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# Transboundary Environmental Issues Affecting Biodiversity in Selected Shared Freshwater Ecosystems Towards Formulating Harmonized Regional Strategy for Conservation of Aquatic Biodiversity and Joint Action Plans



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# Executive Summary

Transboundary freshwater basin account for about 60% of Global freshwater flow and which affects more than 150 Countries, covers 46% of the world's land area and serves about 42% of the world's population. Of all the Continents, the African Continent has the largest number of transboundary basins and these support a population of over 800 million people. Poorly managed transboundary water supplies are projected to be potential sources of conflict and social strife among Countries. Their management is thought to be more complex than freshwater basins at the National level since the water management regime, priorities and cultures usually differ more between than within Countries. Transboundary management of water resources, therefore, require coordination across different political, legal, institutional, and technical settings. The study assesses transboundary freshwater ecosystems in the Africa Region to identify critical aquatic environmental issues affecting biodiversity and presents a framework for management of transboundary freshwater aquatic ecosystems for conservation and joint action plans.

The study involved a general overview of transboundary freshwater bodies in Africa to identify critical aquatic environmental issues affecting biodiversity. This was achieved through literature search and stakeholder engagements. Stakeholders engaged include Regional Economic Communities (RECs), Regional Basin Organisations (RBOs), Regional Fisheries Bodies (RFBs), Biodiversity and Freshwater Basin Organizations. Whiles consultations were by online/email survey, face to face interviews with key persons representing the Volta Sub-basin in Ghana.

Key environmental stressors identified from the survey results were Illegal Unregulated Unreported fishing, changing climate, over-exploitation of freshwater resources, pollution from point and non-point sources, destruction of habitats, invasion of exotic species and emergence of diseases that affect freshwater biota especially fish among others.

There were however some environmental monitoring activities being undertaken in selected basins and this included rehabilitation and strengthening the resilience of socio-ecological synthesis of the Lake Chad Basin and reversing ecosystem and water degradation in the Volta Basin.

The results further showed that most of the transboundary freshwater basins on the Continent had some forms of management agreements among riparian Countries, but these were basin specific and lack of resources to support national and Regional Strategies, non-designation of protected areas, unregulated access to resources, inadequate governance and bad riparian community organizations, hampered management of these reservoirs.

The report outlines Strategies and Protocols to address the stressors or challenges confronting biodiversity conservation in transboundary freshwater bodies in Africa. The objectives of the proposed Strategies are intended to

- To improve knowledge and understanding of the concepts of climate change and how it impacts life in the aquatic ecosystem.
- To reduce vulnerability to climate change and institute mitigation measures

- To improve water quality and reduce discharge of untreated waste materials and enhance data collection
- To manage and protect freshwater aquatic environments to minimize deleterious effects of any water and land use practice which might adversely affect aquatic habitats
- To secure and maintain the habitat conditions necessary to protect significant species, groups of species, biotic communities, or physical features of the environment where these require specific
- To minimise invasion of aquatic exotic species
- To minimise Illegal, Unreported and Unregulated (IUU) fishing of aquatic living resources that contravenes National, Regional or International Laws and frameworks to maintain a sustainable and healthy aquatic freshwater basin

The expected outcomes of these objectives if achieved would include

- Integrated strategies for sustainable operationalized at Country level
- Enhanced climate change related data
- Risk management framework developed, harmonised and operationalised
- Improved financing for climate change studies, mitigation and adaptation measures
- Harmonized environmental standards and monitoring protocols across riparian states
- Equipped regional information database and dissemination hubs created
- Critical areas for freshwater biodiversity conservation identified and protected areas created in selected Basins
- Database of species status in selected basin established
- Public knowledge on critical habitats enhanced
- Habitat management controls established
- Coordination and cooperation of National and regional programs on invasion of exotic species among stakeholders
- Improved enforcement actions against IUU fishing to enhance food and nutrition security

Some proposed regional strategy for conservation of aquatic biodiversity and joint action plans are:

1. Set up institutional structures that promote stakeholder engagement at the local level and the need for well-defined objectives for biodiversity conservation.
2. Develop strong and balanced capacity building and collaboration among associated institutions in different Countries.
3. Need for improved and integrated monitoring and evaluation systems that meet accepted standards.

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# List of Acronyms and Abbreviations

AU	African Union
AFDB	African Development Bank
AU-IBAR	African Union Inter-African Bureau for Animal Resources
BGR	Federal Institute of Geosciences and Natural Resources
CBD	The Convention on Biological Diversity
CITES	The Convention on International Trade in Endangered Species
CIWA	Cooperation in International Waters in Africa
CoE	Centres of Excellence
DSS	Decision Support Systems
FFEM	The French Facility for Global Environment
GEF	Global Environment Facility
GEF	Global Environment Facility
GIZ	German Agency for international Cooperation
GIZ-	German Agency for international Cooperation
IDA	International Development Association
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
LCBC	Lake Chad Basin Commission
LVTB	Lake Victoria
MEA	Multilateral Environmental Agreement
POPs	Persistent Organic Pollutants
PRESIBALT	Programme to Rehabilitate and Strengthen the Resilience of Lake Chad Basin Systems Ramsar Convention The Convention on Wetlands of International Importance especially as Waterfowl Habitat
SAP	Strategic Action Programme
SAP	Strategic Action Programme
SIDA	Swedish International Development Cooperation Agency
TDA	Transboundary Diagnostic Analysis
UN	United Nations
UNCLOS	The United Nations Convention on the Law of the Sea
UNE	United Nations Environment
UNECE	United Nations
UNEP	United Nations Environment Programme
UNEP	UN Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VBA	Volta Basin Authority
VRB	Volta River Basin
VSIP	Volta Basin Strategic Action Program Implementation Project
WANI	Water and Nature Initiative
WRC	Water Resources Commission

# I.0 Introduction

## I.1 General Introduction

Freshwater is a critical Global natural resource with no substitute and is important for the functioning of all terrestrial ecosystems (de Castro-Pardo, et al., 2021). Although two-thirds of the earth's surface is water, the Oceans, Seas and bays, and saline surface and groundwater resources account for about 99.2 percent. Of the 0.8 percent freshwater available, about 98.8 percent is locked up in permanent snow, ice caps, glaciers and groundwater aquifers (Shiklomanov, 1993). Freshwater water available in Rivers, Lakes, swamps, the atmosphere, etc therefore account for just about 1.2 percent of the world's available freshwater resource. At the Continental level, America has the largest share of the world's total freshwater resources with 45 percent, followed by Asia with 28 percent, Europe with 15.5 percent and Africa with 9 percent and in relation to available water resource per inhabitant in each Continent, America has 24 000 m<sup>3</sup>/year, Europe 9 300 m<sup>3</sup>/year, Africa 5 000 m<sup>3</sup>/year and Asia 3 400.1 m<sup>3</sup>/year (FAO 2003).

Lakes, reservoirs, and Rivers are among the most extensively transformed ecosystems on earth (Carpenter, et al., 2011). Some of the transformations are in connection with the morphology of the Rivers and Lakes, changes in the hydrology, biogeochemistry of nutrients and toxic substances, ecosystem metabolism and the storage of carbon (C), loss of native species, expansion of invasive species, and disease emergence. Key drivers of these changes are climate change, hydrologic flow modification, land-use change, chemical inputs, aquatic invasive species, and harvest (Carpenter, et al., 2011).

Ecosystem services are the benefits people attain directly or indirectly from nature. In relation to freshwater, these services are generally classified as provisional as it refers to the human use of freshwater for domestic, industrial, agricultural, power generation and transport purposes. The contribution of freshwater to human well-being can, however, improve if society improves the design and management of water resource infrastructure, establishes more inclusive governance and integrated approaches to water management, and adopts water conservation technologies, demand management, and market-based approaches to reallocation that increase water productivity.

Transboundary freshwater basin account for about 60% of Global freshwater flow which spans more than 150 Countries, covers 46% of the world's land area and serves about 42% of the world's population. (UNEP-DHI & UNEP, 2016) (Uitto & Duda, 2002). These waters are made up of aquifers, and lake and river basins shared by two or more Countries and support the lives and livelihoods of millions of people across the globe.

Of all the Continents, the African Continent is reported to have the highest number of transboundary rivers basins (Chikozho, 2014). About 63 river basins, covering 64% of the Continent's land area (Figure I-1) and serving several millions of people. The transboundary basins as shared by the various African Countries are presented in Table I in Appendix I.





**Figure 1 I:** *Transboundary River Basins of Africa (Transboundary Freshwater Dispute Database, 2014)*

Shared ecosystems face major threats, which include depletion of natural resources due to the rising population pressure, expansion in human activities, over-exploitation, unsustainable agricultural practices, over-fishing, pollution, rampant conversion, and destruction of wetlands in ecosystems (Yelesiere, et al., 2018). These threats, if not managed, may have significant negative ecological, environmental, and social impacts. This complicates management and development of these resources. Meeting the increasing demand will be further hampered by reduced water availability, due to unsustainable use, pollution, and climate change. People living in poverty, especially women and girls, are disproportionately affected by water stress through reduced access to water and unstable energy and food prices. These pose a major threat to sustainability of aquatic ecosystems, biodiversity management, conservation of aquatic resources and fair distribution of water resources in Africa.

Freshwater scarcity related to both water quantity and quality is increasing on a Global scale (van Vliet, 2021). The main determinant of this scarcity is the increasing water use by a steadily increasing world population. Growing literature suggest that conflicts around water resources will increase dramatically in the years to come and may even lead to war (Renner 1996). The Africa Blue Economy Strategy which is recognized at the highest political level of the Continent incorporates key critical vectors for promoting blue economy development of the Continent, including fisheries, aquaculture, and ecosystem conservation;

shipping, maritime safety and trade; climate change, environmental sustainability and ecotourism; sustainable energy and extractive mineral resources; governance, institutions and job creation. Approaches for enhancing cooperation between Countries for the management of transboundary freshwater bodies and contributing basins to support the transition to sustainable development is therefore necessary. This assumes that shared water resources can provide the basis for cooperation and sharing of benefits, rather than conflict, provided that the threats to the International waters are objectively recognized and institutional structures for collaboration are created.

Poorly managed transboundary water supplies are projected to be potential sources of conflict and social strife among Countries. Transboundary water management is likely to be more complex than that at the National level since the water management regime, priorities and cultures usually differ more between than within Countries. Transboundary management of water resources therefore requires coordination across different political, Legal, institutional, and technical settings (UNEP 2016).

## 1.2 Rational for the Study

Several environmental challenges have been identified as threats to sustainability of freshwater resources and biodiversity conservation Globally. Major among these are:

- Over-exploitation of freshwater resources.
- Water pollution
- Flow modification (water obstruction and reduced flows)
- Destruction or degradation of habitats
- Invasion of exotic species and emergence of diseases that affect freshwater biota especially fish.
- Overuse of water resources
- Riparian degradation
- Changing climatic conditions
- Artificial channeling of rivers
- Weed growth
- Introduction of alien species
- Wetland drainage or lowered water levels for both agriculture and urban purposes

These threats, if not checked, may have significant negative ecological, environmental, and social impacts since most environmental issues are transboundary in nature and could cut across territorial boundaries. It is therefore, important to develop Regional Strategies for conservation of aquatic biodiversity and the corresponding joint action plans.

As part of the Blue Economy Agenda, AU-IBAR seeks to develop joint management plans and protocols, involving all the blue economy actors as well as other stakeholders including private sector, women and youth for inclusivity to provide space for all entities within the framework of conservation of aquatic biodiversity and the environmental sustainability. The joint management plans and protocols would partly be underscored by International Conventions and Treaties on environment and natural resources such as Multilateral Environmental Agreements (MEAs) that are available under International Law to provide

framework for Countries to collaborate on a broad range of Global environmental challenges (Regional groupings). Amongst the Global environmental issues that MEAs are designed to respond to include loss of biological diversity, adverse impacts of Climate Change, depletion of the ozone layer, hazardous waste, organic pollutants, plastics, marine pollution, trade in endangered species, destruction of wetlands and critical habitats for significant number of biodiversity, among others etc.

In the regards to the above the study assesses two transboundary freshwater ecosystems in the Africa Region to identify critical aquatic environmental issues affecting biodiversity and develop framework for management of transboundary freshwater aquatic ecosystems for conservation of aquatic biodiversity and joint action plans.

### 1.3 Approach to the Study

The study involved a general overview of transboundary freshwater bodies in Africa to identify critical aquatic environmental issues affecting biodiversity and from that develop framework for Regional cooperation on conserving biodiversity.

These were achieved through:

- Literature search
- Stakeholder engagements

#### 1.3.1 Literature Search

The literature search depended largely on materials available online, journal articles, books and reports at the websites of various organizations, institutions. Information retrieved covered aquatic ecosystems hotspots, trends in species compositions of various transboundary waterbodies, environmental issues/status, existing biodiversity Policy frameworks and biodiversity management Strategies.

#### 1.3.2 Stakeholder Engagements

Stakeholders engaged included Regional Economic Communities (RECs), Regional Basin Organisations (RBOs), Regional Fisheries Bodies (RFBs), Biodiversity and Freshwater Basin Organizations. Consultations were by:

1. Online/Email survey
2. Face to face interview with the Director Legal and Corporate Affairs of the Water Resources Commission, responsible for the Volta Basin in Ghana.
3. Telephone interview with Dr Charles Biney, a former Executive Secretary of the Volta Basin Authority.

Sample of the questionnaires circulated are presented in Appendix 2.

#### 1.3.3 Drafting of Water Related Policies, Biodiversity Management Frameworks and Protocols

The management framework and Policy draft were based on best practices and existing International Protocols. Some of the documents consulted included:

- West Africa Water Resources Policy

- Convention on the Protection and Use of Transboundary Watercourses and International Lake
- Shared Water Resources in West Africa
- United Nations Water Courses Convention
- United Nations Economic Community for Europe
- Convention on Biological Diversity
- Existing treaties and Agreements by the Basin Organisations

## 1.4 Outline of the Report

The report is presented in six main sections.

- Section 1 which is this section presents an introduction to the report and outlines approaches to the study
- Section 2 provides the state of transboundary freshwater ecosystems in Africa and is based on responses from the questionnaire survey
- Section 3 analysis the state existing initiatives
- Section 4 proposes Regional Protocols and Strategies for the conservation of aquatic biodiversity and joint actions
- Section 5 outlines mechanisms for strengthening the capacities of Regional institutions to sustainably manage critical transboundary ecosystems
- Section 6 mechanisms for institutional collaboration in biodiversity conservation and environmental management.

## 2.0 The State of Transboundary Freshwater Ecosystem in Africa

Biodiversity within Africa's inland waters is both highly diverse and of great importance to livelihoods and economies. An assessment of the status and distribution of all described species of freshwater fishes, molluscs, odonates, crabs and selected families of aquatic plants, by IUCN, across mainland Africa recorded a total of 4,898 species. Of this, 21 percent are threatened, and 91 percent are endemic to the continent and, therefore, Globally threatened (Darwall, et al., 2011). Africa, per estimation could lose 20-30% of lake productivity by 2100.

This section of the report combines data obtained from the questionnaire survey and literature to establish the state of selected transboundary freshwater basins in Africa. It also outlines primary uses of the selected basins, biodiversity hotspots, key environmental stressors and existing Agreements and Protocols.

Responses to the questionnaires were received from the following institutions

- Water Resources Commission, Ghana for Volta Basin in Ghana (In-person interview)
- Malawi Fisheries Department for Lake Malawi - Zambezi basin
- Ministry of Livestock and Fisheries, South Sudan for White and Blue Nile - Nile Basin
- Ministry of Agriculture, Eswatini for in relation River Lomati
- Ministry of Water and Environment
- Ministère De l'Environnement et de la Lutte Contre la Désertification, Niger for Chad Basin in Niger
- Lake Chad Basin Commission, Chad for the Chad Basin
- Lake Tanganyika Authority, Bujumbura-BURUNDI for Lake Tangayinka
- Commission Économique du Bétail de la Viande et des Ressources Halieutiques CEBEVIRHA, for Lake Chad Basin
- Lake Victoria Fisheries Organization, Uganda for Nile Basin
- FCWC, Volta Basin
- Ministry of Livestock, Fisheries and Animal Industries (MINEPIA) MINEPIA, Cameroon
- Ministry of Agriculture/FSTS, Sudan in regard to the Blue and White Nile – Nile basin

### 2.1 Primary Uses of Transboundary Freshwater Basin in Africa

The sizes of Africa's boundary freshwater basins are varied and the number of Countries sharing the basins are equally varied. The Congo Basin is the largest in Africa and the second largest freshwater basin in the world. Economic uses of these basins per the responses received are very similar despite the variations in sizes. Agriculture, fishing, hydropower generation, industry, mining, potable water supply and navigation were the most common uses. Information relation to the selected persons are summarised in Table 2-1.

## 2.2 Environmental Challenges affecting aquatic biodiversity in shared freshwater ecosystems in Africa

Per the survey data, major environmental challenges identified, by respondents, as threats to sustainability of freshwater resources and biodiversity conservation in transboundary basins in Africa are:

- Changing climate
- Over-exploitation of freshwater resources.
- Water pollution
- Flow modification (water obstruction and reduced flows)
- Destruction or degradation of habitats
- Invasion of exotic/alien species (animals and plants) and emergence of diseases that affect freshwater biota especially fish.

### 2.2.1 *Changing climate*

Climate change poses threats to the environment and economies of all Countries across the globe. Africa already experiences high levels of climate variability and is widely recognized as the Continent most vulnerable to climate change under all climate scenarios above 1.5 °C (World Meteorological Organization, 2020). The warming is expected to have severe impacts on human well-being, aquatic ecosystems, associated biodiversity and on economic development. Among the institutions interviewed, more than half of the respondents identified climate change as a major threat to biodiversity in their respective basins. Studies by (Cohen, et al., 2016), showed climate change as being a major cause for the decline of fish production in Lake Kariba and Lake Tanganyika. In Lake Volta, most climate predictions point to reduction in water availability and higher temperatures with increased evapo-transpiration. These factors alone have the potential to negatively affect water availability for energy production and agriculture now and in the foreseeable future. High variability of rainfall patterns and distribution would lead to an increase of water demand for irrigation.

### 2.2.2 *Water pollution*

Pollution from agricultural, industrial, illegal mining of sand and minerals and urbanization were identified by seven of the thirteen respondents as major sources of pollution to the transboundary water bodies. These pollutants can be categorized as point and non-point sources. Often freshwater basins especially small rivers (tributaries) situated in urban communities are used as receptacles for industrial and urban sewages which has devastating effect on the shelf – life of these aquatic ecosystems (Assegide, et al., 2022). Freshwater pollution negatively alters the physical, biological and chemical characteristics of water in these basins and these tend to affect the abundance and diversity of inhabiting aquatic flora and fauna (Xu, et al., 2014)

Wastes from agriculture, industry, urbanization and mining include pesticides, toxic chemicals and agrochemicals. High sedimentation and toxic chemicals have also been attributed to illegal small-scale mining operations in Ghana and Cameroon. Reports from (Oguttu, et al., 2008) showed high nutrient load in Lake Victoria which has impacted negatively on surrounding communities that depend on the water



for their livelihood. Furthermore, the water quality of the Rift Valley Lake in Ethiopia has declined due to surface runoffs from industrial, agricultural, and other anthropogenic activities (Ayenew & Legesse, 2007). And in Ghana sixty percent of freshwater bodies are estimated to be polluted because of activities from illegal mining.

### 2.2.3 *Habitat degradation*

Freshwater ecosystems especially lakes and rivers are greatly impacted negatively when there is a change in ecosystem or habitat (Tickner, et al., 2020). Human activities such as excavation of river sand, channelization of river courses alters freshwater basins which lead to loss of some aquatic organisms and subsequent reduction in biodiversity. Habitat destructions were listed among the environmental stressors affecting aquatic biodiversity in Lake Victoria in Uganda, Lake Malawi in Malawi, Lake Chad in Cameroon, Nile Basin in Sudan, Lomati in Eswatini and Volta Basin in Ghana. When riparian vegetations are destroyed surface runoffs increase which results in high sediment loads in Rivers. This phenomenon changes the entire ecosystem of the River which may decrease the abundance of thriving organisms. Furthermore to the degradation of riparian vegetations, shoreline erosion and clogging of river bottoms or floodplain aggradation occurs which alters the entire aquatic ecosystem thereby affecting the existence of most aquatic flora and fauna. The conversion of lentic systems into lotic systems for hydropower generation also affect ecosystem balance which threatens freshwater biodiversity. The entire ecosystem becomes divided as a result of changes in the hydrological and water quality regimes which affects the distribution of fish communities, macro-invertebrate populations and other aquatic organisms because downstream migratory paths are destroyed (Olden & Naiman, 2010) Fragmentation of the ecosystem further lead to growth of some particular fish species which may overpopulate the system and subsequently change the entire ecosystem functions (Moore & Olden, 2017).

### 2.2.4 *Overexploitation*

Illegal, unreported and unregulated fishing was identified as a threat to biodiversity in Lake Victoria, the Blue Nile, Lake Malawi and Lomati River Basins. Lake Malawi in the Zambezi River Basin has the highest diversity of fish species in the world but ninety percent of these are reported to be endemic. Commercial fish stock has reduced by 20% (Kolding, et al., 2008). Excessive use of freshwater resources to the point of diminishing returns has been identified as a major threat to the sustainability of freshwater ecosystems. It was obvious from the data received that growing human population increased the demand of goods and services derived from freshwater resources in Africa. The freshwater basins are overfished due to increase in economic activity because for many riparian communities, fishing is a major source of income/livelihood and its over exploitation was attributed to poverty and unemployment and gradual increase in fishing effort. Decline of fisheries due to loss of biodiversity in Lake Tanganyika and Lake Victoria have also been reported in literature and primarily attributed to overfishing among other factors (West, 2001).

### 2.2.5 *Invasive species*

Invasive species were identified as threat to biodiversity in the Lower Volta Basin, Lake Victoria, Lake Tanganyika, Lake Chad and Lake Lomati. Freshwater invasive species are plants and animal organisms that are not native to a particular ecosystem but often times occupy larger surface area because of their prolific nature and their ability to easily adapt to new environments (Sladonja, et al., 2018). They sometimes thrive

because there are no organisms directly feeding on them in the environment in which they are found. Many invasive species are commonly introduced into a new Region mostly through human-aided or accidental pathways but in some cases introduced through transportation – aided pathways, linking waterbodies and several others (Meyer, et al., 2021). A common human – aided pathway is the introduction of aquatic species (plant or animal) to freshwater ecosystems. Some accidental – pathways also include introduction of pest by migratory birds or escaped domestic animals, science laboratory escapes or introductions, Aquatic farming on freshwater environments among others. Water hyacinth for example, is a plant native to south America but has now become a common species in most Sub-Saharan African freshwater ecosystems.

For example, in Lake Victoria, Uganda, the population of water hyacinth is reported to have increased tremendously such that canoes and boats could not get access to most parts of the waterbody which affected the state of fishery in the area. Fish populations reduced due to insufficient sunlight to support primary production (Darwall, et al., 2011) that, Nile tilapia, *Oreochromis niloticus*, has been introduced both for aquaculture and fisheries in many parts of Africa where they have shown negative impacts on indigenous fish fauna according to (Anabo, 2013) (Canonico, et al., 2005). The introduction of Nile tilapia through Cage aquaculture in Lake Bosomtwi, Ghana also predicted likely ecological impacts of Nile tilapia species on the fishery according to studies done by (Obirikorang, et al., 2020).

Invasive species are therefore reported to be key environmental concern for many Sub-Saharan African Countries, and this threatens the sustainability of most freshwater resources. This is because, they could lead to the extinction of native plants and animals, and permanently alter ecological habitats which affects biodiversity (Leprieur, et al., 2009). Crayfish populations have also become a threat to most African freshwaters. These species have invaded some of the major Lakes and Rivers of Africa (Lakes Victoria and Edward, the Semliki River, the Nile and the Zambezi basins) and have also changed the vegetation and invertebrate fauna of Lake Naivasha in Kenya (Darwall, et al., 2011).

#### 2.2.6 Hydrological Alterations

Rivers and streams exhibit different patterns in water flow, sediment and nutrients loads at different times of the year often termed as 'hydrological regime'. These changes in hydrological regime are mainly influenced by human activities such as agriculture, inland water transport, energy production and flood protection (Lintern, et al., 2018). Hydropower represents a significant source of electricity production in Eastern and Southern Africa. Currently 90% of National electricity generation in Ethiopia, Malawi, Mozambique, Namibia and Zambia comes from hydropower.

Changes in the intensity and duration of extreme weather events is already putting Global infrastructure to the test. Assessing resilience of infrastructure is a matter of strategic importance. Hydrological alterations of freshwater ecosystems can therefore be described as any anthropogenic activity that changes the magnitude and quantity of natural river flows which threatens the sustainability of most aquatic plants and animals. Furthermore, the functional organization of streams and Rivers is altered, which reduces the diversity and abundance of biota within these ecosystems (Lian, et al., 2012). River flow in many of Africa's River basins is highly sensitive to changes in rainfall. Hydropower expansion programmes will also face the problems of a changing climate.

**Table 2 1:** Examples of water use, vulnerabilities, and challenges of selected freshwater basins in Africa\*.

Freshwater Basin	Water Use	Environmental stressors	Hotspots	Factors behind the stressors	Vulnerable Biodiversity	On-going interventions and Institutional Capacity
Congo	<ul style="list-style-type: none"> <li>• Agriculture</li> <li>• Hydropower</li> <li>• Industry</li> <li>• Mining</li> <li>• Domestic water supply</li> <li>• Navigation</li> <li>• Fishing</li> </ul>	<ul style="list-style-type: none"> <li>• Climate variability and change</li> <li>• Industrial and agricultural pollution</li> <li>• Land degradation</li> </ul>	Cameroon Crater Lake Barombi Mbo, Malebo Pool, Lower (Kinsuka rapids) and Upper Congo Rapids	<ul style="list-style-type: none"> <li>• Population increases</li> <li>• Overexploitation of aquatic resources</li> </ul>	Fish Wildlife	Very weak institutions poor penetration of services into the basin, limited and collapsing infrastructure
Nile in Sudan	<ul style="list-style-type: none"> <li>• Agriculture</li> <li>• Hydropower</li> <li>• Industry</li> <li>• Mining</li> <li>• Domestic water supply</li> <li>• Navigation</li> <li>• Fishing</li> <li>• Protection of public health</li> </ul>	<ul style="list-style-type: none"> <li>• Climate variability and change</li> <li>• Illegal Unreported Unregulated fishing</li> <li>• Severe water shortages,</li> <li>• water pollution from municipal, industrial effluent and agricultural waste</li> </ul>	Hot spots include cultivated steep sloping lands in the highlands of Ethiopia, Kenya, Uganda, Rwanda, and Burundi and the overgrazed grassland in Sudan, Ethiopia, and Uganda <sup>a</sup> .	<ul style="list-style-type: none"> <li>• Overexploitation of resources due to unemployment and poverty.</li> <li>• Sediment erosion upstream</li> <li>• Pollution from dumping</li> <li>• Overgrazing by livestock</li> </ul>	African Clawless Otter, Hippopotamus African buffalo Winter migratory birds Endemic fish species	BAS Multipurpose Water Resources Development Study - accomplished by ENTRO Socioeconomic assessment of the BAS Basin for fisheries resources development – IGAD Study on co-management of the BAS Basin fisheries resources - IGAD
Lake Chad in Chad	<ul style="list-style-type: none"> <li>• Agriculture</li> <li>• Industry</li> <li>• Mining</li> <li>• Domestic water supply</li> <li>• Navigation</li> <li>• Fishing</li> </ul>	<ul style="list-style-type: none"> <li>• Land degradation</li> <li>• Land subsistence from ground water abstraction</li> <li>• Lack of integrated use and management of water resources by member states</li> <li>• Climate change</li> <li>• Overfishing</li> </ul>	Lake Chad	<ul style="list-style-type: none"> <li>• Climate change</li> <li>• Floods</li> <li>• Erosion and siltation</li> </ul>	Declined fish stocks	<p>Integrated Program for Development and Adaptation to Climate Change in the NIGER River Basin (PIDACC/BN)</p> <p>Lake Chad Region Recovery and Development Project</p> <p>Program for the Rehabilitation and Reinforcement of the Resilience of Socio-Ecological Syntheses in the Lake Chad Basin</p>
Lake Chad in Niger	<ul style="list-style-type: none"> <li>• Domestic</li> <li>• Agriculture</li> <li>• Hydroelectric power generation</li> </ul>	<ul style="list-style-type: none"> <li>• Over-exploitation of water resources (including inefficient water storage in large reservoirs with high evaporative losses</li> <li>• Over-abstraction of groundwater resources) and land-use changes</li> <li>• Persistent drought</li> </ul>	Access to safe drinking water in the Basin in some parts of Niger is very limited. Uncoordinated operation of dams, growth of weeds and silt blockages in the Old Hadejia River preventing its contribution to the Komadugu-Yobe River	<ul style="list-style-type: none"> <li>• Global climate change</li> <li>• Desertification</li> <li>• Anthropogenic stream flow modifications</li> <li>• Uncontrolled exploitation of vegetal resources</li> </ul>	2-near endermic bird species and 2-near endermic rodent species	<p>National Council for the Environment and Sustainable Development (CNEDD) which consist of the Cabinet leaders, ministers, civil society, university and NGOs.</p> <p>Promotion of the Use of Renewable Energy Resources and Conservation of Flora Species in the Drylands of Mega Chad of the West African sub-Region, 2001-2004</p>

Freshwater Basin	Water Use	Environmental stressors	Hotspots	Factors behind the stressors	Vulnerable Biodiversity	On-going interventions and Institutional Capacity
Zambesi	<ul style="list-style-type: none"> <li>• Agriculture</li> <li>• Hydropower</li> <li>• Industry</li> <li>• Mining</li> <li>• Domestic water supply</li> <li>• Navigation</li> <li>• Fishing</li> </ul>	<ul style="list-style-type: none"> <li>• Siltation and sedimentation from illegal mining of sand, gold, coal and precious stones</li> <li>• Infrastructure development near shoreline of the lake</li> <li>• Agricultural activities</li> </ul>	Lake Malawi	<ul style="list-style-type: none"> <li>• Infrastructural development</li> </ul>	Has the highest species of fish in any lake. Ninety percent are endemic	<p>Introduction of Management Plans, Community &amp; council by-laws to promote sustainable utilisation of natural resources</p> <p>A proposal to delineate biodiversity zero extinction sites in Lake Malawi</p>
Gambia River	<ul style="list-style-type: none"> <li>• Agriculture</li> <li>• Domestic</li> <li>• Mining(traditional)</li> </ul>	<ul style="list-style-type: none"> <li>• deforestation from slash-and-burn agriculture;</li> <li>• desertification;</li> <li>• water pollution;</li> <li>• water-borne diseases</li> </ul>	Excessive fishing downstream of river Gambia, Bao Bolon, Niumi National Park, Tanbi Wetland Complex, Tanji/Bijol Reserve, Bintang Bolong, Kiang West National Park and Abuko Nature Reserve	<ul style="list-style-type: none"> <li>• Over exploitation/ overfishing.</li> <li>• Cemeteries, schools, hospitals and religious sites</li> <li>• High value infrastructure</li> </ul>	Endangered species in the Gambia River Estuary include: The West African manatee The Western Red Colobus <i>Piliocolobus badius temminckii</i> The Tortoise <i>Kinixys belliana</i> The Nile crocodile <i>Crocodylus niloticus</i>	The OMVG consists of the Conference of the Heads of State and Government; the Council of Ministers, the Executive Secretary, the Standing Committee on Water; and the Consultative Committee.
Lake Malawi (Zambezi basin)	<ul style="list-style-type: none"> <li>• Agriculture</li> <li>• Domestic</li> <li>• Industry</li> <li>• Mining</li> </ul>	<ul style="list-style-type: none"> <li>• Degraded aquatic vegetation (emergent &amp; submerged)</li> <li>• Illegal mining activities (Sand, Gold, Coal &amp; precious stones)</li> <li>• Costal development - cottages, lodges &amp; hotels</li> <li>• Agricultural activities within riverbanks &amp; shorelines</li> </ul>	Entire lake is a hotspot within the Zambezi Basin	<ul style="list-style-type: none"> <li>• High unemployment</li> <li>• High population growth</li> <li>• Limited human &amp; financial capacity to manage the resources</li> </ul>	Bird species of conservation such as the Corncrake, Madagascar Squacco Heron and Wattled Crane.	The Zambezi River Authority 2020-2024 Corporate Strategy where the 5th Corporate Strategy for the period 2020-2024 formulated
Lake Victoria	<ul style="list-style-type: none"> <li>• Agriculture</li> <li>• Industry</li> <li>• Domestic</li> <li>• Fishery</li> </ul>	<ul style="list-style-type: none"> <li>• Climate variability and change affect catchment environment</li> </ul>	Increase in frequency of waterborne diseases and water hyacinth in bay areas in Kenya and Uganda	<ul style="list-style-type: none"> <li>• Industrial and agricultural pollution,</li> <li>• Overfishing, climate change and depletion of water due to large volumes of sediments washed into the lake from surface runoffs.</li> </ul>	Over 200 indigenous species are facing possible extinction due to overfishing, introduction of Nile perch and eutrophication	Lake Victoria Fisheries Organization (LVFO) established by the riparian states in cooperation with FAO, EU, and WorldBank.

Freshwater Basin	Water Use	Environmental stressors	Hotspots	Factors behind the stressors	Vulnerable Biodiversity	On-going interventions and Institutional Capacity
Volta	<ul style="list-style-type: none"> <li>• Agriculture</li> <li>• Domestic</li> <li>• Hydropower</li> <li>• Industrial</li> <li>• Mining</li> <li>• Tourism</li> </ul>	<ul style="list-style-type: none"> <li>• Increasing temperature (Increasing to north), decreasing precipitation. (Increasing to south)</li> <li>• deforestation and desertification</li> <li>• Invasive aquatic species</li> <li>• Increased sedimentation of river courses</li> <li>• Loss of soil and vegetative cover</li> <li>• Pollution from Agriculture, Industrial and domestic pollution of water courses</li> </ul>	Several national designated parks in all the basin countries.	<ul style="list-style-type: none"> <li>• Overexploitation on natural resources</li> <li>• Population pressure and demographic change</li> <li>•</li> </ul>	Reptiles Birds Mammals Reptiles	The National Development Framework, Ghana Water Vision 2025 and the National Environmental Action Plan.
Senegal	<ul style="list-style-type: none"> <li>• Agriculture</li> <li>• Domestic</li> <li>• Industry</li> <li>• Hydropower</li> <li>•</li> </ul>	<ul style="list-style-type: none"> <li>• Overfishing</li> <li>• Poaching</li> <li>• Water pollution</li> </ul>	The Senegal River Delta, another highly interesting site with respect to biodiversity, is the only ecosystem affected by invasive alien species issues	<ul style="list-style-type: none"> <li>• Habitat degradation</li> <li>• Prolonged drought due to climate change</li> <li>•</li> <li>• Overexploitation of fisheries resources</li> </ul>	The Niokolo Koba National Park alone holds 330 species of birds, 80 species of mammals, 60 species of fish, 36 species of reptiles, and 2 species of amphibians	Government Agencies/ Departments/ Ministries dealing with IAS
Okavango	<ul style="list-style-type: none"> <li>• Agriculture</li> <li>• Domestic</li> <li>• Hydropower</li> <li>•</li> </ul>	<ul style="list-style-type: none"> <li>• Rainfall variability</li> <li>• Sediment supply</li> </ul>	Decades of conflict in Angola, where the Delta's source waters a	<ul style="list-style-type: none"> <li>• Climate change, overgrazing of rangelands, Arable farming, wildlife decline, deforestation, bushfires, land use conflicts.</li> </ul>	Wildlife populations such as White Rhino, Cheetah and Wild Dog. Birdlife (Vulture and Egret populations) and fish populations	Three OKACOM commissioners are appointed by cabinet, being assisted by three senior technical staff from each country that serve on the Okavango Basin Steering Committee (OBSC).
Limpopo	<ul style="list-style-type: none"> <li>• Agriculture</li> <li>• Domestic</li> <li>• Industrial Mining</li> </ul>	<ul style="list-style-type: none"> <li>• Climate variability and change</li> <li>• Industrial and Agricultural pollution</li> </ul>	Kruger National Park and the UNESCO Vhembe Biodiversity Reserve, Upper Limpopo, Pretoria North Moretele, Shashe Limpopo, Upper Umzingwane, Soutpansberg, Pafuri Triangle, Middle Oilfants, Lower Limpopo – Chokwe – a floodplain with an intensive agricultural system.	<ul style="list-style-type: none"> <li>• Pollution from mining</li> <li>• And abstractions from irrigation, agriculture</li> <li>• construction of dams and introduction of alien species.</li> </ul>	Fish species such as Opsaridium peringueyi Barbus rapax and Chiloglanis swierstrai are endangered. and <i>O. mossambicus</i> is rapidly being replaced by <i>O. niloticus</i>	The Agreement on the Establishment of the Limpopo Watercourse Commission, signed in 2003; The LIMCOM Action Plan, produced in 2005 in partnership with SADC/WD; and the Joint Limpopo Scoping Study, completed in 2010.

Freshwater Basin	Water Use	Environmental stressors	Hotspots	Factors behind the stressors	Vulnerable Biodiversity	On-going interventions and Institutional Capacity
Orange	<ul style="list-style-type: none"> <li>• Agriculture</li> <li>• Domestic</li> <li>• Industry</li> <li>• Mining</li> <li>• Hydropower</li> </ul>	<ul style="list-style-type: none"> <li>• Climate variability and change.</li> <li>• Pollution</li> </ul>	the Kgalagadi Trans-frontier Park, Ai-Ais-Richtersveld Trans-frontier Park, and Augrabies Falls Nature Reserve	<ul style="list-style-type: none"> <li>• Over Extraction/ water scarcity, Climate change, Water pollution, Land degradation</li> </ul>	24 fish species being found in the basin, with 7 species being endemic, 2 of which are threatened with extinction. Two endemic birds species also exist in the basin.	South Africa's resources are governed by the Water Services Act of 1997, and the National Water Act of 1998

\* (Konrad Adenauer Stiftung and Law and Policy Research Foundation, 2004)

aAbdel-Meguid, M. (2016). Ecosystem and Biodiversity in the Nile Basin "Case Study: Lake Nasser". *The Nile River*, 305-356.

## 2.3 Roles of Freshwater Basin and Sub-Basin Organization

Most of the transboundary freshwater basin organizations, in the various Countries serve as focal points for the Regional organizations and managed the water resource at the National level. Activities undertaken by the organizations in relation to biodiversity conservation include fisheries Policy and management, coordination, development and management of projects at the sub-basin level, fish stock assessments, developing fisheries and aquaculture Strategies, water use rights and coordination of activities at the transboundary level. Others are implementation of programs and project activities in accordance with provisions of the Conventions and perform functions determined by the Management Committee and Conference of Ministers. They also coordinate the management and development of fisheries and aquaculture control, promote sustainable utilization of aquatic resources, extension of fishing techniques and technologies while ensuring transboundary Agreements are developed and followed to guide sustainable utilisation of resources between and among neighbouring Countries. Examples of past and on-going joint projects undertaken in the Volta and Chad basins are summarized in Table 2-2 and Table 2-3 respectively.



**Table 2 2: Past and On-going project Activities in the Volta Basin**

Project Title	Goals/Objectives	Project period	Participating countries	Key Findings / Expected outcomes	Recommendations/ Lessons learned	Funding Agency
Reversing ecosystem and water degradation in the volta river basin (reward-volta river basin)	Reverse ecosystem and water degradation and support integrated ecosystem-based development in the Volta River Basin through strengthened transboundary governance and restoration and conservation of ecosystems for sustainable livelihoods	September 2017- January 2022	Benin Burkina Faso Cote d'Ivoire Ghana Mali Togo	1) Establishment of an improved Knowledge Base of the Volta Basin 2) Establish a reliable water resources system model for the Volta River Basin. 3) implementing the DSS for water resources planning and management		GEF (Global Environment Facility) Trust Fund
Volta Basin Strategic Action Program Implementation Project (VSIP)	The VSIP project aims to strengthen the capacities of the VBA for the management of transboundary water resources.	2015-2019	Benin Burkina Faso Cote d'Ivoire Ghana Mali Togo	Improved capacity and operations for more effective transboundary water resources management in the (VRB) Volta River Basin  Direct project beneficiaries benefitting from implementation of the Strategic Action Programme (SAP) priority actions		1) World Bank 2) CIWA 3) Global Environment Fund – FEM
UNEP/GEF Volta River Basin Project	1) Build capacity, improve knowledge and enhance stakeholders' involvement to support the effective management of the Volta River Basin. 2) Develop River basin legal, regulatory and institutional frameworks and management instruments for addressing transboundary concerns in the Volta River and its downstream coastal area.  3) Demonstrate national and regional measures to combat transboundary environmental degradation in the Volta.	Jan 2008- Dec 2014  Terminal evaluation of the project was initiated in April 2015	Benin Burkina Faso Cote d'Ivoire Ghana Mali Togo	1) Stakeholders' capacity were enhanced leaving a valuable legacy for the effective management of the VRB and its downstream coastal areas 2) updating and validation by all the countries of the regional TDA, which forms the scientific basis for the strategic Action Programme 3) demonstrated measures to address specific problems that were identified as priority in selected local communities in order to be replicated at other areas of the basin.	1) The VBA member countries (specifically the water and environment ministries) should make every effort to strengthen the VBA for coordination of SAP implementation. 2) Project results should be disseminated to all key stakeholders using appropriate communication channels.	GEF (Global Environment Facility)

Project Title	Goals/Objectives	Project period	Participating countries	Key Findings / Expected outcomes	Recommendations/ Lessons learned	Funding Agency
Improving Water Governance in the Volta River Basin	1) improve water governance through consensus on key water management principles and to institutionalise coordination mechanisms 2) demonstrate integrated management of water resources at the local level and build trust and capacity for developing governance mechanisms	2010	Ghana Burkina-Faso	1) Strengthening communication between Ghana and Burkina Faso, creating multi-scale participatory governance frameworks for joint management of water resources and improving livelihoods through riverbank protection schemes. 2) Legal tools, including the Code of Conduct, the Local Transboundary Committee and the Volta Basin Authority have now been established to tackle basin-wide issues, resolve conflicts and to provide the framework to manage shared water resources sustainably	1) Experience in the Volta Basin has created new opportunities and partnerships with other basins in West and South Africa. 2) It has also been shown that community-level participation in transboundary water resource management is achievable and adds value to conventional transboundary approaches	WANI

**Table 2 3: Past and On-going project activities in the Chad Basin**

Project Title	Goals/Objectives	Project period	Participating countries	Key Findings / Expected outcomes	Recommendations/ Lessons learned	Funding Agency
The Lake Chad Basin Sustainable Development Programme (PRODEBALT)	To implement the project in the conventional basin of Lake Chad to fight against various forms of land degradation	December 2008-June 2022	Cameroon, Niger, Nigeria, Central African Republic, Chad	sustainable conservation of Lake Chad to ensure the economic security of the freshwater ecosystem resources  An integrated and judicious management of the basin to achieve sustainable development and equitable use of the natural resources for each Country, while preserving its ecosystems and biodiversity.		African Development Fund, GIZ (German Agency for international Cooperation), BGR, European Union, World Bank, and the Islamic Development Bank
Programme to Rehabilitate and Strengthen the Resilience of Lake Chad Basin Systems (PRESIBALT) ON-GOING	1) Preservation and development of water resources 2) Development of ecological services and value chains 3) Institution capacity building and programme management	2016-2021	Cameroon, Niger, Nigeria, Central African Republic Chad	1) PRESIBALT will directly benefit 15.3 million people living in the Lake's impact area, 52% of them women, by improving their incomes, food security and access to basic social infrastructure  2) It will also improve regional and local consultation / cooperation for integrated natural resources management and intra-regional trade in agricultural produce as well as address the social dimensions of resilience, which will in the long run reduce potential sources of conflict.		African development Bank Group (AFDB)
PROLAC Lake Chad Region Recovery and Development Project On-going	Contribute to the recovery of the Lake Chad Region by supporting Regional coordinating and crisis monitoring, connectivity and agricultural livelihoods in selected provinces of the Republic of Cameroon, Republic of Chad, and Republic of Niger.	5 years	Cameroon Chad Niger	improve the enabling environment for mitigating risks, preventing conflict and reducing poverty around the Lake Chad through a Regional coordination and knowledge/monitoring platform support the recovery of agricultural livelihoods with the help of targeted productive and agriculture investments (polders, oasis and ponds)		The World Bank's International Development Association (IDA)

Project Title	Goals/Objectives	Project period	Participating countries	Key Findings / Expected outcomes	Recommendations/ Lessons learned	Funding Agency
Sustainable Water Resources Management in the Lake Chad Basin (GIZ) – Module: “Organizational advisory services for the Lake Chad Basin Commission”	To support LCBC in its organizational development and to strengthen its planning, cooperation, and communication capacities for a better performance of its tasks and to achieve sustainable results.	July 2011-July 2017	Cameroon, Niger, Nigeria, Central African Republic Chad			German Federal Institute for Geosciences and Natural Resources (BGR)

## 3.0 Status of Selected Existing Initiatives on Multilateral Environmental Agreements (MEAS) at Regional Levels, Lessons Learnt and Best Practices

Existing transboundary freshwater basin management Policies, initiatives and frameworks are intended to assist stakeholders and managers to implement Policies at the Regional, National and transboundary level while addressing societal challenges and simultaneously providing human well-being and biodiversity benefits. Existing initiatives relating to the Volta Basin, the Chad Basin and Basins in the SADC Region are listed below.

### 3.1 Existing Initiatives and MEAS: Examples of Lake Volta and Lake Chad

#### A. Volta Basin

The Volta Basin is the ninth largest River basin in sub-Saharan Africa, consisting of the Black Volta, Red Volta, White Volta, and Oti Rivers. It is shared by six (6) countries; Benin, Burkina Faso, Cote d'Ivoire, Ghana, Mali and Togo (Figure 3-1). Its four principal sub-basins are the White Volta, Black Volta, Oti River and the Lower Volta Basin which includes the Volta Lake and small tributary Rivers which flow directly into the Volta Lake (United Nations Environment Programme, 2013). Until the year 2006 the Volta Basin remained one of the few transboundary River basins in Africa with no formal institutional arrangements for managing its water resources (Ampomah, et al. 2008).

To introduce sustainable measures for transboundary water resource management, the Volta Basin Authority (VBA), established a 5-year Strategic framework to meet its 5 Strategic objectives. The Strategies adopted and how they are executed are as follows;

#### 1. *Strengthening Policies, legislation and institutional framework*

- a. Defining ownership and internalization of water resources Policies in West Africa and the Volta Basin.
- b. Assisting Member States, introduce Integrated Water Resources Management into National legislations and harmonization of approaches where necessary.

#### 2. *Deepening knowledge about the basin;*

- a. Conducting inventory of water resources and their uses.
- b. Conducting studies on the environmental status of the basin including land use, biodiversity, climate change and socio-economic aspects of the basin.
- c. They also pursued to support National institutions to strengthen, monitor and evaluate the quality and quantity of surface underground water and of socio-economic conditions.

#### 3. *Coordination, planning and management*

- a. This will direct sustainable water resources management initiatives in the basin
- b. Formulate a validated process for the identification, monitoring and dialogue of projects.

#### 4. Communication and capacity building for all stakeholders

- It also aims at developing and implementing a communication plan that considers both technical information and general awareness raising tools such as documentary films.
- Developing and implementing plans for stakeholder participation and capacity building.
- Establishing partnerships and networks with stakeholder groups and basin users.

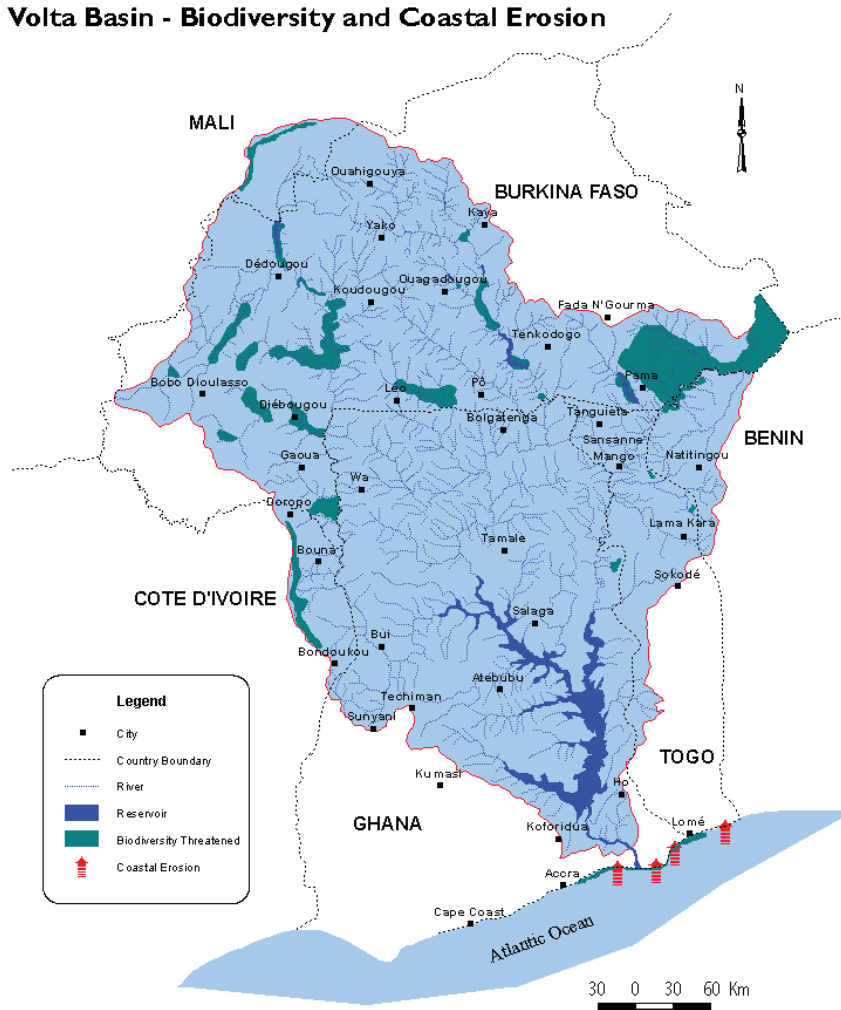
#### 5. Effective and sustainable operations.

- Monitoring and evaluation of framework done
- Directing the implementation of plan
- Engaging and extending Donors Consultative Group network of technical or financial partners

In addition, National institutions such as the Volta River Authority in Ghana developed a document titled “Framework for Aquaculture Development on the Volta Lake” to ensure strict compliance with all Legal and Regulatory requirements. The document provides guidance to aquaculture farmers for effective utilization of water resource in tandem with sustainable hydropower generation - the primary reason for construction of the Volta Lake. The framework for aquaculture development on the Volta Lake are well defined in the Volta Lake Implementation Guidelines Document (Volta River Authority 2017).

The management of the Lower Volta Basin in Ghana is also guided by the Ghana Water Policy and the Water Resources Commission Act which provide guidelines on the use of water resources in Ghana.

**Volta Basin - Biodiversity and Coastal Erosion**



**Figure 3 I: Volta Basin**

Sources: <https://newsghana.com.gh/volta-river-basin-strategic-action-implementation-project-launched/>



## B. Lake Chad:

The Lake Chad Basin is one of the largest inland drainage basins in Africa covering about 2,500,000 km<sup>2</sup> and shared between Cameroon, Chad, Nigeria, and Niger Figure 3-1. Its main source of water supply is the Chari-Logone River, accounting for over 90% of inflows into the Southern section of the lake.



Figure 3 2: Lake Chad Basin<sup>1</sup>

Signing of the Lake Chad Basin Commission (LCBC) Convention, as far back as 1964, indicated the riparian Countries' willingness to address issues related to the sustainable management of the Lake and its catchment area (Bloxom and Bdliya 2012). The Agreement like several other International Agreements signed by Member Countries, has, however, not been supported by relevant National legislations that can make its implementation effective.

A previous UNDP/GEF project conducted in 2008 assisted Member Countries and Lake Chad Basin Commission in preparing a Regional transboundary diagnostic analysis leading to a Regionally endorsed Strategic Action Plan (SAP).

The focus of the initiative of the implementation of SAP was the overall objective to achieve climate resilience, integrated ecosystem-based management of Lake Chad Basin through implementation of Agreed Policies, Legal and institutional reforms and investments that improve water quality and quantity, protect biodiversity and as well as sustainability of livelihoods.

The objectives were geared towards achieving these outcomes:

1. A strengthened Lake Chad Basin Commission that will be capable of developing and implementing Policies, investments and improved integrated ecosystem-based lake management through monitoring;

<sup>1</sup> Source: <https://allafrica.com/stories/202209200005.html>

2. Strengthened and harmonized approaches to implementing sustainable Legal and Policy Instruments across the Lake Chad Member Countries;
3. Technical capacity and awareness of National Ministries, institutions and other stakeholders that can contribute to sustainable management practices;
4. Enable Member States and Lake Chad Basin Commission to maximize the utilization of data and information from Management Information Systems for effective management;
5. National governments, local communities, and Lake Chad Basin Commission to gain practical experience and upscaling validation on sustainable ecosystem management and livelihoods; and,
6. Assessing stress reduction and livelihood strengthening activities that are identified in the Strategic Action Plan for further SAP implementation.

The low level of attention given to this basin and the issues relating to its reduction, or even disappearance, led to the shortcomings and gaps pointed out by a 2015 joint environmental audit by UNDP. The UNDP-GEZ 2016 document on “Improving Lake Chad management through building climate change resilience and reducing ecosystem stress through implementation of the SAP” indicates:

1. The lack of institutional coordination of actions related to water resources management in the Lake Chad Basin;
2. The lack of formal strategies for directing actions and interventions of ministries and other organizations regarding the resource’s management in the Lake Chad basin;
3. Insufficient control measures of water users in the Lake Chad basin;
4. The inadequacy of the water resources monitoring and surveillance framework of the Lake Chad basin; the insufficient application of the legal and regulatory framework for water resources management in the Lake Chad basin;
5. The non-operationalization of structures and technical means of water resources management that could contribute to the safeguarding of Lake Chad water resources in the riparian states;
6. The failure to comply with financial commitments by the Member States of the LCBC to this; and,
7. Organization, reflected by the general observation of significant arrears in contributions for the financing of its activities.

Strategies and principles on Lake Chad. Member states like Cameroon, Niger and Nigeria of Lake Chad have each developed and adopted a National Biodiversity Strategy and action plans aligned with Biodiversity Targets (UNDP-GEF, 2012). Each Biodiversity Strategy pays attention to the role of biodiversity in poverty reduction as well as sustainable development.

## **1. Cameroon**

Cameroon’s National Biodiversity Strategy and Action Plan was completed in 2012 implemented through to 2020 and contained 4 Strategic goals, 20 National-level targets and 10 ecosystem-specific targets, priority actions, defining timeframes for action, performance indicators and actors/organizations responsible for implementation.

## 2. Niger

The preparation of the second edition of Niger's *Stratégie Nationale et Plan d'Actions sur la Diversité Biologique*, adopted in 2014, was guided by the objectives of the Strategic Plan for Biodiversity (2011-2020) and the National Plan for Social and Economic Development (2012-2015). The revision contains 5 Strategic objectives, eighty actions, along with associated responsible actors and indicators.

## 3. Nigeria

Nigeria's Biodiversity Strategy and Action Plan was launched in 2006. National Biodiversity Strategy and Action Plan (NBSAP 2016 – 2020) was revised and adopted by the Nigerian Government as a Policy Instrument in 2015. This is geared towards the planning of capacity development and technical capacity needs assessment, a communication and outreach Strategy and a plan for resource mobilization. Finally, a Water Resources Strategy document which is aligned with the goal of the Lake Chad Basin Water Charter has also been adopted by the Federal Executive Council of Nigeria in 2016.

### 3.2 Transboundary Natural Resource Management Challenges and Implementation of MEAs.

1. A study by the Water Resources Coordinating Unit of ECOWAS (2006) revealed that one of the major institutional constraints to the development of National as well as transboundary water resources management is the absence of clearly defined intervention frameworks for water resources projects by the private sector and the civil society without recourse to the appropriate authorities for legal authorizations;
2. Another challenge had to do with equity in the distribution of benefits from resources. An example is the transboundary development authority of the Okavango River where inhabitants in the Angolan side of the basin derive relatively very little based income although the entire basins come from Angola and it has 57% of the basins population (OKACOM, 2011b). However, Botswana with only 18% of basins population derives the bulk of the River base income;
3. Poor security is also another limitation to transboundary resource management. Bad security has led to the collapse and illegal exploitation of shared resources; and,
4. One of the basic requirements for transboundary water basins is an effective and efficient information gathering system of which forms the basis for planning, implementation and monitoring. The ability to gather or have access to information is limited.

Additional information on Agreements for basins in the South Africa Development Corporation Regions and Lake Victoria basin are provided in the Tables 3-1 and 3-2 respectively.

**Table 3 1: Existing agreements in SADC region**

Name of Basin	Titles of the Agreement	Countries Involved	Year agreement (signed)	State of Implementation (Operational or Non-operational)
	Agreement between Botswana and Namibia on the Establishment of a Joint Water Commission	Botswana, Namibia	1990	Operational, Joint Water Commission
Orange-Senqu Basin	Agreement for the Establishment of the Orange Senqu Commission	Botswana, Lesotho, Namibia, South Africa	2000	Operational, Orange-Senqu River Commission
Incomati & Maputo River Basins (INMACOM)	Tripartite Interim Agreement on Water Sharing of the Incomati and Maputo Rivers (the IncoMaputo agreement)	Mozambique, South Africa, and Swaziland	August, 2002	Operational, Tripartite Permanent Technical Committee (TPTC) between Mozambique, South Africa and Swaziland,
	INMACOM RBO Establishment; and Secretariat Hosting Agreement	Mozambique, South Africa, and Eswatini	November, 2021	Operational, institutional establishment; and hosting agreement
Limpopo Basin	Agreement on the Establishment of the Limpopo Watercourse Commission	Botswana, South Africa, Zimbabwe and Mozambique	2003	Operational, Limpopo Basin Commission
Zambezi Watercourse	Agreement on the Establishment of the Zambezi Watercourse Commission	Angola, Botswana, Malawi, Mozambique, Namibia, the United Republic of Tanzania, Zambia, Zimbabwe.	2004	Operational, Zambezi Watercourse Commission
Okavango Basin	Permanent Okavango River Basin Water Commission (OKACOM) Agreement	Governments of the Republics of Angola, Botswana and Namibia.	15 September 1994	Operational, Permanent Okavango River Basin Water Commission
Pungwe river basin	Mozambique-Zimbabwe Bilateral Agreement for the Pungwe River basin	Mozambique, Zimbabwe	July, 2016	
Buzi Watercourse	Agreement on Co-operation on the Development, Management and Sustainable Utilization of the Water Resources of the Buzi Watercourse.	Mozambique, Zimbabwe	29th July 2019	
Kunene River Basin	Establishment of the Permanent Joint Technical Commission (PJTC)	Angola, Namibia	1969	Operational, institutional agreement
Cuvelai River Basin (CUVECOM)	Cuvelai Water Cooperation Agreement	Angola, Namibia	2014	Operational, Joint Water Commission

**Table 3 2: Existing Agreements in the Lake Victoria Basin**

Name of Basin	Title of the Agreement	Countries Involved	Year Agreement was instituted	State of Implementation (Operational or Non-operational)
Lake Victoria	Convention for the establishment of LVFO	Burundi, Kenya, Tanzania, Uganda	1994	Operational
Lake Victoria	The Protocol for Sustainable Development of the Lake Victoria Basin	Burundi, Kenya, Rwanda, Tanzania, Uganda	2003	Operational
EAC	The Treaty for the Establishment of EAC	Burundi, Kenya, Rwanda, South Sudan, Tanzania, Uganda	1999	Operational

### 3.3 Regional Legal and Institutional Frameworks for Water Basins in Africa

#### 1. ***The African Convention on the Conservation of Nature and Natural Resource***

The African Convention on the Conservation of Nature and Natural Resources (AU African Union 1969) applies to all areas that fall within the National jurisdiction of any Party and all the activities carried out under that jurisdiction or control of any Party within the area of its jurisdiction or beyond the limits of its National jurisdiction (African Union, African Convention on the Conservation of Nature and Natural Resources, 1969).

The main objectives of this Convention are: to enhance environmental protection, conservation and sustainable use of natural resources and to harmonize and coordinate Policies. This is to enhance ecologically rational, economically sound and socially acceptable development Policies. This Convention is guided by the principle of the right of all peoples to a satisfactory environment favourable to their duties.

#### 2. ***West Africa Water Resources Policy***

The general objective of the Regional Water Policy is to contribute to poverty reduction and sustainable development by instructing the Community and its Member States on water resources management, reconciling economic development, social equity and environmental protection. The Policy outlines fifteen guiding principles among which are the repair/polluter-pay principle which anybody or institution responsible for an incidence of pollution must pay for or repair the damage caused or likely to be caused to the environment and gender equality, principle according to which the interests and contributions of women, men and vulnerable people in the society are taken into account in the formulation of Policies, capacity development, planning, and implementation of programmes and overall investments in the water sector.

#### 3. ***East Africa Community Treaty, 1999***

This was established by the East African Community as the Regional intergovernmental organization of the Republics of Kenya, Uganda, the United Republic of Tanzania, Republic of Burundi and Republic of Rwanda with its headquarters in Arusha, Tanzania. According to the Treaty for the Establishment of the East African Community (1999), it aims at widening and deepening co-operation among the Partner States and other Regional Economic Communities, political and social fields for their mutual benefit.

The objective of the Treaty is to ensure sustainability of natural resources of Member States and to promote the sustainable utilization of natural resources like wetlands, Lakes forests and other aquatic and terrestrial ecosystems (East African Community, 1999). The East African Court of Justice is established under this Treaty as the judicial body of the community and is mandated with ensuring the adherence to Law in the interpretation and application of and compliance with the Treaty. The East Africa Community Treaty was signed on 30th November, 1999 in Arusha, Tanzania by the Heads of its five Member States – Burundi, Rwanda, Uganda, Kenya and Tanzania – who are referred to in the Treaty as Partner States of the Community.

#### **4. The Protocol on Environment and Natural Resources Management**

A report on the East African Community (2006), suggests that this protocol was instituted to ensure cooperation among Partner States in the management of the environment and natural resources in their jurisdiction. The governance and management of transboundary resources are well defined in this protocol. The Protocol is currently not in force and hence not a legally binding document pending ratification by all Partner States.

#### **5. The East African Community (EAC) Regional Environment Impact Assessment Guidelines for shared Ecosystems**

Guidelines from East African Community assessment, (2006) are for application of environmentally sound approaches in the management as well as ensuring the sustainability and biophysical integrity of shared ecosystems within the East African Region. These guidelines provide procedures for conducting transboundary environmental assessment in shared ecosystems in East Africa and the roles for the key stakeholders and players during the implementation of the Transboundary Environment Assessment process in the Partner States.

#### **6. Lake Victoria Fisheries Organisation (LVFO)**

The LVFO East African Community Institution constituents are from Kenya, Tanzania and Uganda. Its main aim is to harmonize, develop and adopt conservation and management measures for the sustainable utilization of resources of Lake Victoria while optimizing the socio-economic benefits from the basin for the three Partner States (The Lake Victoria Fisheries Organization Profile, 2009). The profile states that LVFO guides, supports and implements the building of the capacity of communities to participate in management and is making a real difference to their lives.

In conclusion, dealing with the management of transboundary water resources is still vague and difficult to enforce, especially when allocation of water for different uses comes in.

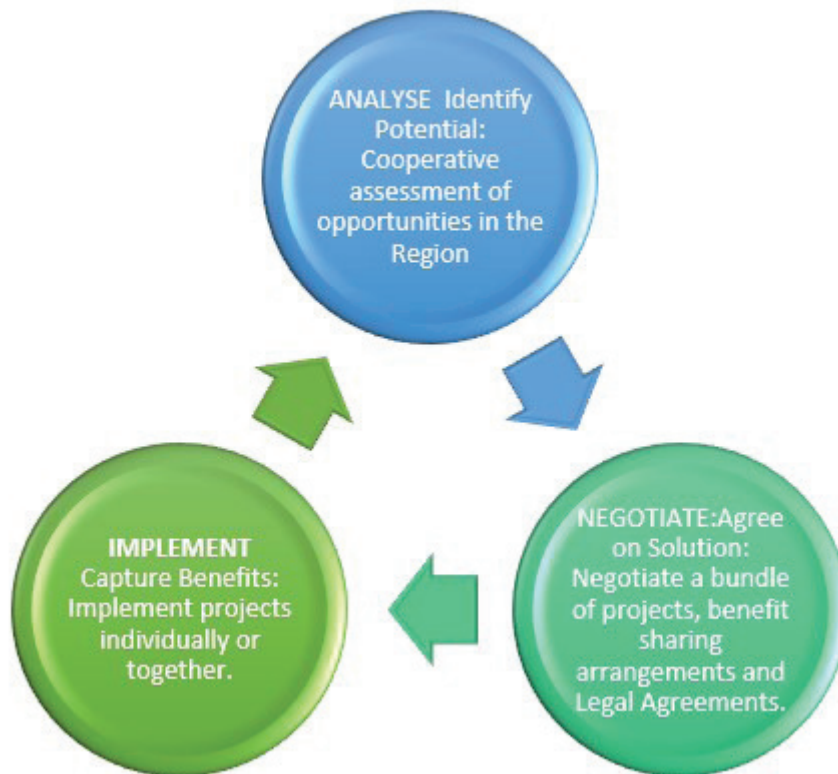
Correia and Silva (1999) suggested that the evolution that can be observed in environmental issues at the International level is having a positive impact on water issues which can be understood in three different phases (Figure 3-3).

**Phase 1** deals with the analysis of the opportunities for transboundary water cooperation. This is where benefit assessment is primarily located.

**Phase 2** talks about cooperative solutions are negotiated. Benefit assessment can provide information to be considered in the framework of this negotiation phase.

**Phase 3** is the implementation of Agreed cooperative solutions. This is the source of additional information to improve the benefit assessment. The benefits of transboundary cooperation are likely to evolve as enhanced cooperation opens new options.





**Figure 3 3.:** The process of transboundary water cooperation.  
(Source: Sadoff and Grey, 2005)

### 3.4 Global Freshwater Biodiversity Conservation Related Global Multilateral Environmental Agreements

There are existing Global Multilateral Environmental Agreements which several Countries in Africa are Party to or a contracting State and which could contribute to conservation of biodiversity in transboundary freshwater bodies if implemented by the contracting States. Most popular among these is the United Nations Convention on Biological Diversity. Provisions in this MEA contribute to various aspects of biodiversity conservation in transboundary freshwater bodies. A list of other popular Global Conventions of relevance to biodiversity conservation are presented below.

- The United Nations Framework Convention on Climate Change (UNFCCC)
- The Convention on Biological Diversity (CBD)
- The Convention on International Trade in Endangered Species (CITES)
- The Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention)
- The Stockholm Convention on Persistent Organic Pollutants
- African Convention on the Conservation of Nature and Natural Resources
- UNECE Water Convention

Brief excerpts of these Conventions and Agreements are provided below.

The main objective of UNFCCC is to prevent dangerous human interference with the climate system to maintain greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. The convention stipulates this to be achieved within

a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner (UN 1992).

The CBD is aimed at the conservation of biological diversity from all sources such as, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part. Each contracting Party among others is expected to establish a system of protected areas or areas where specialised measures must be taken to conserve biological diversity, and as much as possible rehabilitate and restore degraded ecosystems and promote recovery of threatened species, inter alia, through the development and implementation of National Strategies, plans or programmes for the conservation and sustainable use of biological diversity. All African on the Continent are Party to the CBD (UN 1992).

CITES is a Multilateral Environmental Agreement intended to ensure that International trade in specimens of wild animal and plant species are done in a sustainable way. International trade in wildlife poses a serious threat to protection and conservation of biodiversity. Illegal trades have resulted in extinct of several subspecies and poses a serious threat to protection and biodiversity in general.

The RAMSAR Convention is focused on water fowls and it rests on three main pillars:

- i. Wise use of wetlands** – Parties are required to include wetland considerations in their National planning activities. This could lead to institution of Policies and acts that would promote biodiversity conservation.
- ii. List wetlands of international importance** – Parties are required to designate one wetland at the time of accession for inclusion in the “Ramsar List” and promote its conservation, and in addition to continue to “designate suitable wetlands within its territory” for the List. The selected site(s) would have to contain representative, rare or unique wetland types - of International importance for conserving biodiversity
- iii. International Cooperations** – Parties Agree to consult with other Contracting Parties about implementation of the Convention, especially in regard to transboundary wetlands, shared water systems and shared species. This cooperation is of relevance to shared River basins and transboundary wetlands;

The Stockholm Convention on Persistent Organic Pollutants is primarily geared towards protecting the human health and environment from POPs.

Finally, the African Convention on the Conservation of Nature and Natural Resources provides comprehensive conservation approaches to various components of the environment and ecosystem. Specific directives are given for soil, water, faunal resources, flora, conservation areas, protection of species, etc. For water, the Convention proposes management of aquatic environments, whether in fresh, brackish or coastal water, with a view to minimise deleterious effects of any water and land use practice which might adversely affect aquatic habitats. In regards to protected species, entreats contracting States to accord special protection to those animal and plant species that are threatened with extinction. All Contracting States are required to supply the AU with: (a) the text of Laws, Decrees, Regulations and Instructions in

force in their territories, which are intended to ensure the implementation of this Convention; (b) reports on the results achieved in applying the provisions of this Convention; and (c) all the information necessary for the complete documentation of matters dealt with by this Convention if requested. Of the Fifty-five (55) Countries in Africa, Forty-Six (46) have signed the Treaty and Thirty-three (33) have ratified it and deposited it with the African Union. Cape Verde, Eritrea, Namibia, South Africa and Zimbabwe are yet to sign or ratify the Convention.

The UNECE Water Convention is specific to transboundary water bodies. To prevent, control and reduce impacts on transboundary water bodies, the Convention entreates Parties to adopt, implement and as far as possible render compatible relevant Legal, administration, economic, financial, and technical. Forty-Seven Countries are Party to the Convention Globally and six are Africa Countries with Cameroon being the latest Country to join. Chad, Senegal, Ghana, Guinea-Bissau and Togo are the other Africa Countries Party to the Convention.

## 4.0 Proposed Regional Protocols and Strategies for the Conservation of Aquatic Biodiversity and Joint Action Plans in Identified Shared Freshwater Ecosystems for Regional Protocols Aquatic Biodiversity Conservation and Environment

### 4.1 Introduction and Goal

Effective freshwater conservation Strategies often call for the use of multiple interconnected approaches. The best blend of Strategies may depend on the scale of conservation and significance of the ecosystem. Biodiversity conservation, although is very important, can be very expensive and therefore there is the need to prioritise. From the survey data, most of the freshwater basins already have some forms of aquatic biodiversity conservation protocols and Strategies outlined but implementation and enforcement are constrained by a lack of financial commitment. As indicated in a previous chapter, major challenges affecting aquatic biodiversity conservation are the climate change, illegal mining of sand and precious minerals, overexploitation, siltation, and pollution.

The overall goal of the proposed Regional Protocol and Strategies is to ensure long term protection of biodiversity in transboundary freshwater basins in Africa

The specific objectives of the Strategies are to:

1. Preserve the diversity of aquatic species
2. Sustain utilization of species and ecosystems
3. Maintain life supporting systems and critical ecological processes

Proposed Strategies to address the identified challenges in freshwater basins and deliverables/outcomes are presented in Table 5.1 below.

**Table 4 I: Proposed management Strategies for conservation of aquatic biodiversity**

Biodiversity Conservation Challenge	Management Objective	Priority Action	Outcomes/Deliverable
Climate Change	<ul style="list-style-type: none"> <li>To improve knowledge and understanding of the concepts of climate change and how it impacts life in the aquatic ecosystem.</li> <li>To reduce vulnerability to climate change and institute mitigation measures</li> </ul>	<ul style="list-style-type: none"> <li>Promote the development and implementation of education and training programs, including strengthening of National human and institutional capacities on climate change</li> <li>Develop Strategies for the transfer, acquisition and adaptation of relevant technology to alleviate the pressure on fragile ecosystems and natural resources and contribute to mitigation of climate change.</li> <li>Formulate Nationally determined prioritized actions, considering vulnerable people, places and ecosystems</li> <li>Provide scaled-up financial resources for climate adaptation and mitigation, considering country-driven Strategies, and the priorities and needs of Member States. Such funds could be from public or grant-based resources for adaptation</li> <li>Strengthening climate change legislation, financing and management - (CCDA) through: <ul style="list-style-type: none"> <li>Reviewing and updating of CC legislation to link with changing domestic and International Legislation.</li> <li>Development of robust financial management systems to integrate climate finance with work of key sectors</li> <li>Support to development of capacity within CC institutions to effectively support and coordinate action on CC across sectors, levels of Government and stakeholder groups</li> <li>Strengthening capacity of Member States to enforce legislation through review of resources and support to development of management systems</li> <li>Increase capacity of Member States and training and research institutions to raise awareness of and operationalize improved approaches to time operations including legislation through support to universities, training colleges, government staff, communities</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Integrated Strategies for sustainable operationalized at Country level</li> <li>Enhanced climate change related data</li> <li>Risk management framework developed, harmonised and operationalised</li> <li>Improved financing for climate change studies, mitigation and adaptation measures</li> </ul>
Water pollution from domestic and industrial activities	<ul style="list-style-type: none"> <li>To improve water quality and reduce discharge of untreated waste materials and enhance data collection</li> </ul>	<ul style="list-style-type: none"> <li>Develop and harmonize common environmental standards and Laws for the control of atmospheric, terrestrial and water pollution arising from urban, agricultural and industrial development activities.</li> <li>Develop for riparian Countries common methods for determination of environmental standards reflecting the need for socio-economic development and protection of the environment and natural resources for the benefit of the peoples of the Community.</li> <li>Facilitate data collection, monitoring and dissemination among Member States by setting up well equipped remote sensing centres for environmental data collection</li> </ul>	<ul style="list-style-type: none"> <li>Harmonized environmental standards and monitoring protocols across riparian States</li> <li>Equipped regional information database and dissemination hubs created</li> </ul>
Over exploitation of freshwater resources	<ul style="list-style-type: none"> <li>To manage and protect freshwater aquatic environments to minimize deleterious effects of any water and land use practice which might adversely affect aquatic habitats</li> </ul>	<ul style="list-style-type: none"> <li>Undertake regular inventories of species of fauna and flora and prepare maps of their distribution and abundance</li> <li>Conduct regular reviews to facilitate the monitoring of the status of such species and their habitats with a view to: <ul style="list-style-type: none"> <li>Identifying species that are threatened or may become so, and providing them appropriate protection,</li> <li>Identify areas of critical importance for the survival of species of fauna and flora which are threatened and protect from public.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Critical areas for freshwater biodiversity conservation identified and protected areas created in selected Basins</li> <li>Database of species status in selected basin established</li> </ul>
Destruction or degradation of habitats	<ul style="list-style-type: none"> <li>To secure and maintain the habitat conditions necessary to protect significant species, groups of species, biotic communities, or physical features of the environment where these require specific</li> </ul>	<ul style="list-style-type: none"> <li>Enhance public education and appreciation of the characteristics of the habitats concerned and of the work of wildlife management</li> <li>Providing opportunities for public enjoyment through recreation and tourism appropriate in type and scale to the essential qualities of the areas.</li> <li>Manage visitor use for inspirational, educational, cultural and recreational purposes at a level which will maintain the area in a natural or near natural state; to secure examples of the natural environment for scientific studies, environmental monitoring and education, including baseline areas from which all avoidable access is excluded.</li> <li>Undertake research and other approved activities; for controlling fires and forest exploitation.</li> <li>Reduce access that may lead to land clearing for cultivation, grazing by domestic and wild animals, and invasive species; Establish Forest reserves and carry out afforestation program</li> </ul>	<ul style="list-style-type: none"> <li>Public knowledge on critical habitats enhanced</li> <li>Habitat management controls established</li> </ul>

Biodiversity Conservation Challenge	Management Objective	Priority Action	Outcomes/Deliverable
Invasion by exotic species	<ul style="list-style-type: none"> <li>Minimise invasion of aquatic exotic species</li> </ul>	<ul style="list-style-type: none"> <li>Create mechanisms to coordinate National programs</li> <li>Review relevant Policies, Legislation and institutions to identify gaps, inconsistencies and conflicts, and, as appropriate, adjust or develop Policies, legislation and institutions.</li> <li>Enhance cooperation between the various sectors, including the private sector that might provide pathways or vectors for the unintended transfer of invasive alien species, in order to improve prevention, early detection, eradication and/or control of invasive alien species, and in particular, ensure communication between focal points of respective relevant International Instruments.</li> <li>Promote awareness of the threats to biological diversity and related ecosystem goods and services posed by invasive alien species and of the means to address such threats, among Policy makers at all levels of Government, and in the private sector; quarantine, customs and other border officials; and the general public.</li> <li>Collaborate with trading partners and neighbouring Countries, Regionally, and with other Countries, as appropriate, to address threats of invasive alien species to biological diversity in ecosystems that cross International boundaries, to migratory species, and to address matters of common interest.</li> <li>Develop capacity to use risk assessment/analysis to address threats of invasive alien species to biological diversity, and incorporate such methodologies in environmental impact assessments, and strategic environmental assessments, as appropriate and relevant</li> <li>Incorporate invasive alien species considerations into National biodiversity Strategies and action plans and into sectoral and cross-sectoral Policies, Strategies and plans, considering the ecosystem approach</li> </ul>	<ul style="list-style-type: none"> <li>Coordination and cooperation of National and regional programs on invasion of exotic species among stakeholders</li> </ul>
Illegal Unreported Unregulated fishing	<ul style="list-style-type: none"> <li>To minimise Illegal, Unreported and Unregulated (IUU) fishing of aquatic living resources that contravenes national, Regional or International Laws and frameworks to maintain a sustainable and healthy aquatic freshwater basin</li> </ul>	<ul style="list-style-type: none"> <li>Quantitative estimation of IUU fishing and its impact on resource sustainability in affected Member States</li> <li>Strengthening National Policy and Legislative frameworks to combat IUU fishing.</li> <li>Strengthening Monitoring, Control, and Surveillance</li> </ul>	<ul style="list-style-type: none"> <li>Improved enforcement actions against IUU fishing to enhance food and nutrition security</li> </ul>

## 5.0 Mechanisms for Strengthening the Capacity of Regional Institutions to Sustainably Manage Critical Transboundary Ecosystems

The UN Freshwater Strategy (2017 – 2021) identifies initial capacity assessment of Countries as an important step in designing or defining activities to monitor, protect and restore freshwater ecosystems (UN Environment, 2017). The assessment when done is expected to highlight the ability of a Country to implement the Strategy. The capacity assessment has four components, and these are outlined as stated in the report:

- a. **Enabling Environment:** The existence of provisions in Government plans, Policies and Law related to the protection and sustainable use of freshwater ecosystems.
- b. **Institutions and Participation:** The institutional and human capacity, from the National level through sub-national and basin levels to the local level, to manage and protect freshwater ecosystems. The capacity to effectively engage with the private sector and other stakeholder groups should also be assessed.
- c. **Management Instruments:** such as monitoring programmes, and financial incentives and measures to protect and restore ecosystems.
- d. **Financing:** Financial resources available, including grants and more sustainable revenue streams

It may therefore be worth considering these subject areas when it comes to instituting mechanisms for strengthening building capacity of Regional institutions for biodiversity conservation. Following, therefore, in the same order, a first step to strengthening the capacity of AU Regional institutions to sustainably manage critical transboundary ecosystems is to create an enabling environment. A key finding of this study is the existence of several freshwater basin management policies and frameworks at the Regional, National and transboundary levels designed to address ecological and societal challenges, and at the same time provide human well-being and biodiversity benefits. The Regional bodies institute Strategies and Protocols, but implementations of these Policies are by National focal institutions. Most Countries have, in addition to the basin organization's Conventions and Agreements, International Instruments such as the 1997 UNECE Water Convention, Nagoya Protocol, etc. and National instituted Policies and Acts for managing the basins at the National level. Capacity strengthening, should therefore not be limited to Regional basin or fisheries organizations but transcend to individual Countries forming the basin Region with the basin organisation play a coordinating role. A way of improving support to National and Regional institutions is by creating an enabling environment for domesticating and operationalising biodiversity protection legislations and Policies into the National Laws and setting up National and basin-wide Visions, priorities and plans to achieve these.

Taking the example of the Volta Basin, to institute measures for sustainable transboundary water resource management, the Volta Basin Authority (VBA) developed a 5-year strategic framework which involved, among many others, assisting Member States to introduce Integrated Water Resources Management Policies into National Legislations and harmonization of approaches where necessary. Summary of the VBA Strategic plan is provided in section 3.2 above. These has led to the institution of basin management



officers for selected local and transboundary water bodies in Ghana.

The second step to capacity building is to strengthen institutions and participation. Institutional strengthening may include development and implementation of educational and training in basin-based prioritised programs and actions. Some of the training programs may include environmental sampling, monitoring and management procedures, climate change modelling, introduction of relevant data collection tools and technologies, policy formulation, among others by identified specialised AU Centres of Excellence (CoE) or other well-resourced institutions.

Participation may involve engaging all stakeholders, starting at the Regional, to National (focal institutions) sub-national, basin level and finally to local communities, to manage and protect freshwater ecosystems. In addition, there would be a need to encourage a Regional approach towards capacity-building, starting with existing partnerships and creating new ones as deemed appropriate; ensuring effective engage of private sector and other stakeholder groups involved in aquatic biodiversity conservation. In effect good communication and networking among National and Regional institutions.

A third consideration in building capacity for freshwater management strategy for biodiversity conservation is to institute management Instruments such as monitoring programmes, financial incentives (through programs like carbon sequestration) and measures to protect and restore ecosystems tool. Data is important in establishing trends in climate change, biodiversity water quality, etc. The African Union through funding agencies would have to equip National institutions, Regional bodies, working together with the AU Centres of Excellence with relevant scientific tools and monitoring equipment to facilitate long term joint aquatic environmental data collection. Data collection could be enhanced further using remote sensing and geographical information systems. An African institution with relevant capacity could be identified and given additional support to obtain data at the Continental level and create databases for easy access by relevant National and Regional institutions.

Finally, there must be scaled up financial resources for data collection and institution of biodiversity conservation management Strategies.

## 6.0 Mechanisms for Institutional Collaboration on Aquatic Biodiversity Conservation and Environmental Management

Successful collaborations on aquatic biodiversity conservation and environmental management across the Continent will require resources and building capacities of relevant institutions on the Continents to serve as centres of excellence in biodiversity conservation thematic areas. Resource here refers to physical and human capital. Managing biodiversity and environment begins with managing the stressors underlining the biodiversity conservation challenges in transboundary freshwater ecosystems. The environmental stressors have been identified as Climate Change, Water pollution from domestic and industrial sources, over exploitation of freshwater resources, degradation of habitats from illegal mining and other activities such as overgrazing by livestock, Invasion of exotic species and Illegal Unreported Unregulated fishing. These can serve as the thematic area.

To facilitate collaboration, there should be harmonised procedures for environmental data collection across the Continent. The AU-IBAR may put together groups of experts to draw common monitoring protocols and procedures to be used by the Centres of Excellence for biodiversity conservation work. Most of the Centres of Excellence are aquatic environment and fisheries based but existing strengths of these institutions are outlined in the Table below. The African Union should identify focal institutions to lead aspects of the challenges identified as affecting biodiversity in transboundary freshwater ecosystems. These centres will liaise with National and Regional institutions to collect data across the Continent and lead in capacity building activities. Below are proposed areas of specialisation by the AU Centres of Excellence and other key research institutions.

**Table 6 I:** Suggested institution leads thematic areas for collaboration

	Proposed lead Institution(s)	Country/Region	Biodiversity Stressor	Existing Capacity/Expertise
1.	Faculty of Fisheries Resources, Suez University, Cairo - Suez Road, Suez, El Salam City, Egypt	Egypt/North Africa	Climate Change	<ul style="list-style-type: none"> <li>Undergraduate and Postgraduate training</li> <li>Aquaculture and Fisheries Resources</li> </ul>
2.	Department of aquaculture and fisheries management University of Ibadan, Nigeria	Nigeria/West Africa	Water Pollution Climate Change	<ul style="list-style-type: none"> <li>Undergraduate and Postgraduate training</li> <li>Integrated agriculture aquaculture</li> <li>Aquaculture facilities</li> </ul>
3.	The National Fisheries Resources Research Institute (NAFIRRI) P.O. Box Jinja, Uganda	Uganda/East Africa	Overexploitation of Freshwater Resources	<ul style="list-style-type: none"> <li>Freshwater biodiversity</li> <li>Fish stock assessment</li> <li>Climate change adaptation</li> <li>Sustainable aquaculture development</li> </ul>
4.	Department of Ichthyology and Fisheries Science (DIFS), Rhodes University, Grahams Town, Eastern Cape, South Africa	South Africa/South Africa	Invasion by Aquatic Species	<ul style="list-style-type: none"> <li>Undergraduate and postgraduate training</li> <li>Molecular research</li> <li>Aquaculture and Fisheries</li> </ul>
5.	World Bank Africa Centre of Excellence in Coastal Resilience, ACECoR. Department of Fisheries & Aquatic Sciences, University of Cape Coast, Ghana	Ghana/West Africa	Illegal Unregulated Unreported Fishing	<ul style="list-style-type: none"> <li>Postgraduate training and Short Courses</li> <li>Biodiversity and ecosystem monitoring</li> </ul>
6.	L'Agence Gabonaise d'Etudes et d'Observation spatiale (AGEOS) The Gabonese Agency for Studies and Space Observation (AGEOS)	Gabon/Central Africa	Degradation of Aquatic Habitat	<ul style="list-style-type: none"> <li>Remote sensing,</li> <li>Satellite imagery,</li> <li>Land monitoring and planning, biodiversity monitoring,</li> <li>Environmental change dynamics</li> <li>Maritime satellite surveillance.</li> </ul>
7.	Council for Scientific and Industrial Research Water Research Institute	Ghana/West Africa	Water Pollution Climate Change	<ul style="list-style-type: none"> <li>Postgraduate training</li> <li>Water Resources management</li> <li>GIS, Remote sensing</li> <li>Climate change modelling</li> </ul>

## 7.0 Appendices

### **Appendix 1:** International freshwater basins with area and country units\*

Basin	Basin area (km <sup>2</sup> )	Country	Basin country Unit (km <sup>2</sup> )	Percentage of total basin area
Akpa	2400	Cameroon	570	23.70%
		Nigeria	1800	76.30%
Annole	11,200	Kenya	6600	58.90%
		Somalia	4600	41.10%
Awash	152,300	Djibouti	11,100	7.30%
		Ethiopia	140,900	92.60%
		Somalia	210	0.10%
Bahr at Tubat	7800	Egypt	6200	79.40%
		Libya	1600	20.60%
Benito/Ntem	44,300	Cameroon	17,900	40.50%
		Gabon	11,500	25.90%
		Equatorial Guinea	14,900	33.60%
Bia	11,300	Ivory Coast	4700	41.90%
		Ghana	6600	58.10%
Oued Bou Namoussa	2800	Algeria	2400	85.90%
		Tunisia	390	14.10%
Baraka	63,800	Eritrea	42,100	66.00%
		Sudan	21,700	34.00%
Buzi	2850	Mozambique	24,800	87.00%
		Zimbabwe	3700	13.00%
Chiloango	13,000	Angola	4600	35.20%
		Congo	1100	8.20%
		Democratic Republic of the Congo	7300	56.60%
Congo/Zaire	3,688,900	Angola	287,700	7.80%
		Burundi	13,600	0.40%
		Central African Republic	404,100	11.00%
		Cameroon	95,000	2.60%
		Congo	247,800	6.70%
		Malawi	60	0.00%
		Rwanda	4500	0.10%
		United Republic of Tanzania	161,700	4.40%
		Democratic Republic of the Congo	2,300,500	62.40%
		Zambia	173,800	4.70%
Cross	52,800	Cameroon	13,400	25.40%
		Nigeria	39,400	74.60%
Cestos	12,700	Ivory Coast	2200	17.50%
		Liberia	10,500	82.50%
Cavally	29,500	Ivory Coast	16,100	54.80%
		Guinea	1400	4.80%

Basin	Basin area (km <sup>2</sup> )	Country	Basin country Unit (km <sup>2</sup> )	Percentage of total basin area
		Liberia	11,900	40.50%
Daoura	49,700	Algeria	9600	19.30%
		Morocco	40,100	80.70%
Dra	94,200	Algeria	15,600	16.50%
		Morocco	78,600	83.50%
Cuvelai/Etosha	173,700	Angola	54,100	31.20%
		Namibia	119,600	68.90%
Gambia	77,200	Guinea	11,700	15.20%
		Gambia	9900	12.80%
		Senegal	55,500	72.00%
Gash	23,700	Eritrea	16,800	71.20%
		Ethiopia	5900	25.20%
		Sudan	850	3.60%
Geba-Corubal	36,600	Guinea	17,700	48.50%
		Guinea-Bissau	17,600	40.00%
		Senegal	4200	11.60%
Galana	46,700	Kenya	40,800	87.60%
		United Republic of	5800	12.40%
		Tanzania		
Great Scarcies	7800	Guinea	5200	66.80%
		Sierra Leone	2600	33.20%
Guir	108,700	Algeria	83,600	76.90%
		Morocco	25,100	23.10%
Incomati	46,600	Mozambique	15,300	32.90%
		Swaziland	2600	5.50%
		South Africa	28,700	61.60%
Juba-Shibeli	792,300	Ethiopia	365,700	46.20%
		Kenya	208,900	26.40%
		Somalia	217,700	27.50%
Komoe	83,400	Burkina Faso	17,800	21.30%
		Ivory Coast	62,600	75.10%
		Ghana	2500	3.00%
		Mali	420	0.50%
Kunene	108,500	Angola	94,100	86.70%
		Namibia	14,400	13.30%
Lotagipi Swamp	31,700	Ethiopia	160	0.50%
		Kenya	20,500	64.50%
		Ilemi triangleb	2600	8.10%
		South Sudan	6900	21.90%
		Uganda	1600	5.00%
Lake Chad	2,596,900	Central African Republic	214,800	8.30%
		Cameroon	48,000	1.90%
		Algeria	106,000	4.10%
		Libya	57,500	2.20%
		Niger	694,500	26.70%
		Nigeria	178,900	6.90%

Basin	Basin area (km <sup>2</sup> )	Country	Basin country Unit (km <sup>2</sup> )	Percentage of total basin area
		Sudan	163,700	6.30%
		Chad	1,133,400	43.70%
Lake Chilwa	8700	Mozambique	2900	33.20%
		Malawi	5800	66.80%
Lake Cayo	3500	Angola	100	3.00%
		Congo	3400	97.00%
Lak Dera	5400	Kenya	2800	50.90%
		Somalia	2700	49.10%
Lake Natron	27,300	Kenya	17,700	64.80%
		United Republic of Tanzania	9600	35.20%
Lake Rukwa	79,300	United Republic of Tanzania	77,700	98.00%
		Zambia	1600	2.00%
Lake Turkana	173,100	Ethiopia	99,000	57.20%
		Kenya	65,300	37.80%
		Ilemi triangle <sup>b</sup>	600	0.40%
		South Sudan	5300	3.10%
		Uganda	2900	1.70%
Limpopo	406,500	Botswana	81,400	20.00%
		Mozambique	79,500	19.60%
		South Africa	182,800	45.00%
		Zimbabwe	62,700	15.40%
Lo□a	10,400	Guinea	1400	13.80%
		Liberia	9000	86.20%
Little Scarcies	18,500	Guinea	5500	29.70%
		Sierra Leone	13,000	70.40%
Mana-Morro	7600	Guinea	30	0.40%
		Liberia	5700	74.60%
		Sierra Leone	1900	25.00%
Mbe	8200	Gabon	7500	92.00%
		Equatorial Guinea	600	8.00%
Medjerda	23,200	Algeria	7800	33.70%
		Tunisia	15,400	66.30%
Moa	19,600	Guinea	8500	43.50%
		Liberia	1700	8.80%
		Sierra Leone	9300	47.80%
Mono	24,000	Benin	2700	11.30%
		Togo	21,300	88.70%
Maputo	30,600	Mozambique	2000	6.60%
		Swaziland	11,100	36.30%
		South Africa	17,500	57.10%
Niger	2,132,200	Benin	44,700	2.10%
		Burkina Faso	83,400	3.90%
		Ivory Coast	23,600	1.10%
		Cameroon	86,800	4.10%
		Algeria	161,000	7.60%

Basin	Basin area (km <sup>2</sup> )	Country	Basin country Unit (km <sup>2</sup> )	Percentage of total basin area
		Guinea	95,800	4.50%
		Mali	555,700	26.10%
		Mauritania	2700	0.10%
		Niger	487,900	22.90%
		Nigeria	571,200	26.80%
		Chad	19,500	0.90%
Nile	2,961,300	Burundi	13,200	0.50%
		Egypt	236,400	8.00%
		Ma'tan al-Sarrac	2000	0.10%
		Hala'ib triangled	4100	0.10%
		Eritrea	7700	0.30%
		Ethiopia	357,300	12.10%
		Kenya	49,500	1.70%
		Rwanda	20,800	0.70%
		Sudan	1,265,500	42.70%
		Abyeie	9900	0.30%
		South Sudan	617,600	20.90%
		United Republic of Tanzania	119,700	4.00%
		Uganda	237,000	8.00%
		Democratic Republic of the Congo	20,500	0.70%
Nyanga	24,900	Congo	5000	19.90%
		Gabon	20,000	80.10%
Oued Bon Naima	370	Algeria	100	27.40%
		Morocco	270	72.60%
Ogooue	214,900	Cameroon	5200	2.40%
		Congo	20,200	9.40%
		Gabon	187,900	87.40%
		Equatorial Guinea	1700	0.80%
Okavango	690,200	Angola	150,100	21.80%
		Botswana	344,400	49.90%
		Namibia	170,200	24.70%
		Zimbabwe	25,500	3.70%
Orange	935,600	Botswana	135,400	14.00%
		Lesotho	30,200	3.10%
		Namibia	242,800	25.10%
		South Africa	557,200	57.70%
Oueme	59,900	Benin	49,100	82.00%
		Nigeria	10,500	17.50%
		Togo	320	0.50%
Pangani	40,300	Kenya	2700	6.80%
		United Republic of Tanzania	37,600	93.20%
Pungwe	32,100	Mozambique	30,700	95.70%
		Zimbabwe	1400	4.40%
Ruvuma	155,200	Mozambique	100,500	64.80%

Basin	Basin area (km <sup>2</sup> )	Country	Basin country Unit (km <sup>2</sup> )	Percentage of total basin area
		Malawi	2600	1.70%
		United Republic of Tanzania	51,900	33.50%
Sabi	102,400	Mozambique	17,600	17.20%
		Zimbabwe	84,800	82.80%
Sanaga	133,000	Central African Republic	720	0.50%
		Cameroon	132,300	99.50%
Sassandra	68,100	Ivory Coast	60,000	88.00%
		Guinea	88,100	12.00%
Senegal	448,400	Guinea	314,500	7.00%
		Mali	171,600	38.30%
		Mauritania	168,300	37.50%
		Senegal	77,000	17.20%
St. John (Africa)	16,300	Guinea	2700	16.30%
		Liberia	13,700	83.70%
St. Paul	20,300	Guinea	9300	45.60%
		Liberia	11,000	54.40%
Tafna	7300	Algeria	5300	73.70%
		Morocco	1900	26.30%
Tano	16,800	Ivory Coast	1800	11.00%
		Ghana	14,900	89.00%
Umbeluzi	9800	Mozambique	6100	62.00%
		Swaziland	3600	37.00%
		South Africa	90	0.90%
Umba	6700	Kenya	1600	23.90%
		United Republic of Tanzania	5100	76.10%
Utamboni	7400	Gabon	3600	48.10%
		Equatorial Guinea	3800	51.90%
Volta	411,200	Togo	27,200	6.60%
Zambezi	1,375,000	Angola	255,800	18.60%
		Botswana	17,000	1.20%
		Mozambique	159,000	11.60%
		Malawi	110,200	8.00%
		Namibia	17,200	1.20%
		United Republic of Tanzania	27,700	2.00%
		Zambia	575,700	41.90%
		Zimbabwe	212,500	15.50%

\* Source: (McCracken & Wolf, 2019)



## **Appendix 2: Transboundary Water Basins Management**

There are some basic principles that can be employed as guiding tools in the management of many riparian States. This has led to the codification of a number of International Conventions and Multilateral Agreements between such States.

According to Kaua (2012) these management Strategies or principles are;

1. The need to set up institutional structures that promote stakeholder engagement at the local level before proceeding to the National level. Their roles need to be well defined and objectives clearly analyzed;
2. The general principle to develop strong and balanced capacity building among associated institutions in different Countries. This should aim at existence of well- established partners in each riparian state;
3. There is the need for improved and integrated monitoring and evaluation systems that meet accepted standards. This can be achieved if local National and International data bases are of high quality, reliable and up to date;
4. Resource management needs to be devolved such that, the communities involved do not just participate but also benefit from all initiatives;
5. Trust needs to be built and this can be ensured through transparency. Equitable sharing of benefits. All Parties involved need to be accountability;
6. African States need to strive to build their own capacity by soliciting their own funds. We should therefore limit our reliance on foreign donations and aids;
7. NGOs, civil societies and sympathizers need to ensure that the States implements Policies and Agreements. They can be 'watch dogs' ensuring that communities are not exploited;
8. Since most private sectors are also key players in management initiatives, it is important that their utilization of any form of resources are sustainably used; and,
9. Regular meetings, sharing interpersonal contacts, networking conferences can be major boost to information exchange and public engagements.

# References

1. Amenyogbe E, C. G.W. Z. L. M. L. X. 9. 5., 2018. A Review of Ghana's Aquaculture Industry.. Journal Aquaculture Research Development, Volume 9.
2. Anabo, A., 2013. The myth of 'Tragedy of the Commons' in sustaining water resources, Mizan Law Review.. Volume 7, pp. 309-350.
3. Anabo, A. H., 2013. The myth of 'Tragedy of the Commons' in sustaining water resources. Mizan Law Review, 7(2), pp. 309-350.
4. Assegide, E. et al., 2022. Impacts of Surface Water Quality in the Awash River Basin, Ethiopia: A Systematic Review.. Frontiers in Water, Volume 4, p. 782124..
5. Ayenew, T. & Legesse, D., 2007. The changing face of the Ethiopian rift lakes and their environs: call of the time.. Lakes and Reservoirs: Research and Management, Volume 12, p. 149–165. .
6. Brauman, K. A., Daily, G. C., Duarte, T. K. & Mooney, H. A., 2007. The nature and value of ecosystem services: an overview highlighting hydrologic services. Annual Reviews of Environmental Resources, Volume 32, pp. 67-98.
7. Canonico, G., Arthington, A. & McCrary, J. M., 2005. .The effects of introduced tilapias native biodiversity.. Aquatic cconservation: Marine and Freshwater Ecosystems.
8. Carpenter, S. R., Stanley, E. H. & Vander Zanden, J. M., 2011. State of the World's Ecosystems: Physical, Chemical and Biological Changes. Annual Review of Environmental Resources, Volume 36, pp. 75-99.
9. Chen, G., 2009. Politics of China's Environmental Protection: Problems and Progress. Series on Contemporary China.. 5 toh tuck link singapore: World Scientific Publishing Co. Pte. Ltd.
10. Chikozho, C., 2014. Pathways for building capacity and ensuring effective transboundary water resources management in Africa: Revisiting the key issues, opportunities and challenge. Physics and Chemistry of the Earth, pp. 72-82.
11. Cohen, A. et al., 2016. Climate warming reduces fish production and benthic habitat in Lake Tanganyika, one of the most biodiverse freshwater ecosystems.. Proceedings of the National Academy of Sciences, Volume 113(34),,, pp. 9563-9568..
12. Coulter, G., 1991. Lake Tanganyika and its Life., Oxford: Oxford University Press.
13. Darwall, W. R. T. et al., 2011. The Diversity of Life in African Freshwaters: Under Water, Under Threat. An analysis of the status and distribution of freshwater species throughout mainland Africa, Gland; Cambridge: IUCN, Gland, Switzerland and Cambridge, UK.
14. Darwall, W. R. T. et al., 2009. Freshwater biodiversity: a hidden resource under threat. In: J. C. Vié, C. Hilton-Taylor & S. N. Stuart, eds. Wild Life in a changing world: An analysis of the 2008 IUCN Red List of Threatened Species. Gland, Switzerland: International Union for Conservation of Nature and Natural Resources, pp. 43-54.
15. Darwall, W. et al., 2011. The diversity of life in African freshwaters: underwater, under threat. An analysis of the status and distribution of freshwater species throughout mainland Africa. Gland: The World Conservation Union (IUCN).
16. de Castro-Pardo, M., Martínez, P. F., Pérez Zabaleta, A. & Azevedo, J. C., 2021. Dealing with Water Conflicts: A Comprehensive Review of MCMD Approach to Manage Freshwater Ecosystem Services. Land, 10(469), pp. 1-32.
17. Ewaid, S. & Abed, S., 2017. Water quality index for Al-Gharraf river, southern Iraq.. Egyptian Journal of

- Aquatic Research, Volume 43 (2), p. 117–122. .
18. Ewaid, S. H. & Abed, S. A., 2017. Water quality index for Al-Gharraf river, southern Iraq. Egypt. 43 (2),.. Journal of Aquatic Resources, 43(2), p. 117–122.
  19. Falkenmark, M., 2003. Freshwater as shared between society and ecosystems: from divided approaches to integrated challenges. Phil. Trans. R. Soc. Lond. B3582, Volume 358, p. 2037–2049.
  20. Falkenmark, M., 2003. Freshwater as shared between society and ecosystems: from divided approaches to integrated challenges. Philosophical Transactions of the Royal Society, Biological Sciences., Volume 358, p. 2037–2049.
  21. FAO, 2003. Review of World Water Resources by Country, Rome: Food and Agriculture Organization.
  22. Goudswaard, P. C. & Ligtoet, W., 1988.. Recent developments in the fishery for haplochromines (Pisces: Cichlidae) and the Nile Perch, *Lates niloticus* (L) (Pisces: Centropomidae) in Lake Victoria. Fisheries . FAO, Rome, Rome: FAO.
  23. Grill, G. et al., 2019. Mapping the world's free-flowing rivers.. Nature, Volume 569, p. 215–221..
  24. Grill, G. et al., 2019. Mapping the world's free-flowing rivers. Nature, Issue 569, p. 215–221.
  25. Hansen, G. & Cramer, W., 2015. Global distribution of observed climate change impacts., 5(3),. NATURE CLIMATE CHANGE, Volume 5, pp. 182-185.
  26. Kolding, J. et al., 2008. Are the Lake Victoria fisheries threatened by exploitation or eutrophication? Towards an ecosystem-based approach to management. .. The ecosystem approach to fisheries, pp. 309-350.
  27. Leggett, J. A., 2020. The United Nations Framework Convention on Climate Change, the Kyoto Protocol, and the Paris Agreement: A Summary. UNFCCC, New York, 2., USA: Congressional Report Service.
  28. Leprieur, F. et al., 2009. Scientific uncertainty and the assessment of risks posed by non-native freshwater fishes.. Fish and Fisheries, Volume 10, p. 88–97..
  29. Lian, Y., You, J., Sparks, R. & Demissie, (., 2012. Impact of human activities to hydrologic alterations on the Illinois River.. Jounal of Hydrological Engineering, Volume 17, p. 537–546.
  30. Lintern, A. et al., 2018. Key factors influencing differences in stream water quality across space.. Wiley Interdisciplinary Reviews, Water, Volume 5(1), p. 1260..
  31. Loaiza, J. G. et al., 2021. Assessment of Water Quality in A Tropical Reservoir in Mexico: Seasonal, Spatial and Multivariable Analysis. International Journal of Environmental Research and Public Health, 18(14), pp. 1-20.
  32. Malin, F., 2003. Freshwater as shared between society and ecosystems: from divided approaches to integrated challenges. Phil. Trans. R. Soc. Lond. B3582037–2049.
  33. Meyer, S. E., Callahan, M. A., Stewart, J. E. & Warren, S. D., 2021. Invasive species response to natural and anthropogenic disturbance. n: Poland, Therese M.; Patel-Weynand, Toral; Finch, Deborah M.; Ford Miniati, Chelcy; Hayes, Deborah C.; Lopez, Vanessa M., eds. Invasive Species in Forests and Rangelands of the United Sta.
  34. Millennium Ecosystem Assessment, 2005. Freshwater Ecosystem Services. In: K. Chopra, L. Rik, P. Kumar & H. Simons, eds. Ecosystems and Human Well-being: Policy Responses, Volume 3. Washington: Island Press, Washington, pp. 213-256.
  35. Mkuna, E. & Baiyegunhi, L. J., 2020. Impact of Nile perch (*Lates niloticus*) overfishing on fishers' income: Evidence from Lake Victoria, Tanzania.. African Journal of Agricultural and Resource Economics, Volume 15, pp. 213-229..

36. Moore, J. & Olden, J., 2017. Response diversity, nonnative species, and disassembly rules buffer freshwater ecosystem processes from anthropogenic change.. *Global Change Biology* , Volume 23, p. 1871–1880.
37. Munir, T., Hussain, M. & Naseem, S., 2016. Water pollution-a menace of freshwater biodiversity: a review. *Journal of Entomology and Zoology Studies*, 4(4), pp. 578-580.
38. Munir, T., Hussain, M. & Naseem, S., 2016. Water pollution-a menace of freshwater biodiversity: a review.. *Journal of Entomology and Zoology Studies*, Volume 4(4), pp. 578-580.
39. Munir, T., Hussain, M. & Naseem, S., 2016. Water pollution-a menace of freshwater biodiversity: a review.. *Journal of Entomology and Zoology Studies*, Volume 4(4), pp. 578-580..
40. Munir, T., Hussain, M. & Naseem, S., n.d. Water pollution-a menace of freshwater biodiversity: a review.. *Journal of Entomology and Zoology Studies*, Volume 4(4), pp. 578-580.
41. Naiman, R. J. et al., 2006. freshwater BIODIVERSITY : Challenges for freshwater biodiversity research, Seattle WA 98195-5020, USA: DIVERSITAS .
42. Obirikorang, K.A., Ansong, M., Gyampoh, B.A. & Attu, G.A.T., 2020. First report of aquaculture-mediated introduction of the Nile tilapia, *Oreochromis niloticus* (Linnaeus, 1758) into Lake Bosomtwe, Ghana.. *BioInvasions Record*, Volume 9, p. 4.
43. Oguttu, H. et al., 2008. Pollution menacing Lake Victoria: quantification of point sources around Jinja Town, Uganda.. *Water SA*, Volume 34(1), pp. 89-98..
44. Olden, J. & Naiman, R., 2010. Incorporating thermal regimes into environmental flows assessments: Modifying dam operations to restore freshwater ecosystem integrity.. *Freshwater Biology*, Volume 55,, p. 86–107.
45. Pérez, A., 2015. An Introduction to African Hydropolitics, UCL: Oregon .
46. Postel, S. & Carpenter, S., 2011. Freshwater Ecosystem Services. In: G. Daily, ed. *Nature Services*. Washington DC, USA: Island Press, pp. 195-214.
47. Renner, M., 1996. *Fighting for survival: environmental decline, social conflict, and the new age of insecurity* WW Norton, New York: WW Norton.
48. Sala, o. E. et al., 2000. Global biodiversity scenarios for the year 2100. *Science*, Volume 287, p. 1770–1774.
49. Shiklomanov, I.A., 1993. World Freshwater Resources. In: P. H. Gleick, ed. *Water in Crisis: A Guide to the World's Fresh Water Resources*. New York: Oxford University Press, New York, pp. 13-24.
50. Shikuku, K. M. et al., 2021. Lock-ins to the dissemination of genetically improved fish seeds. *Agricultural Systems*.. *Agricultural Systems*, Volume 118.
51. Sladonja, B., Poljuha, D. & Uzelac, M., 2018. Non-Native Invasive Species as Ecosystem Service Providers. *IntechOpen*.. *Ecosystem Services and Global Ecology*.
52. Solaymani, S. & Kari, F., 2014. Poverty evaluation in the Malaysian fishery community.. *Ocean and Coastal Management*, Volume 95, p. 165–75.
53. Tickner, D. et al., 2020. Bending the Curve of Global Freshwater Biodiversity Loss: An Emergency Recovery Plan.. *BioScience* , p. 70.
54. Transboundary Freshwater Dispute Database, 2014. Transboundary River Basins of Africa, Oregon: University of Oregon.
55. Uitto, J. I. & Duda, A., 2002. Management of transboundary water resources: lessons from international cooperation for conflict prevention. *The Geographical Journal*, 168(4), pp. 365-378.
56. UNEP-DHI & UNEP, 2016. Transboundary River Basins: Status and Trends, Nairobi: United Nations Environment Programme.

57. van Viliet, M.T. H., 2021. Global water scarcity including surface water quality and expansions of clean water technologies. *Environmental Research Letters*, 16(024020).
58. West, K., 2001. Lake Tanganyika: Results and Experiences of the UNDP/GEF Conservation Initiative (RAF/92/G32) in Burundi, DR Congo, s.l.: s.n.
59. WWF, 2020a. Freshwater Species of the Week, Gland, Switzerland:World Wide Fund for Nature.
60. WWF, 2020b. Freshwater, Gland, Switzerland:World Wide Fund for Nature.
61. Xenopoulos, M.A. et al., 2005. Scenarios of freshwater fish extinctions from climate change and water withdrawal.. *Global change biology*, Volume 11(10), pp. 1557-1564..
62. Xu, M., Wang, Z. & Duan, X., 2014. Effects of pollution on macroinvertebrates and water quality bio-assessment. *Hydrobiologia*, Volume 729, p. 247–259.
63. Xu, M., Wang, Z., Duan, X. & Pan, B., 2014. Effects of pollution on aquatic ecology and water quality bio-assessment. *Hydrobiologia*, Volume 729.
64. Yeleliere, E., Cobbina, S. J. & Duwiejuah, A. B., 2018. Review of Ghana's water resources: the quality and management of with particular focus on freshwater resources.. *Applied Water Science*, pp. 1-12.



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