eco-DRR experiences in the region (cont.)

- Adaptive phenotypic plasticity: this applies for species that have the capacity to respond to environmental changes through flexible behavioural or physiological strategies that promote their survival and the resistance of ecosystem functions. For example, species that have the capacity to regulate temperature will increase their chances of surviving in extreme temperatures.
- Genetic variability: species that have a high adaptive genetic variation will likely resist in the case of environmental disturbances; they will not be impacted along with their ecosystem functions.
- Allee effects: this effect makes populations more susceptible to environmental perturbations. Those species that have an inability to find mates or avoid predators will be more susceptible to allee effects.

In West Africa, millet tolerates particularly difficult conditions of production: drought and acidity of soils. Thus, it is generally admitted that millet will continue to play a significant role in this part of the world, especially with demographic pressure, the marginal lands of the arid and semi-arid regions will be exploited for the production of cereals.

Genetic diversity of plant and animal species guarantees a diversified production for a rich and diverse diet, in a world where there is an urgent need to ensure food security given increased population and the increasing effects of climate change and variability. Crop wild relatives are a source of resistance genes to diseases, pests, droughts and extreme temperatures. They are also a source to maintain food security. They are used by farmers for their subsistence. Increasing the diversity of varieties of a given crop improves the chances that the crop will better cope with the hazards mentioned above because they are likely to be the most adaptable (as a consequence of diverse cropping systems) (Engels et al., 2014).

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) has been working on improving millet for farmers in Niger, using participatory selection: farmers participate in the selection process in order to better target the demand and propose the best varieties adapted to climate change, and to crop conditions.

By protecting the wild relatives of modern cultivated species like millet or sorghum in protected areas, the productivity of the species and their availability to be used for DRR purposes are increased. This has been the case in Mali and in Burkina Faso where agrobiodiversity of sorghum (*Sorghum bicolor* (L) Moench) is preserved in situ (Vom Brocke, K et al, 2016). Sorghum is the main cereal in Burkina Faso and the second main cereal in Mali. Sorghum and millet are the staple food in rural areas and therefore contribute to food security in these areas. This landrace is facing genetic erosion for the following reasons: great inter-annual variability of rains, the reduction in the duration of the rains, the impoverishment of the soil, pressure of certain pests, competition with other crops, in particular corn, and the requirements of the market. Due to this genetic erosion, a project has been conceived in order to develop a wide range of new varieties that are more efficient and adapted to local climate conditions and to the needs of farmers¹⁹. However, it should be noted that the practice of using crop wild relatives as a possible response to disaster reduction is not well developed in West and Central Africa yet and hence, there is a lack of information on the issue. There is an opportunity to develop this further in the region.

Forest regeneration can also be used as a mechanism for Eco-DRR. By using genotypes that are resistant to droughts or artificial regeneration with specific tree species, or by controlling invasive species, biodiversity can contribute to Eco-DRR. For instance, *Ziziphus mauritiana* is a species of sahelo-sudanian to sudanian savannas. It grows in areas with rainfall varying between 250 and 2,000 mm a year. It can establish at up to 600 m of altitude. It is a very hardy species that tolerates severe droughts (from 6 to 12 months a year), and can grow in poor soils. Its deep and twisting root system enables it to tolerate long periods of droughts and combined crops. The species *Vitellaria paradoxa* (shea tree) is also a drought tolerant species. Its deep and twisting root system enables it to tolerate long droughts and combined culture can also resist to long periods of droughts.

Forest ecosystems in Burkina Faso and Ghana are vulnerable to climate change, which manifests in these countries mainly through intense and frequent extreme climate events (high rainfall variability,

¹⁹ <http://books.openedition.org/irdeditions/556?lang=fr>

4. Eco-DRR experiences in the region (cont.)

leading to droughts or floods, high temperatures, windstorms, and forest fires). Sustainable forest management in Burkina Faso and Ghana under climate change will be highly dependent on successful natural regeneration and agroforestry measures such as artificial regeneration through reforestation and afforestation activities. However, reforestation and afforestation programmes in Burkina Faso and Ghana historically focused on large-scale projects without paying too much attention to small-scale natural and artificial regeneration at family farm and community levels. The countries have therefore promoted reforestation activities through both large-scale plantation development and small-scale on-farm regeneration activities. Species with high market value like *Tectona grandis* (teak) were planted in Ghana and other species used for reforestation activities include *Cedrela* species, *Ceiba* species, *Khaya senegalensis* (mahogany), and *Triplochiton scleroxylon* (wawa).

Plant diversity has an important role to play in restoration activities and their success. Some species may be better adapted to a specific region and more resilient to climate change. And some species possess specific characteristics that are desirable for some restoration projects, for example, they may be resistant to drought or tolerant to salinity or have root structures that can contribute to prevent or reduce soil erosion. As mentioned earlier, assisted natural regeneration and reforestation is carried out in both Senegal and Burkina Faso as part of the EPIC project, to increase tree cover and restore the land. Deforestation driven by local demand for firewood further exacerbates land degradation brought about by salinisation and droughts in the two countries. The approaches and species used for the restoration activities are key factors here. Assisted natural regeneration (ANR) is a “low-cost forest restoration method that can effectively convert deforested lands of degraded vegetation to more productive forests. The method aims to accelerate, rather than replace, natural successional processes by removing or reducing barriers to natural forest regeneration such as soil degradation, competition with weedy species, and recurring disturbances (e.g. fire, grazing and wood harvesting) (Shono et al., 2007). ANR provides an opportunity to integrate biodiversity in restoration activities as it focuses on restoring the existing pool of native species in the targeted

area to be restored and these are also already adapted to the local climate. Using this method, the restored forest will support more biodiversity and provide more resources for subsistence (Shono et al., 2007). Tree seedlings are also produced by communities for reforestation in the two countries. In Senegal, due to salinisation, plant species that are salt-resistant are used in reforestation activities. In northern Burkina Faso, 12,000 local plants have been planted by 2015 to restore the land in six villages. A participatory approach using local knowledge was used to identify resilient local plant species that are being used in the reforestation activities.

In Senegal, in the areas of the Niayes, because of movements of the sand dunes caused by wind erosion, the dunes have invaded the houses and land used for vegetable production. A hedge of *filas* (*Casuarina equisetifolia*) was thus put in place to reduce the speed of the wind (protective barrier) and to stabilise the sand dunes, which made it possible to protect the low-lying land used for vegetable production. Without protection, these low-lying lands would be under permanent threat of burial by the dunes. It should be noted that the majority of vegetable products for the whole country comes from this area.

There are no examples of soil bioengineering and erosion control for the region. It should, however, be noted that the Vetiver System (VS) is a system that can reduce soil erosion, landslides, mudslides, road batter instability, and erosion (riverbanks, canals, coastlines, dikes, and earth-dam batters). *Vetiveria zizanioides* (L.) Nash. Vetiver, part of this system, is a densely tufted, awnless, wiry, glabrous perennial grass. It has a deep and rigorous root system that helps stabilise the slopes structurally while its shoots disperse surface run-off, reduce erosion, and trap sediments to facilitate the growth of native species. Furthermore, it is a fast growing species, has the ability to become quickly established in difficult soil conditions (hardpan, and rocky layers with weak spots), so it might even be more suitable than other plants for stabilising slopes. The main disadvantage of VS applications is the vetiver's intolerance to shading, particularly within the establishment phase. Vetiver also requires protection from livestock during its establishment phase. This species finds its origin

4. Eco-DRR experiences in the region (cont.)

in Asia; however, there is an opportunity to find a species with the same characteristics in Africa in order to address the issue of slope stabilisation.

Forest fires affect biological diversity. On a worldwide scale, they are an important source of carbon emissions and contribute to the warming of the planet, which could involve changes in biodiversity. At the regional and local levels, they modify the volume of the biomass, deteriorate the hydrological cycle with consequences on marine systems such as coral reefs, and influence the life cycle of plants and animals. New fires may occur in the following years, since vulnerable zones without vegetative cover will have been created by previous fires, and the species vulnerable to fire, like fire-dependent grass, proliferate.

Wildfires are not a natural hazard in West and Central Africa (refer to section 3.2). However, land users can still control it naturally and therefore prevent the damages related to its extent. To avoid uncontrolled fires, voluntary bush fires are usually practiced in areas of savanna and in the Niger Delta. Farmers create fires in savanna and on the flooded plains with perennial grass to allow regeneration of a nutritive green grass of high quality for the cattle. But sometimes uncontrolled fires occur in the south sahelian area and destroy the herbaceous carpet thus depriving the cattle of pasture.

Each year Senegal is also affected with bush fires, around the months of January and February. The fires destroy hundreds of thousands of hectares of

Table 10: Common techniques and methods to quantify values (Vorhies, 2006)

Methods	Description
<i>Market-based valuation</i>	quantifies the value of environmental goods and services traded in open commercial markets (e.g. direct use values of environmental tourism through the direct sales to tourists that may include expenditures on lodging and meals, entrance fees, concessions, etc.)
<i>Contingent valuation</i>	quantifies the value of an environmental good or service by asking people what they are willing to pay for it or willing to accept for its loss (concepts of “willingness to pay” and “willingness to accept”)
<i>Hedonic pricing</i>	uses existing markets – such as the property or labour markets – to determine the value of an environmental good or service
<i>Travel costs</i>	also uses existing markets to determine the value of an environmental asset from estimating the costs incurred when travelling to the environmental asset in terms of time, travel expenditures and entry fees
<i>Changes in productivity</i>	can be used to estimate the change in the value of production of a good or service that occurs as a result of the change in land use (e.g. if a protected forest provides a watershed service and is considered for logging, the change in land use would result in a change in the productivity of the farmers, which could be estimated as an indicator of the value of the forest’s watershed service)
<i>Loss (or gain) of earnings</i>	evaluate the change in human productivity resulting from environmental deterioration or improvement
<i>Opportunity costs</i>	provide an estimate of the value of a natural ecosystem based on the foregone income of the next best alternative use of the area. Measuring the opportunity cost of the protected area, for example, can give the manager an idea of the competitive threats to the area.
<i>Replacement costs</i>	can be used to measure the cost of damage done to the ecosystem by estimating the cost of replacing the damaged environmental assets

Source: Vorhies, 2006

4. Eco-DRR experiences in the region (cont.)

productive farming lands. Those of 2006 destroyed more than 400,000 hectares of farming lands. Thus, the government of Senegal has developed a project for the management and prevention of bush fires in eight rural communities on the periphery of the Niokolo Koba National Park, which is also a World Heritage site. This site of high biodiversity is threatened by recurrent bush fires. The objective of the project is to protect the biodiversity at risk in an area on the periphery of the Niokolo Koba National Park and participate in the mitigation of climate change. Activities include: preventing bush fires and the management of biodiversity and creation of open and green firewall protection (over a distance of 40 km); reduction of human pressures in the park; reforestation of the limits of the park and village territories; introduction of energy saving technologies (improved woodstoves, biogas, etc.). The aim of the firewalls is to create a break in the forest to reduce the intensity of fire and effectively fight the fire at specific areas. There are different types of firewalls; the selection of the firewall depends on the soil, financial means and the needs of the populations.

Firewalls that could be used include:

- open firewall: completely cleared, sometimes efficient to protect small areas;
- firewall under natural vegetation (annually burnt with early fires): it borders an open firewall of five metres over a width of 30–40 metres, where the vegetation is burned at an early stage;
- the cultivated firewall: located on the best grounds, the cultivations must be made up of early species and the residues removed after harvest (a fast reduction in productivity of the cultivations is generally noted in this type of firewall);
- The wood firewall: the goal is to create a permanent and dense cover that prevents grass from growing. The species that can meet these requirements in West Africa are, among others, *Anacardium occidentale*, *Azadirachta indica*, *Khaya senegalensis*, *Ziziphus mauritania*, *Z. mucronata* or other species with dense foliage (*Gmelina arborea*, *Mangifera indica*). It is recommended to choose species with small leaves, because the carpet of leaves that fall on the ground (litter) is less combustible than that formed by large leaves

(FAO, 1997). However, some of the species used to fight fire, like the neem tree (*Azadirachta indica*), are invasive so here there is a need for trade off.

4.4. Economic case for Eco-DRR

Ecosystems provide many goods and services (see section 3.1.). Forests, for example, provide wood and fibre, purify water, control the climate and constitute a reservoir of genetic resources, mitigate the effects of droughts and extreme temperatures, are used as areas for leisure and eco-tourism. Coastal wetlands mitigate the effects of floods and are sites for essential reproduction and nursery sites for fisheries. Ecosystems are thus important for society. However, these ecosystems are degraded, because of a combination of several factors including anthropogenic, and are likely to lose their capacity to provide the services mentioned above, with sometimes dramatic consequences for the direct beneficiaries. Indeed, the loss of certain species of medicinal plants, of timber for construction and the unavailability of drinking water can contribute to diminishing household incomes and to degrading wellbeing. Protecting ecosystems and the services that they provide is thus economically and socially important. In order to highlight the importance of biodiversity, of ecosystems and the abundant services and their important roles in conservation, it is advisable to quantify them. This will help to integrate the costs and the advantages related to the conservation of biodiversity (cost-benefit analyses) in decision-making processes.

The Economics of Ecosystems and Biodiversity (TEEB) is an international initiative to draw attention to the global economic benefits of biodiversity, to highlight the growing costs of biodiversity loss and ecosystem degradation and to draw together expertise from the fields of science, economics and policy to enable practical actions moving forward; it implements the ecosystem as well as the ecosystem services approach²⁰.

Environmental economists have developed techniques for quantifying various types of values. Common techniques and methods are set out in the table below.

²⁰ www.teebweb.org

4. Eco-DRR experiences in the region (cont.)

Economic valuation of mangrove services

Mangroves are among the most productive ecosystems in the world: they are rich in carbon due to their high carbon storage and sequestration potential, and provide important services such as fisheries production, shoreline stabilisation, nutrient and sediment trapping and biodiversity habitats. Furthermore, they play an important role in DRR as they protect coastal areas from natural hazards such as erosion and flooding. The total economic value of mangroves has been estimated at US\$ 9,900 per ha per year by Costanza et al., (1997) or US\$ 27,264–35,921 per ha per year by Sathirathai and Barbier (2001).

A study has been carried out to assess the carbon pools, ecosystem services and benefits of the mangroves in the Central African countries of Cameroon, Gabon, Republic of Congo (RoC) and Democratic Republic of Congo (DRC). There are mangrove species of economic importance and the dominant species is *Rhizophora racemosa*. Other associated species are *Avicennia germinans*, *Conocarpus erectus*, *Laguncularia racemosa*, *Rhizophora harrisonii*, *Rhizophora mangle*, *Rhizophora racemosa*, *Hibiscus* sp, *Phoenix* sp. Unfortunately, these mangroves are threatened by deforestation, overexploitation of timber, and pollution. As an example, from 2000 to 2010, they were cleared at a rate of 1.77 percent per year (77,107 ha)²¹. However, if we consider the net mangrove cover loss it was only of 6,800 ha which is the equivalent to the emission of 8,833,200 tonnes of carbon dioxide emitted between 2000 and 2010. Losses are high, including in protected areas: Conkouati-Douli National Park contains 78 percent of the country's mangroves but at the same time the park records 40–50 percent deforestation in some areas (Rao et al., 2013).

As well as carbon benefits, mangroves also provide other multiple benefits to communities living in their vicinity. The multiple benefits of mangroves can often exceed the value of carbon, and this study has shown that mangroves could provide values up to the equivalent of:

- US\$ 7,142 per ha in benefits for protection of rural infrastructure against shoreline erosion (US\$ 151,948 per ha for urban mangroves): it

is estimated that between 25 and 50 percent of the value of infrastructure is currently protected by mangrove ecosystems;

- US\$ 545 (49.53 tonnes of wood) per ha per year per household in wood consumption: harvesting of wood destined for fuelwood for fish smoking, construction material, etc.;
- US\$ 12,825 per ha per year in fisheries benefits in the four countries: mangroves provide suitable habitats for nurseries and for fish development. Many tonnes of fish are produced in mangrove ecosystems. Gabon has the highest quantity of fish production per ha and per year (109 tonnes) (US\$ 12,932). The mangroves are therefore highly important to maintain the livelihoods of communities and ensure food security in the region. Protecting the mangroves also protects and maintains their capacity to protect the coasts from flooding.

The study has also conducted a cost analysis of building a sea wall within mangrove areas of Central Africa, replacing the protective function of mangroves. This cost amounts to US\$ 11,286 per ha for the region (countries assessed). The most costly would be in Cameroon with US\$ 18,000. It is important to note that seawalls can reduce sediment availability and thus affect the health of adjacent coastal ecosystems, whereas with mangroves, we only need to invest in protection and management; they are therefore cheaper while providing other values. Mangroves can therefore be considered a solution to adapting to storm and coastal erosion related to climate change in the future in Central Africa (Ajonina et al, 2014).

In Waza Logone floodplain, Cameroon, scientists evaluated the economic effects of floodplain degradation in the Waza Logone region by evaluating the economic benefits of wetland restoration. The degradation had severe impacts on the floodplain ecologies, and the fisher and pastoralist populations who rely on these resources. The study looked at the economic costs of flood loss and the potential benefits of re-inundation with a view to influencing the decision on investment in flood relief measures.

In their questionnaire, the Communauté Baptiste au centre de l'Afrique, (CBCA) a community resources management institution based in Eastern

²¹ 18 percent loss between 2000 and 2010 in Cameroon, 35 percent loss in the RoC, 6 percent loss in the DRC and 19 percent loss in Gabon

4. Eco-DRR experiences in the region (cont.)

DRC has estimated the economic valuation for engineered infrastructures for DRR at US\$ 200,600. Indeed, they estimate that the seismic activity of Lake Kivu requires permanent surveillance using adequate equipment; meteorological stations are also required at Mont Katala.

In the questionnaire on Eco-DRR that was addressed to the Direction Nationale des Eaux et Forêts (DNEF, Mali) (see methodology section above) they reported the following:

- The cost of drought in Cercle – Bougouni Yanfolila is 1 billion CFA Francs (equivalent to US\$ 1,725,000) and drought caused the loss of 2,000 ha of land in the complex

- They estimate the cost of restoration of 2,300 ha of degraded land at CFA 1,150,000 per ha (equivalent to US\$ 1,980)
- Regarding the economic valuation for engineered infrastructures for DRR, they estimate it at CFA 1,140,000,000 (equivalent to US\$ 1,966,000) for construction of bridges, establishment of forest guard posts, creation of ponds and construction of a drilling rig.

Economic valuation of ecosystem services is important to inform biodiversity and ecosystems related decisions. This requires having access to the most reliable data and information for better decision making.

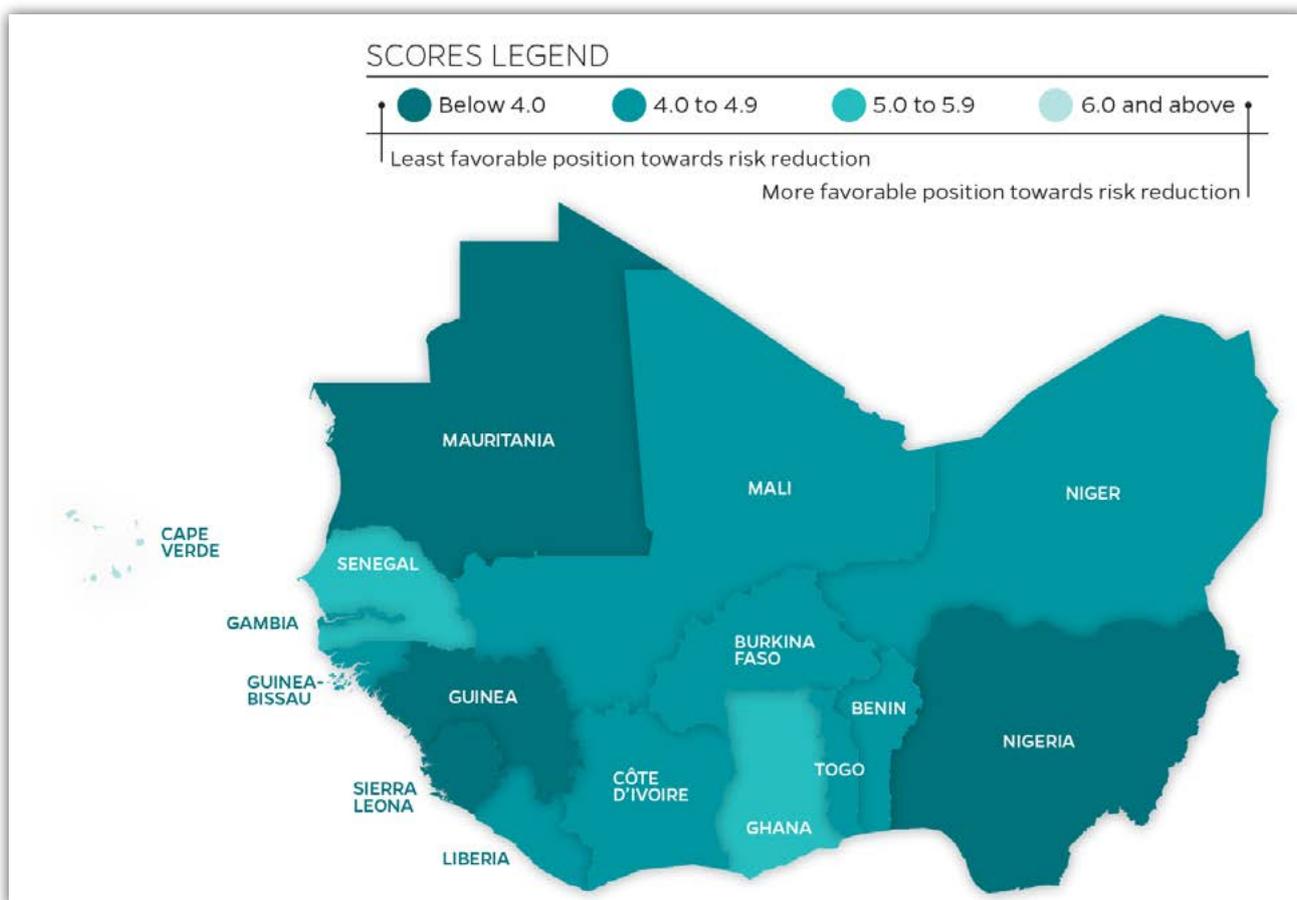


Figure 26 Risk reduction index in West Africa

4. Eco-DRR experiences in the region (cont.)

4.5. Effective Eco-DRR implementation in the region: why is there a bottleneck?

The present study shows several initiatives that could be considered in Eco-DRR and EbA approaches to mitigate the impacts of natural hazards on people and on the ecosystems that they rely on for their subsistence. These initiatives deserve greater interest from all stakeholders given that they could improve the lives of people that might be affected by environmental disturbances, and reduce in the long-term human losses as well as social, economic and environmental consequences. If these initiatives do not experience more success in their implementation as shown in this study, this has several reasons, some of which to consider could be:

Lack of awareness, knowledge and information on DRR

Awareness raising, information and knowledge of the key concept of DRR for all stakeholders, including communities are important to better understand and hence develop relevant projects accordingly. In addition, this study gives examples of projects that do not necessarily make the link between the objectives and expected outputs and Eco-DRR outcomes, whereas the results could be clearly linked to Eco-DRR. Better knowledge of the relationships will help highlight this link. In addition, awareness could help increase communities' engagement, hence, information dissemination.

Lack of capacities to reduce the risks, including inadequate funding

This is crucial and many countries affected by natural hazards and disaster do not have sufficient capacities to prepare themselves for possible disasters and to cope with them when they arise. A recent evaluation (CADRI, 2015) on capacities for disaster risk reduction conducted in seven countries of West Africa, including Burkina Faso and Nigeria, between 2012 and 2015 highlights the weakness of legal and institutional frameworks for DRR, especially in the Sahel region, even where human, technical and financial capacities exist. However, the study highlights the need for harmonised methodologies and adequate human, technical and financial resources to efficiently process the data that will serve as a basis for risk analysis.

Another study on the conditions and capacities for disaster risk reduction was conducted in six West Africa countries (DARA, 2013). The analysis led to the estimation of an RRI (risk reduction index), which was obtained from qualitative analysis (local perceptions of risk factors through site visits to obtain a detailed picture of these conditions and capacities at the local level), and a quantitative analysis that used the data from public databases in order to compare countries. From the analysis, scores were calculated and a map of risk in West Africa was elaborated: a score of 0 indicating that conditions and capacities of a country are the least favourable. The study shows there are still efforts to be made on disaster risk reduction by governments as no country in the whole West African region obtained a score higher than 6.

Lack of integrated policies and coordination

Mechanisms to integrate sectoral policies and effectively promote inter-ministerial collaboration should be strengthened as well as the coordination with multi-partners, including the private sector. This will encourage all concerned parties to work together towards the same objective of reducing damages from disasters and increasing the resilience of populations and ecosystems, including the most vulnerable ones. It will also enhance and foster the implementation of joint activities between ecosystem management actors and disaster risk management actors. Emergency responses, especially those aimed at managing food crises caused by disasters, may be well in place in most countries because of the frequency of such events. However, working together to reduce and prevent the risk of disasters can also reduce the costs associated with emergency responses. Disaster risk managers can help develop a disaster preparedness plan based on the specific risk identified by ecosystem managers in a specific ecosystem; this will be even more effective if both managers understand the stakes and concepts of the other discipline (ecosystem management and disaster risk management). This would require that joint training sessions are organised to better understand these concepts but also, and more importantly, to interact with each other.

5. Policies

In light of the impacts that disasters are causing on people and their livelihoods, regional, subregional and national strategies and programmes have been put in place to address the issue in order to mitigate these impacts and increase the resilience of the affected communities.

5.1. Biodiversity related policies and programmes

National Biodiversity Strategies and Action Plans (NBSAPs) are the principal instruments for implementing the Convention on Biological Diversity at the national level. The Convention requires countries to prepare a national biodiversity strategy (or equivalent instrument) and to ensure that this strategy is mainstreamed into the planning and activities of all those sectors whose activities can have an impact (positive and negative) on biodiversity²².

Countries that are part of this regional assessment have included Eco-DRR or EbA concepts in their NBSAPs as follows:

Burkina Faso: Action 7 of the strategy promotes a better management and protection of wetlands against siltation, pollution and invasive species, through the elaboration and implementation of operational programmes to combat these hazards and programmes to restore and protect sites and manage river basins.

Ghana: The fifth national report (December 2015) and the draft NBSAP developed in 2012 highlights nine targets for biodiversity conservation and mainstreaming. Among these targets are the following:

- Invasive alien species: integrated control on important water bodies (e.g. Volta);
- Appropriate technologies for agro-biodiversity conservation for climate change adaptation and mitigation identified and adopted.

Mali: Objective 14 of the strategy and action plan 2015–2020 will address the issue of ecosystem resilience through climate change adaptation measures and actions to combat desertification. Activities will include the restoration of degraded areas and vulnerability assessments.

Senegal: Under strategic direction 2, Senegal will restore and conserve biodiversity by restoring degraded ecosystems, strengthening the adaptation and resilience capacities of stakeholders and managing and protecting ecosystems. The issue of invasive species will also be addressed in Senegal River where more than 100,000 ha are infested with species such as *Typha domingensis*.

Togo: Objective 6 of the strategy will consist of addressing the issue of wildfires by implementing efficient measures by 2018.

Nigeria: the country will establish a National Forest and Vegetation Recovery Programme, including mangroves and other coastal areas, and support the implementation of the Great Green Wall Initiative.

DRC: the country will protect habitats by: restoring mangroves, setting up an observatory of coastal erosion and stabilising the coastline. It is also expected that by 2020, all relevant sectoral strategies and the development plan integrate biodiversity aspects.

Cameroon: some of the actions will consist of:

- Identifying and replicating good ecosystem-based lessons-learned on climate change adaptation and mitigation projects;
- Promoting the establishment of a community-based Montane ecosystem;
- Managing and incorporating management of endangered species and disaster hotspots;
- Rehabilitating degraded flood and drought zones with high biodiversity. Intensify programmes for the rehabilitation of drought and flood zones in semi-arid ecosystems.

Despite the fact that these countries have included Eco-DRR and EbA approaches in their NBSAPs, on the ground we are yet to see more concrete and successful examples of initiatives that use biodiversity and ecosystems for DRR and vice versa.

5.2. National disaster risk management (DRM) policies

As stated above, the Convention on Biodiversity requires countries to ensure that their strategy on

²² <https://www.cbd.int/nbsap/>

biodiversity is mainstreamed into the planning and activities of all those sectors whose activities can have an impact (positive and negative) on biodiversity²³. However this is not always the case as DRM policies do not always include biodiversity aspects.

At the regional and subregional levels

The African Union established an Africa Regional Strategy for Disaster Risk Reduction in 2004, which aims to contribute to the attainment of sustainable development and poverty reduction by facilitating the integration of disaster risk reduction into development. A Program of Action for the implementation of this Strategy was adopted in 2006, then replaced by the Extended Program of Action for the Implementation of the Africa Regional Strategy for Disaster Risk Reduction (2006–2015) in 2010. The overall goal of the Extended Program of Action is a substantial reduction of social, economic and environmental impacts of disasters on African people and economies. The African Union also established a disaster risk reduction programme and set up and operationalised the Africa Working Group on DRR with a view to providing coordination and technical support to Regional Economic Communities (RECs), Member States, and other stakeholders for the implementation of the Program of Action (African Union, 2004).

The Strategy's objectives are to:

- Increase political commitment to disaster risk reduction;
- improve identification and assessment of disaster risks;
- enhance knowledge management for disaster risk reduction;
- increase public awareness of disaster risk reduction;
- improve governance of disaster risk reduction institutions; and
- integrate disaster risk reduction in emergency response management.

The AU has a specific strategy to achieve each objective mentioned above. However, these strategies do not include Eco-DRR aspects; they

do not specifically mention the use of biodiversity or ecosystems to address the issue of DRR.

The Great Green Wall of the Sahara and the Sahel Initiative was launched in 2007 by the African Union. It seeks to reduce the effects of desertification and climate change. The aim of the initiative is to:

- tackle the issue of land degradation and desertification in Sahel and the Sahara
- improve food security
- support communities to adapt to climate change

The current focal countries for the initiatives are Algeria, Burkina Faso, Chad, Djibouti, Egypt, Eritrea, Ethiopia, Gambia, Mali, Mauritania, Niger, Nigeria and Senegal.

The Great Green Wall (GGW) will contribute to improved local incomes; it will thus be a global answer to the combined effect of natural resources degradation and drought in rural areas. The Sahel and West Africa Programme (SAWAP) is the World Bank and GEF contribution to the GGW. In this programme, Eco-DRR issues will be addressed mainly through sustainable land and water management.

The FAO Strategy of disaster risk management in West Africa and Sahel (2011–2013) aims to safeguard and rebuild agricultural and rural livelihoods as quickly as possible when the capacity of adaptation of the communities in the post-disaster phase is exceeded. The strategy envisages the elaboration of disaster risk reduction plans and adaptation plans in the sector of fisheries and forest specifically. This is the only passing reference to biodiversity in the plan.

The Economic Community of Central African States (ECCAS) – Coordinating Bureau for the Environment and Natural Resources, with technical support from UNISDR, drafted a DRR policy and outlined a process to develop and validate this policy among a broad range of regional stakeholders in 2009.

A regional policy on preventing disaster risk was adopted by the Heads of State of ECOWAS in 2007, as well as an Action plan (2010–2015) (ECOWAS, 2013; AU, UNISDR and World Bank, 2008). The "PRC"²⁴ Division of ECOWAS worked out and validated new guidelines for the reinforcement of national platforms in the Member

²³ <https://www.cbd.int/nbsap/>

²⁴ *Preventing Disaster Risk*

5. Policies (cont.)

States. One of the strategies envisages supporting the efforts of integration of disaster risk reduction strategies into adaptation to climate change, in particular the management of drought and the fight against desertification. However, this strategy does not include specific biodiversity aspects.

At the national level

Not all countries being assessed have DRM Country Plans.

Ghana has a Plan of Action for Disaster Risk Reduction and Climate Change Adaptation coordinated by the National Disaster Management Organisation (NADMO).

Senegal, Nigeria and Cameroon do not have their DRM plan yet. However, Senegal has set up a Commission in charge of preventing and managing disaster risks (CPGRC). This initiative is supported by IUCN-Senegal. The Commission has main missions of: (i) contributing to the sustainable development and the eradication of poverty by the integration of the reduction of disaster risks in political instruments, (ii) ensuring the coordination of interventions on prevention and management of disaster risk at the departmental level, (iii) drafting and validating a departmental strategy of disaster risk reduction with stakeholders, (iv) setting up a departmental plan of prevention and management of disaster risk, and (v) ensuring information and communication to the actors on the risks of natural disaster.

In 1999, Nigeria established the NEMA (National Emergency Management Agency), which has a DRR unit since 2009. This unit has been created to monitor the implementation of the national strategy for DRR developed in 2006. NEMA also coordinates the national platform.

In addition, countries have a national platform for disaster risk reduction, as a means to increase resilience through coordination of interventions, advocacy, awareness raising and the facilitation of integration of DRR in the different sectors. However, most of these platforms are not operational; the development of an action plan could help revive them.

5.3. Climate change adaptation (CCA) policies

At the regional level

There is no strategy/policy on climate change, even if much progress has been made towards trying to understand the impacts of climate hazards on people and to develop possible adaptation or risk reduction strategies at national and regional levels (Masumbuko & Somda, 2014). However, climate change-related action plans and programmes in particular do exist.

For example:

- A subregional action programme to reduce West Africa and Chad's vulnerability to climate change was developed by the Economic Community of West African States (ECOWAS), the International Standing Committee on Combating Drought in the Sahel (CILSS), the Economic Commission for Africa (ECA) and the African Centre of Meteorological Application for Development (ACMAD). The overall objective of the programme is to develop and build resilience and adaptation capacities in the subregion to manage climate change and extreme climatic phenomena.
- The African Development Bank (AfDB) also developed a climate change action plan (CCAP) for 2011–2015. This plan should help countries in the Africa region to adapt to climate change and mitigate its effects. The plan aims to help African countries to build their capacity to manage climate change and mobilise resources. This plan does not include Eco-DRR aspects.
- The Sahel and West Africa Programme (SAWAP)²⁵ is jointly funded by the Global Environment Fund (GEF), the Least Developed Countries Fund (LDCF) and the Special Climate Change Fund (SCCF). This programme encompasses 12 national projects in the following countries: Benin, Burkina Faso, Chad, Ethiopia, Ghana, Mali, Mauritania, Niger, Nigeria, Senegal, Sudan and Togo. The projects aim, among other things, to reduce vulnerability and increase the capacity for adapting to current or potential effects of climate variability. Many of these countries will use ecosystems to reduce the disasters caused by natural hazards. This programme includes biodiversity

²⁵ This programme is also supported by an umbrella project called BRICKS Building Resilience through Innovation, Communication and Knowledge services

5. Policies (cont.)

and Eco-DRR aspects through sustainable land and water resources. For example, the Nigeria SAWAP project will address the issue of gully erosion through restoration activities.

National adaptation plans (NAP) established under the Cancun Adaptation Framework (CAF) are still new and being developed by countries. Burkina Faso developed its final version in 2015.

At the national level

National Adaptation Plans of Action (NAPAs) identify priority activities that respond to the urgent and immediate needs to adapt to climate change. The main aim of the NAPA is to identify priority adaptation activities as well as the projects' profiles to facilitate the development of proposals for the implementation of NAPA.

Several countries have developed NAPAs: 14 countries in West Africa²⁶ and four²⁷ in Central Africa.

Many countries do not include biodiversity and Eco-DRR in their plan, with only a few doing so: for instance, the Sierra Leone NAPA includes a project for the establishment of new forest reserves, protected areas and national parks; in Gambia, the NAPA proposes adaptation strategies regarding forest protection as regards habitats and species.

Ghana has not submitted a NAPA yet but is putting in place a national climate change adaptation framework, aimed at: strengthening national resilience to disasters, and proactive and effective risk reduction measures. In this regard, in 2012, Ghana launched its national climate change adaptation strategy (NCCAS), in which it identified temperature increase, rainfall variability and decrease, sea level rise, extreme weather events and climate related-disasters as key elements of vulnerability.

The Democratic Republic of Congo plans to include biodiversity aspects in the strategies and plan to mitigate and adapt to climate change.

For Senegal, the NAPA includes mangrove restoration activities as well as activities to reduce coastal erosion, through plantation of filaos over the offshore bar, over a 10 km length (between Djifère and Palmarin) and an average width of 100 m.

²⁶ Benin, Burkina Faso, Cape Verde, Gambia, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Senegal, Sierra Leone, Chad, Togo

²⁷ DRC, Rwanda, Central African Republic, Burundi

5. Policies (cont.)

Table 11: Overview of regional policies, strategies and frameworks related to EbA and Eco-DRR

Agency/ convention	Programme, policy, strategy or framework	Description	Linkages to EbA and Eco-DRR
UNISDR, AU, New Partnership for Africa's Development (NEPAD), AfDB	Africa regional strategy for DRR	The aim of the Strategy is to contribute to the attainment of sustainable development and poverty eradication by facilitating the integration of disaster risk reduction into development.	No
AU	Great Green Wall of the Sahara and the Sahel Initiative	It seeks to reduce the effects of desertification and climate change.	Address the issue of land degradation and drought for improved resilience of communities and ecosystems through sustainable land management interventions
AfDB	Climate Change Action Plan	To help countries in Africa to adapt to climate change and mitigate its effects, by building their capacity to manage climate change.	No
ECOWAS, CILSS, ECA, ACMAD	Action programme to reduce West Africa and Chad's vulnerability to climate change	To develop and build resilience and adaptation capacities in the subregion to manage climate change and extreme climatic phenomena.	Address extreme climate events to build resilience
14 countries in West Africa, 4 in Central Africa	National Adaptation Plans of Action (NAPAs)	To identify priority activities that respond to the urgent and immediate needs to adapt to climate change.	Sierra Leone and the Gambia have specific links to Eco-DRR (new forest reserves and forest protection respectively)
FAO	The FAO Strategy of disaster risk manage- ment in West Africa and Sahel (2011–2013)	To safeguard and rebuild agricultural and rural livelihoods as quickly as possible when the capacity of adaptation of the communities in the post-disaster phase is exceeded.	
ECOWAS	Regional policy on preventing disaster risk and Action plan (2010–2015)		Management of drought and fight against desertification; biodiversity not specifically mentioned
GEF, LDCF, SCCF	The Sahel and West Africa Programme (SAWAP)	To reduce vulnerability and increase the capacity for adapting to current or potential effects of climate variability.	Ecosystems will be used to reduce the disasters caused by natural hazards through sustainable land and water resources (forest landscape restoration, watershed management, etc.)
Countries	DRM plans	Management of disaster risks.	No

6. Challenges and opportunities

This section will address the challenges in conducting such an assessment and opportunities to develop or initiate actions towards the gaps identified during the assessment.

One important challenge relates to the availability of information on biodiversity, ecosystems, natural hazards and disasters. Information on biodiversity and ecosystems usually exists although is not always up to date; however, programmes in the region are trying to improve the data availability, reliability and accessibility through, for instance, the establishment of an observatory that will collect, process and manage these data in order to make them available to stakeholders. Information on natural hazards and disasters also exist, but again, their reliability and accessibility should be improved. The above has to be done with the collaboration of the countries themselves through the relevant ministry and data providers so that the best up-to-date and available information is used to process analyses that will lead to policy recommendations. Countries should also be willing to support the cost of data collection, data processing and analysis and the dissemination of best practices, rather than relying on international projects.

Many countries do not implement Eco-DRR activities/projects per se. A project may appear to be responding to a DRR outcome but it is not the main expected outcome. Often, the link between biodiversity and Eco-DRR is missing. So one main challenge was to identify in each relevant project where an Eco-DRR outcome is “eligible”. Countries do not have many examples of biodiversity/ ecosystem cases for Eco-DRR or initiatives that protect biodiversity using Eco-DRR activities. If Eco-DRR is to be achieved for a specific country, group of countries or the region, this will require more thorough research including field visits.

Likewise, the assessment was also challenging in terms of finding information on policies and programmes that integrate biodiversity and Eco-DRR. In most cases, this information currently does not exist because such policies are yet to be formulated and implemented.

Knowing all these gaps, this assessment is a great opportunity to engage in many aspects of Eco-DRR issues, such as:

- Better understanding and perception of the issue/concept: sensitisation and awareness raising, information sharing, training including on Eco-DRR tools.
- Testing some of the methods that use biodiversity to address Eco-DRR: especially examples were lacking regarding crop wild relatives, and soil bioengineering. Another aspect that could be explored is how we could use the biodiversity from the soil (biodiversity of microorganisms) to reduce the effects of natural hazards; for instance those microorganisms that participate in soil formation, nutrient cycling and therefore play an important role in maintaining the structure of the soil that supports ecosystem services.
- In addition to plant species, explore how animal biodiversity can also play a role in Eco-DRR. For instance, species like mountain gorillas, which are endemic to eastern DRC, Uganda and Rwanda disseminate specific seeds in their excrement, thus participating in the natural regeneration of specific tree species that might play an important role in Eco-DRR.
- Enhancing the use of protected areas tool as a way to reduce disaster risks and minimise the effects of hazards. Protected areas, if well managed, are powerful buffers against storms, erosion, strong winds and floods.

Forest regeneration and protected areas management especially (forest protected areas) would lead to ecosystems rich in carbon; they would therefore be eligible for inclusion in national REDD+ strategies.

Mapping is an important way to identify risks to some hazards such as landslides and erosion, and will inform on vegetation cover, vegetation cover types, and the dynamics of plant communities in a landscape. Some species are less resistant to fires than others. Maps will inform on the likelihood of a fire to occur in a specific area according to the species present. They are powerful monitoring tools.

Finally, early warning systems are important tools to increase the resilience of local communities to natural hazards. Such systems exist already but they should also integrate biodiversity and ecosystems concepts.

7. Conclusions

This assessment conducted for West and Central Africa reveals that few projects and/or initiatives make the link between ecosystems or biodiversity management and disaster risks reduction strategies. This is probably because the concept of Eco-DRR is still new to some stakeholders and therefore has not yet been fully adopted by the community of practice. Even if there is a clear link between project activities and Eco-DRR outcomes, it has not been identified as a possible outcome of the project. There should be increased engagement between the scientific community and project managers in developing and implementing EbA and Eco-DRR activities. In this way, scientists will develop tools and strategies that are useful to practitioners on the ground, and will also directly respond to the needs of local communities.

Policies (regional and national) are not integrated. Disaster risk management plans and strategies do not integrate biodiversity conservation and vice versa. This does not facilitate the full and efficient implementation of Eco-DRR activities.

The analysis of the questionnaires reveals the following:

- Many institutions currently implement or plan to implement Eco-DRR projects (71% of the respondents). However, from the projects the institutions mentioned regarding DRR, they were not always specifically linked with DRR or if there was a link, the project did not look at this (not main objective and expected results of project).
- For those countries/institutions that are not implementing Eco-DRR activities, it is mainly due to lack of capacities and financial constraints.
- The current capacity development needs with regards to the implementation of Eco-DRR cited by the respondents include:
 - More training and capacity building on issues in disaster risk management, including: data collection methods and analysis, identifying risks, DRR early warning systems, disaster preparedness, community-based climate change adaptation, disaster/emergency response, tools to analyse economics of DRR, assessment methods and analysis;

- Improve institutions' capacity in terms of equipment and financial capacity;
- Capacity building in Eco-DRR project formulation and on networking on Eco-DRR.

Hence, some of the recommendations/ key messages from this study include:

- Regional and national institutions should be strengthened to better plan and implement climatic resilience for both ecosystems and people, and also climate risk management;
- Joint capacity building initiatives for ecosystem managers, DRM managers and other actors should be implemented in order to help them better understand the links between DRM and ecosystem management;
- Ecosystem managers should collaborate with all stakeholders including researchers, NGOs, communities and decision makers to effectively implement a long-term strategy on resilience and disaster risk reduction that integrates ecosystem and biodiversity aspects;
- Researchers should develop the appropriate tools (including maps) for collecting and analysing data on damages and Eco-DRR to highlight the links between DRM and ecosystem management;
- Government institutions should develop and facilitate the implementation of integrated disaster risk management and environment/ biodiversity conservation management policies.

8. References

- > African Studies Center, (1999). Climate change and climate variability in West Africa. InfoSheet.
- > African Union (2004). La Stratégie régionale africaine pour la réduction des risques de catastrophe. Juillet 2004.
- > AU (African Union), UNISDR (United Nations International Strategy for Disaster Reduction), and World Bank. 2008. Status of Disaster Risk Reduction in the Sub-Saharan Africa Region, by Rakhi Bhavnani, Seth Vordzorgbe, Martin Owor, and Franck Bousquet. Washington, DC: World Bank
- > Ajonina, G. J. G. Kairo, G. Grimsditch, T. Sembres, G. Chuyong, D. E. Mibog, A. Nyambane and C. FitzGerald (2014). Carbon pools and multiple benefits of mangroves in Central Africa: Assessment for REDD+. 72pp
- > Bartens, J., Day, S.D., Harris, J.R., Dove, J.E. and Wynn, T.M. (2008). Can urban tree roots improve infiltration through compacted subsoils for stormwater management? *J Environ Qual.* 37(6):2048–2057. doi: 10.2134/jeq2008.0117. Print 2008 Nov-Dec.
- > Birdlife (2016). Conservation Strategy for the Great Lakes Region of East and Central Africa. http://www.birdlife.org/sites/default/files/attachments/AUTHORISED-GLR-STRATEGY_0.pdf Downloaded on 8 August 2016.
- > Boko, M., Niang, I., Nyong, A., Vogel, C., Githeko, A., Medany, M., Osman-Elasha, B., Tabo, R. and Yanda, P. (2007). Africa. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge, UK: Cambridge University Press, 433–467.
- > Boulanodji, E. (2014). Analyse et compréhension des liens existant entre le changement climatique, les aires protégées et les communautés au Tchad. UNEP-WCMC technical report.
- > Brugière, D., Chardonnet, B. and Scholte, P. (2015). Large-scale extinction of large carnivores (lion *Panthera leo*, cheetah *Acinonyx jubatus* and wild dog *Lycaon pictus*) in protected areas of West and Central Africa. *Tropical Conservation Science* 8(2): 513–527. Available online: www.tropicalconservationscience.org
- > Capacity for Disaster Reduction Initiative (CADRI) (2015). Etude sur les capacités en Réduction des Risques de Catastrophes.
- > CEDEAO (2009). Programme d'action sous-régional pour réduire la vulnérabilité aux changements climatiques en Afrique de l'Ouest, Partie I : Aperçu de la vulnérabilité aux changements climatiques et stratégies de réponse.
- > Conservation International (2011). Biodiversity Hotspots Revisited. Credits: Conservation Synthesis, Center for Applied Biodiversity Science at Conservation International <http://www.biodiversityhotspots.org/xp/Hotspots/resources/maps.xml>
- > Costanza R., d'Arge R., de Groot R., Farberk S., Grasso M., Hannon B., Limburg K., Naeem S., O'Neill R. V., Paruelo J., Raskin R. G., Suttonkk P., & van den Belt M. (1997). The value of the world's ecosystem services and natural capital. *Nature*. Vol 387
- > Craigie, I.D., Baillie J. E.M., Balmford A., Carbone C., Collen B., Green R. E. and Hutton J.M. (2010). Large mammal population declines in Africa's protected areas. *Biol. Conserv.* 143(9): 2221–2228.
- > DARA (2013). Risk Reduction Index (RRI) in West Africa. Analysis of the conditions and capacities for Disaster Risk Reduction Cape Verde, Gambia, Ghana, Guinea, Niger, and Senegal.
- > Diop, S. (2007). Les écosystèmes marins et côtiers de l'Afrique de l' Ouest : enjeux de leur gestion à long terme et de leur développement durable - Exemple du Sénégal <http://www.esalifdiop.org/docs/publications/Article.pdf>

8. References (cont.)

- > Diop, S., Barousseau, J-P. and Descamps C. (2014). The Land/Ocean Interactions in the Coastal Zone of West and Central Africa. Springer International Publishing Switzerland 2014.
- > DNEF (2014). Stratégie Nationale et Plan d'Actions pour la Diversité Biologique. Ministère de l'Environnement, de l'Eau et de l'Assainissement, Mali.
- > Dudley, N., Buyck, C., Furuta, N., Pedrot, C., Renaud, F. and Sudmeier-Rieux, K. (2015). Protected Areas as Tools for Disaster Risk Reduction. A handbook for practitioners. Tokyo and Gland, Switzerland: MOEJ and IUCN. 44pp
- > Dudley, N., Stolton, S., Belokurov, A., Krueger, L., Lopoukhine, N., MacKinnon, K., Sandwith T. and Sekhran, N. (eds.) (2010). Natural Solutions: Protected areas helping people cope with climate change. Gland, Switzerland, Washington DC and New York, USA: IUCN WCPA, TNC, UNDP, WCS, The World Bank and WWF.
- > ECOWAS (2013). Background paper. Sub regional platform on Disaster risk reduction. Available at: http://www.preventionweb.net/files/36258_backgroundpapernigerworkshop1114nov.pdf
- > EM-DAT (2016). The Emergency Events Database. CRED International Disaster Database. Brussels, Belgium: Université Catholique de Louvain.: <http://www.emdat.be>
- > Emslie, R. (2011). *Diceros bicornis* ssp. *longipes*. The IUCN Red List of Threatened Species 2011: e.T39319A10198340. Downloaded on 09 August 2016. <http://www.iucnredlist.org/details/39319/0>
- > Engels, J., Diulgheroff, S. and Sanz Alvarez, J. (2014). FAO. A Field Guide for Disaster Risk Reduction in Southern Africa: Key Practices for DRR Implementers.
- > European Commission. (2010). Etude de faisabilité d'un programme d'appui aux parcs de l'entente. Rapport janvier 2010.
- > FAO (1997). Aménagement des forêts naturelles des zones tropicales sèches. Available at <http://www.fao.org/docrep/w4442f/w4442f0o.htm>
- > FAO (2011). Stratégie de la FAO de gestion des risques de catastrophe en Afrique de l'Ouest et au Sahel (2011-2013).
- > FAO (2015). Evaluation des ressources forestières mondiales. Comment les forêts de la planète changent-elles ? FAO. ISBN 978-92-5-208821-9
- > GIEC (2001). Changements climatiques 2001. Troisième rapport d'évaluation.
- > GIEC (2014). Changements climatiques 2014: Incidences, adaptation et vulnérabilité – Résumé à l'intention des décideurs. Contribution du Groupe de travail II au cinquième Rapport d'évaluation du Groupe d'experts intergouvernemental sur l'évolution du climat [sous la direction de Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea et L.L. White]. Organisation météorologique mondiale, Genève (Suisse), 34 pages (publié en anglais, en arabe, en chinois, en espagnol, en français et en russe).
- > Henschel, P., Coad, L., Burton, C., Chataigner, B., Dunn, A., MacDonald D., Saidu Y., Hunter L.T.B. (2014). The Lion in West Africa Is Critically Endangered. PLoS ONE 9(1): e83500. Doi:10.1371/journal.pone.0083500.
- > IEPF/UICN (2008). Biodiversité, énergie et changement climatique. Enjeux et perspectives. Numéro spécial « Liaison énergie-environnement »
- > IPCC (2002). Climate change and biodiversity. IPCC technical paper V.
- > IRD (2001). Fiches d'actualité scientifique / 145 - Bassin du fleuve Congo La nature des sols module les effets de la sécheresse. <https://www.ird.fr/la-mediatheque/fiches-d-actualite-scientifique/145-bassin-du-fleuve-congo-la-nature-des-sols-module-les-effets-de-la-secheresse>

8. References (cont.)

- > IPCC (2014). Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 688 pp.
- > IUCN and UNEP-WCMC (2013). The World Database on Protected Areas (WDPA). October Release. Cambridge: UNEP-WCMC.
- > IWMI (2005). The Volta River Basin. Comprehensive Assessment of Water Management in Agriculture: Comparative study of river basin development and management.
- > Janes, T., Jones, R. and Hartley, A. (2015). Projections of change in ecosystem services under climate change. UNEP-WCM Technical Report. http://parcc.protectedplanet.net/system/comfy/cms/files/files/000/000/040/original/PARCC_Ecosystem_Services_FINAL_EN.pdf
- > Kazemi Zadeh, M. and Sepaskhah, A.R. (2016). Effect of tree roots on water infiltration rate into the soil. Shiraz, I. R. Iran: Department of Water Engineering, College of Agriculture, Shiraz University.
- > Iran Agricultural Research (2016) 35(1): 13–20 [http://www.forestry.gov.uk/pdf/Trees-people-and-the-buit-environment_Denman.pdf/\\$FILE/Trees-people-and-the-buit-environment_Denman.pdf](http://www.forestry.gov.uk/pdf/Trees-people-and-the-buit-environment_Denman.pdf/$FILE/Trees-people-and-the-buit-environment_Denman.pdf)
- > Keenleyside, K.A., Dudley, N., Cairns, S., Hall, C.M. and Stolton, S. (2012). Ecological Restoration for Protected Areas: Principles, Guidelines and Best Practices. Gland, Switzerland: IUCN. x + 120pp
- > Masumbuko, B. and Somda, J. (2014). Analysis of the links between climate change, protected areas and communities in West Africa. UNEP-WCMC technical report. <http://parcc.protectedplanet.net/en/regional-and-national-activities/links-between-pas--communities-and-climate-change>
- > Megevand, C. (2013). Dynamiques de déforestation dans le bassin du Congo: Réconcilier la croissance économique et la protection de la forêt. Washington, DC: World Bank.
- > Millennium Ecosystem Assessment (2005). Ecosystems and Human Well-being: Synthesis. Washington, DC: Island Press.
- > Oliver Tom H., Matthew S. Heard, Nick J.B. Isaac, David B. Roy, Deborah Procter, Felix Eigenbrod, Rob Freckleton, Andy Hector, C. David L. Orme, Owen L. Petchey, Vânia Proença, David Raffaelli, K. Blake Suttle, Georgina M. Mace, Berta Martín-López, Ben A. Woodcock, James M. Bullock. (2015). Biodiversity and resilience of ecosystems functions. Trends in Ecology & Evolution, November 2015, 30: 11.
- > OMM (2007). L'état du climat mondial en 2006. © 2007, Organisation météorologique mondiale. ISBN 92-63-21016-0
- > Raffaello C., and Morris M. (eds.) (2015). Affronter la sécheresse dans les zones arides de l'Afrique : des possibilités de renforcer la résilience. World Bank and AfD. Available at: <https://openknowledge.worldbank.org/handle/10986/2150>
- > Ramsar (2007). Les Manuels Ramsar pour l'utilisation rationnelle des zones humides, 3e édition.
- > Sathirathai S, Barbier EB (2001). Valuing mangrove conservation in southern Thailand. Contemporary Economic Policy. Volume 19, Issue 2. Pages 109–237
- > Shono, K., Cadaweng, E.A. and Durst, P.B. (2007). Application of assisted natural regeneration to restore degraded tropical forestlands. Restoration Ecology, 15(4): 620–626.
- > Sonko K.N. (2013). Analysing links between Climate Change, Protected areas and Communities in The Gambia. UNEP-WCMC technical report.

8. References (cont.)

- > Thiombiano, A. and Kampmann, D. (eds). (2010). Biodiversity Atlas of West Africa, Volume II: Burkina Faso. Ouagadougou & Frankfurt/Main.
- > UICN/WCPA (2007). Etat des aires protégées dans le monde, 2007.
- > UNDP (2004). Reducing disaster risk, a challenge for development. United Nations Development Programme, Bureau for Crisis Prevention and Recovery. One United Nations Plaza New York, NY 10017, USA. www.undp.org/bcpr
- > UNEP (2002). Africa Environment Outlook. Past, present and future perspectives. United Nations Environment Programme (UNEP), Nairobi
- > UNEP (2013). Africa Environment Outlook. Our Environment, Our Health. United Nations Environment Programme (UNEP), Nairobi
- > UNFCCC (2006). Background paper on Impacts, vulnerability and adaptation to climate change in Africa for the African Workshop on Adaptation Implementation of Decision 1/CP.10 of the UNFCCC Convention, Accra, Ghana, 21 - 23 September 2006.
- > UNFCCC (2007). Climate change: impacts, vulnerabilities and adaptation in developing countries.
- > Vom Brocke, K., Vaksman M., Trouche G., Bazile D. (2016). Préservation de l'agrobiodiversité du sorgho in situ au Mali et au Burkina Faso par l'amélioration participative des cultivars locaux. In: Ressources génétiques des mils en Afrique de l'Ouest : Diversité, conservation et valorisation [on line]. Montpellier: IRD Éditions, 2004 (accessed 18 May 2016). <<http://books.openedition.org/irdeditions/556>>. ISBN: 9782709918190. <http://books.openedition.org/irdeditions/556?lang=fr>
- > Vorhies, F. (2006). Economic valuation in western Africa. A report on the valuation of environmental goods-and-services in Western Africa as an input into UNEP's GEO-4 report
- > Woodward, G., Perkins, D.M. and Brown, L.E. (2010). Review. Climate change and freshwater ecosystems: impacts across multiple levels of organization. Phil. Trans. R. Soc. B (2010) 365, 2093–2106. Downloaded from <http://rstb.royalsocietypublishing.org/> on 9 August 2016.
- > World Bank (2010). Report on the status of Disaster Risk Reduction in Sub Sahara Africa. © 2010 The International Bank for Reconstruction and Development/The World Bank
- > World Bank (2011). The integrated disaster and land management project, Togo. Africa Water Resources Management (AFTWR). The World Bank.
- > World Bank (2016). World Development Indicators. The World Bank, Washington, DC 20433, USA; ISBN (paper): 978-1-4648-0683-4; ISBN (electronic): 978-1-4648-0684-1; DOI: 10.1596/978-1-4648-0683-4
- > UNESCO (2003). Programme Mondial pour l'Évaluation des Ressources en Eau, 2003. Rapport mondial des Nations Unies sur la mise en valeur des ressources en eau, première édition: L'eau pour les hommes, l'eau pour la vie. Paris, UNESCO and New York, Berghahn Books, Chapitre 20: Bassin du fleuve Sénégal, Guinée, Mali, Mauritanie et Sénégal pp. 447-461

Internet links

- <http://www.fao.org/docrep/004/x6543e/x6543e01.htm>
- <http://africa.wetlands.org/Africanwetlands/Mangroves/tabid/2938/language/fr-FR/Default.aspx>
- <http://books.openedition.org/irdeditions/554>
- <http://www.ascleiden.nl/Pdf/infosheet2.pdf>
- <http://www.fao.org/docrep/w4442f/w4442f0o.htm>
- <https://www.cbd.int/nbsap/>

9. Annex 1: List of institutions contacted

- Direction nationale des Eaux et Forêts (DNEF), Mali
- Agence Nationale pour le Développement Durable (ANDD), Mali
- Réso-Climat, Mali
- Soupir pour le Sahel, Mali
- Nigeria National Park Service
- Federal Ministry of Environment, Nigeria
- National Conservation Foundation (NCF), Nigeria
- Ministry of Environment and Forestry Resources (MERF), Togo
- AGBO ZEGUE NGO, Togo
- Centre de Suivi Ecologique (CSE), Senegal
- Direction des Parcs Nationaux, DPN, Senegal
- ENDA NGO, Senegal
- Direction de développement durable, division chargée de la gestion des catastrophes, DRC
- WWF, DRC
- REC RDC
- SNV NGO, Burkina Faso
- Naturama NGO, Burkina Faso
- Office National des Aires Protégées (OFINAP), Burkina Faso
- Association pour la Gestion de l'Environnement et le Développement (AGED), Burkina Faso
- Ministère de l'Environnement, de l'Economie verte et du Changement Climatique, Burkina Faso
- AROCHA NGO, Ghana
- Wildlife Division, Forestry Commission, Ghana
- Ghana Wildlife Society (GWS), Ghana
- Nature Conservation Research Centre (NCRC), Ghana
- Environmental Protection Agency (EPA), Ghana



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