AFRICAN UNION
INTERAFRICAN BUREAU
FOR ANIMAL RESOURCES

FISHERIES MANAGEMENT AND DEVELOPMENT ISSUES IN SELECTED INLAND WATER BODIES IN WEST AND CENTRAL AFRICA

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Citation: AU-IBAR 2015. Fisheries Management and Development issues in selected Inland Water Bodies in West and Central Africa. AU-IBAR Reports

Published by AU-IBAR, Nairobi, Kenya

ISBN 978-9966-1659-5-4

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Acknowledgments
The Director of AU-IBAR wishes to thank all those who have contributed to the preparation of this document. These include the management of the Lake Chad Basin Commission, the Niger Basin Authority and the Organization for the Development of the Senegal River (OMVS), Ministries/Departments in charge of fisheries and aquaculture in the respective member states in West and Central Africa, other stakeholders and all those who facilitated the work of this consultancy. Special thanks go to the consultant who prepared the document and the team at IBAR for the editorial work. This work was done under the project 'Strengthening Institutional Capacity to enhance governance of the fisheries sector in Africa', Project number: DCI-FOOD 2013/331 -056, funded by the EU to whom we are grateful for the financial support.

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Activity, Consultancy and Client Address

Name of Activity	Consultancy Services for the Assessment of the Performance of Regional Fisheries Bodies in West Africa
Activity coverage	West Africa Niger Basin, Lake Chad Basin , and Senegal River
Tender/Contract No.	PROCUREMENT NO.21/AU-IBAR/14
Client and Address	The Director African Union Inter-Africa Bureau for Animal Resources (AU-IBAR) Kenindia Business Park, Museum Hill, Westlands Road, P.O Box 30786 00100, Nairobi, Kenya
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EXECUTIVE SUMMARY

Background

The necessity for the assessment of fisheries management and development issues of selected Inland water bodies in Africa covering West and Central Africa- Niger Basin, Lake Chad Basin, and Senegal River was undertaken based on the paramount relevance of assessment of fisheries management and development issues to the sustainable utilization of resources in Africa's Inland water bodies. These water bodies contribute to nutrition and food security in Africa, as the latter is the foundation for human security in the region. Majority of the population around the basins depends on fish-based resources for their daily sustenance, with Inland water fisheries making very significant contributions to fish supply and export. Also, it is critically important to formulate policy, identify healthy drivers, determine appropriate ecosystem approach to regulate fishing methods and limit pressure so as to maintain modeled exploitation rate that gives the multispecies maximum sustainable yield of the ecosystem for enhanced management of the Regional Inland Water Bodies for sustainable use and management of the resources therein.

Three Regional Inland Water Bodies located in West and Central Africa: Lake Chad Basin, Niger Basin and Senegal River were assessed. The overall objective of the study is to develop guidelines and action plans for sustainable inland fisheries management. The main aims were to identify the potentials, the main constraints and prospects (visible and invisible) of inland fisheries development; highlight issues, challenges and trends on fisheries development: identify gaps in existing fisheries legislations and propose realistic options for policy formulation and regulatory frameworks for development of guideline and action plans for practical, rational and sustainable management towards the overall development of inland fisheries in Africa. The activity is expected to facilitate and enable AU Member States to focus on key challenges or policy choices, in alignment with regional plan for investments to engender positive transformation of inland water fisheries in contributing significantly to economic growth and livelihoods; and to strengthen policies and provide the evidence-based justification for implementation of improved fisheries resources management approaches that will enhance rapid and sustainable development of inland water bodies in Africa.

In achieving this, assessment of fisheries management and development in the selected inland water bodies was carried out through three (inception, field and synthesis) phasesof assessment

of the Lake Chad Basin Commission (LCBC), Niger Basin Authority (NBA), and Organization for the Development of the Senegal River (OMVS). Comprehensive review of the relevant documentations specifically the legal instruments that established the Inland Water Authorities, reports of activities the Inland Water Authorities have been undertaken, and meetings and working sessions with contracting states that are signatories to the establishment of the RFBs was conducted. Stakeholders including RFBs, CSOs, fisherfolks, fisheries administrators, and officials of relevant ministries and countries, were consulted. Where direct contact is not possible, questionnaires were administered to cover the relevant areas and agencies for vital data collection. Focus Group Discussion (FGD) and interviews were carried out for detailed information. Authorities of the Inland Water Bodies – Lake Chad Basin, Niger Basin, and River Senegal, were contacted for daring needs.

Available critical information having direct or indirect bearing on inland water body assessment initiative, including existing fisheries policy, strategies, management plans and policies, Memorandum of understandings and relevant legal instruments such as legislative framework for trans-boundary water bodies were identified and relevant documents collected, reviewed and analyzed to identify potential areas to facilitate them in line with the objective and purposes of this project.

Updated information on the status of fisheries of the inland water bodies indicated although the fisheries has potentials and prospects for enhanced food security in the region, the fisheries were generally declining due to challenges mainly emanating from factors such as insecurity, inadequate monitoring facilities such as vehicles, communication equipment and trained personnel internet connectivity, lack of unified policies and policy regulations. The priority areas for development to ensure increased contribution of fisheries resources of the inland water bodies to the socio-economic growth of the member states in particular Africa at large include management and mitigation for variability of hydrological regime and fresh water availability; water pollution, decreased viability of biological resources; loss of biodiversity, loss and modification of ecosystems, sedimentation in rivers and water bodies and Invasive species. The diagnostic analyses of trans-boundary issues in the shared water bodies indicated the need for strengthening the manpower of the management authorities as well as ensuremore coherent trans-boundary legislation. In fact, there is need to organize regional strategic remedial actions for unified legislation for development of the basins. The main internal and external drivers

relevant to inland fisheries within the selected water bodies in the regions were identified within the internal and external frameworks.

In conclusion, a comprehensive assessment on the issues, challenges and trends on fisheries and development in selected water bodies in Africa, critical analysis and identification of the potentials, the main constraints (visible and invisible) and prospects of inland fisheries development was carried out. The guidelines and action plans for rational management and development of inland fisheries of studied African water basins was documented for realistic policy formulation and regulatory frameworks.

ACRONYMS

AA	Ability to Achieve
AES-SONEL	National Electric Company
AFD	French Agency for Development
AfDB	African Development Bank
AGHRYMET	Agro-meteorology Hydrology Meteorology
AIDS	Acquired Immunodeficiency Syndrome
AMCEN	African Ministerial Conference on Environment
ARCC	African and Latin American Resilience to Climate Change
ASPS	Annual Sector Policy Statement
NEPAD	New Partnership for Africa's Development
AUC	African Union Commission
AU-IBAR	African Union-Inter African Bureau for Animal Resources
B.M.Z	German Federal Ministry of Economic Co-operation and Development
BMZ	German Federal Ministry for Technical Cooperation and Development
BVC	Beach Village Committee
CAEEN	Cameroon Association for Environmental Education
CAMFA	Conference of African Ministers of Fisheries & Aquaculture
CAR	Central Africa Republic
CBD	Convention on Biological Diversity
CBD	United Nations Convention on Biological Diversity
CBDA	Chad Basin Development Authority (Nigeria)
CBFM	Community Based Fisheries Management
CBNRM	Community-Based Natural Resource Management
CBO	Community Based Organisation
CBO	Congressional Budget Office
CCRF	Code of Conduct for Responsible Fisheries
CCRF	Code of Conduct for Responsible Fisheries
CDMT	Frameworks for Mid-term Expenditures
CEBEVIRHA	Economic Commission for Cattle, Meat and Fisheries Resources
CFA Franc	Monetary Unit

CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna
CO2	Carbon dioxide
COM	Council of Ministers
CPR	Common Pool Resource
CSO	Civil society organization
CSR	Civil Service Rules
CTD	Decentralised Local Authority
DC	Developing Country
DFID	Department for International Development
DoF	Department of Fisheries
DREM	Department of Water Resources and Meteorology (Chad)
DSDSR	Document for the Strategy of the Rural Sector Development
DSDSR	Document for the Strategy for Rural Sector Development
EAF	Ecosystem Approach to Fisheries
EAF	Ecosystem Approach to Fisheries
EAF	Ecosystem Approach to Fisheries
EEZ	Exclusive Economic Zone
EFCC	Economic and Financial Crime Commission
EIA	Environmental impact assessment
EIA	En-vironmental impact assessments
EW	Ecosystem Wellbeing
FACU	Federal Agricultural Co-ordinating Unit
FAO	United Nations Food and Agriculture Organisation
FAO	Food and Agriculture Organization
FAO-UN	Food and Agriculture Organization of the United Nations
FCMA	Fisheries Conservation and Management Act
FDF	Federal Department of Fisheries
FERMA	Federal Road maintenance Agency
FGN	Federal Government of Nigeria
FISON	Fisheries Society of Nigeria
FMAWRRD	Federal Ministry of Agriculture, water Resources and Rural Development

FMWR	Federal Ministry of Water Resources
FPZ	Fisheries Protection Zone
GDP	Gross domestic product
GDP	Gross domestic product
GDP	Gross Domestic Product
GEF	Global Environment Facility
GEF	Global Environmental Fund
GIC	Common Initiative Group
GIWA	Global International Water Assessment
GIZ	Agence Allem and pour le Développement International Deutsche Gesellschaftfür Internationale Zusammenarbeit/German International Development Agency
GNI	Gross National Income
GoM	Government of Malawi
HDI	Human Development Index
HIPC	Highly Indebted Poor Countries
HIV/AIDS	Human immunodeficiency virus/Aquired immune deficiency syndrome
HJRBDA	HadejiaJama'are River Basin Development Authority (Nigeria)
HNCE	High National Committee for the Environment (Chad)
HNWCP	Hadejia-Nguru Wetland Conservation Project
HW	Human Wellbeing
IAP	Invasive aquatic plants
IAPCBM	Integrated Action Plan for Community Based Management
ICPC	Independent Corrupt Practices Commission
IDDRA	Institute for the Sustainable Management of Aquatic Resources
IMCC	Inter Ministerial Coordinating Committee
IMF	International Monetary Fund
IMF	International Monetary Fund
IMP	Integrated Management Plan
IPCC	Intergovernmental Panel on Climate Change
IPZ	Integrated Protection Zone
IRD	Institute for Research and Development

ITCZ	Inter-Tropical Convergence Zone
IUCN	World Conservation Union
IUU	Illegal, Unreported and Unregulated
IWRM	Integrated Water Resources Management
KLFMCU	Kainji Lake Fisheries Monitoring and Co-ordinating Unit
KRIP	Kano River Irrigation Project
KYB	Komadugu Yobe Basin
L.G.A.	Local Government Authority
LADA	Local Authority for Orientation and Decision
LCB	Lake Chad Basin
LCBC	Lake Chad Basin Commission
LDB	Lake Development Board/Bodies
LFA	Lake Fisheries Authorities
LFMA	Local Fisheries Management Authority
LODO	Local Orientation and Decision Organ
MDG	Millennium Development Goals
MEE	Water and Environment Ministry (Chad)
MFI	Micro-Finance Institution
MINADER	Ministry for Agriculture and Rural Development
MINATD	Ministry for Territorial Administration and Decentralisation
MINCOF	Ministry for Female Advancement
MINEP	Ministry for Environment and Nature Conservation
MINEPIA	Cameroon Ministry of Livestock, Fisheries and Animal Industries
MINEPIA	Ministry for Husbandry, Fisheries and Animal Industries
MINFOF	Forestry and Fauna Ministry
MINPLAPDAT	Ministry of National Development Planning and Programming
MMEP	Ministry of Agriculture, Mines, Energy and Oil (Chad)
MMNRE	Ministry of Mines, Natural Resources and Environment
MOU	Memoranda of understanding
MSC	Monitoring, Surveillance and Control
MSY	Maximum Sustainable Yield
NACRDB	Nigerian Agriculture, Co-operative and Rural Development Bank

NAP	National Action Plan
NAPA	National Adaptation Programme of Action
NARP	National Agricultural Research Project
NARS	National Agricultural Research System
NASA	National Aeronautic Space Agency
NBA	Niger Basin Authority
NCA	National Council on Agriculture
NCF	National Conservation Foundation
NCU	National Coordination Unit
NEAP	National Environmental Action Plan
NEAZDP	North East Arid Zone Development Program
NEEDS	National Economic Empowerment Development Strategy
NEPAD	New Partnership for African Development
NFAP	National Fisheries and Aquaculture Policy
NFDC	National Fisheries Development Committee
NFDS	Nordenfjeldske Development Services
NFFP	NEPAD-FAO Fisheries Program
NGKFLPP	Nigerian-German Kainji Lake Fisheries Promotion Project.
NGO	Nigeria National Institute for Freshwater Fisheries Research
NIGER-HYCOS	Niger Hydrological Cycle Observation System
NIOMR	Nigerian Institute for Oceanography and Marine Research
NPC	National Planning Commission
NRM	Natural Resources Management
NSSD	National Strategy for Sustainable Development
NUFFA	National Union of Fish farmers and Aquaculturist
OMVS	Organisation for Senegal River Basin Development
PaCFA	Partnership on Climate, Fisheries and Aquaculture
PAPT	Development Project of the Tikar Plain
PARI	Agricultural Professionalization and Institutional Reinforcement
PAS	Programme d'Action Stratégique, Strategic Action Programme
PFM	Participatory Fisheries Management
PFMP	Participatory Fisheries Management Programme

PNDP	National Participatory Development Programme
PNG	National Governance Programme
PO	Professional Organisation
PREM	Poverty Reduction and Environmental Management (PREM)
PRODEBALT	Lake Chad Sustainable Development Programme
PRS	Poverty Reduction Strategy
PRSP	Poverty Reduction Strategy Paper
RBDA	River Basin Development Authority
RDS	Rural Development Strategy
REDD	Reducing Emissions from Deforestation and Forest Degradation in Developing Countries
RFB	Regional Fisheries Bodies
RNC	River Niger Commission
RNC	River Niger Commission
RPRM	Rapid Participatory Research Method
RSU	Regional Support Unit
RSU	Regional Support Unit
SADC	Southern Africa Development Community
SAED	Société d'Aménagement et d'Exploitation des Terres du Delta du Fleuve Sénégal
SAP	Strategic Action Plan
SDSR	Strategy for the Rural Sector Development
SEA	South East Arm
SEMRY	Company of Growth and Modernization of Yagoua rice cultivation
SFLP	Sustainable Fisheries Livelihoods Programme
SLA	Sustainable Livelihoods Approach
SPC	Secretariat of the Pacific Community
STEE	Society for Water and Electricity (Chad)
SUSFISH	Sustainable Management of Water and Fish Resources in Burkina Faso
TAC	Total allowable catch
TDA	Transboundary Diagnostic Analysis
TI	Traditional Institution

TTT	Technical Task Team
UN	United Nations
UNDP	United Nations Development Program
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
USD	United States Dollar Currency
VNRMC	Village Natural Resource Management Committee
VSC	Village Survellance Committee
WAFRI	West African Fisheries Research Institute
WB	World Bank
WSSD	World Summit on Sustainable Development

CHAPTER ONE

1.0 Introduction

An assessment of fisheries management and development issues is paramount to the sustainable utilization of resources in Africa's Inland water bodies. These water bodies contribute to nutrition and food security in Africa, as the latter is the foundation for human security in the region. Majority of the population depends on fish-based resources for their daily sustenance, with Inland water fisheries making very significant contributions.

Fish is probably the major source of protein in communities along major rivers and lakes in Africa. In addition to provision of food locals inland fisheries are also a major source of income generation, with some products of this fisheries being important export commodities.It is therefore important to formulate policy on the management of Regional Inland Water Bodies for sustainable use and management of the resources therein. It is critically important to identify healthy drivers, determine appropriate ecosystem approach, regulate fishing methods and limit pressure so as to maintain modeled exploitation rate that gives the multispecies maximum sustainable yield of the ecosystem. In West Africa, the Regional Inland Water Bodies selected for assessment are: Lake Chad Basin, Niger Basin, Senegal River. The following RFBs exist:

1. Lake Chad Basin Commission (LCBC)
2. Niger Basin Authority (NBA)
3. Organization for the Development of the Senegal River (OMVS)

1.1 Overall Objectives of the Consultancy

In this exercise, the overall objective is to develop guidelines and action plan for sustainable inland fisheries management. In achieving this, assessment of fisheries management and development in selected inland water bodies was carried out, with the main aim of identifying strategic issues, challenges and regional trends, for the development of appropriate guidelines and action plans for practical, rational and sustainable management towards the overall development of inland fisheries in Africa.

1.2 Specific Objectives

The specific objectives are:

(i) To facilitate and enable AU Member States to focus on key challenges or policy choices, in alignment with regional plan for investments to engender positive transformation of inland water fisheries in contributing significantly to economic growth and livelihoods;

(ii) To strengthen policies and provide the evidence-based justification for implementation of improved fisheries resources management approaches that will enhance rapid and sustainable development of inland water bodies in Africa.

CHAPTER TWO

2.0 Methodology and Activities

In preparation for the production of a comprehensive assessment report, the following specific activities were carried out:

1. Briefing by the AU-IBAR;

The consultant attended the briefing by the AU-IBAR;

2. Meetings were held with the Authorities of selected inland water management bodies as well as other key stakeholders of the water bodies;
3. Identification and collection of relevant documents having direct or indirect bearing on inland water body assessment initiative, including existing fisheries policy, strategies, management plans and policies, Memorandum of understandings and relevant legal instruments such as legislative framework for trans-boundary water bodies were obtained;
4. Review and analysis of documents mentioned in item (iii) above to identify potential areas to facilitate them in line with the objective and purposes of this project was carried out;
5. Review and provision of an update information on the status of fisheries in the inland water bodies by highlighting the potentials, fisheries production, prospects, challenges and priority areas for development to ensure increased contribution of fisheries resources of the inland water bodies to the socio-economic growth of the member states in particular and AU at large was conducted;
6. Diagnostic analysis of trans-boundary issue in the shared water bodies under reviewwas conducted and proposal for regional strategic remedial actionswere developed;
7. The main internal and external drivers (strategic issues) relevant to inland fisheries within selected water bodies in the region (s) of assignmentwere identified;
8. Other relevant information were collected and adequately utilized in the preparation of the final report;
9. The final draft document consisting of the inputs, comments, conclusions and recommendations made by the relevant organizationswas produced;
10. The required reports were compiled as outlined in the TOR.

2.1 Analysis of obtained Information

1. The Inland Water Bodies – Lake Chad Basin, Niger Basin, and River Senegal,Authorities were contacted and the obtained information analysed through:
2. Comprehensive review of the relevant documentations specifically the legal instruments that established the Inland Water Authorities, reports of activities the Inland Water Authorities have undertaken , and meetings and working sessions with contracting states that are signatories to the establishment of the RFBs.
3. Reports from consulted relevant stakeholders including RFBs, CSOs, fisherfolks, fisheries administrators, and officials of relevant ministries and countries were analysed
4. Where direct contacts werenot possible, administered questionnaires were covering relevant areas and agencies were analyse for the collected vitaldata.
5. Information from Focus Group Discussion (FGD) and interviews were logically analysed to draw out relevant issues.

The analyses were carried out in three phases.

2.1.1 Inception Phase

Includes desk review of available/ relevant documents, briefings and inception meetings at AU-IBAR; the outcome of this phase was the inception report outlining the agreed detailed work plan for the field visits, interviews and outline of the final Technical Report.

2.1.2 Field Phase

The field visits covered RFBs secretariats as follows:

LCBC – secretariat in République du Tchad

NBA – secretariat in Niamey, Niger

OMVS – secretariat in Dakar, Senegal

Fisheries Stakeholders in Chad, Niger and Senegal

2.1.3 Synthesis Phase

Draft Report was prepared, describing the main findings, preliminary conclusions and recommendations. The Draft Report was prepared for submission to AU-IBAR secretariat to attract comments for fine-tuning and submission of Final Report..

CHAPTER THREE

BACKGROUND INFORMATION ON INLAND WATER BODIES

The Lake Chad, Senegal and Niger Basins are located within the West and Central African sub-region. The basins are important water reservoirs which serves multiple purposes for the member countries where they are used for municipal water supply, irrigation of agricultural lands and supply of capture fisheries among other benefits. Water and fisheries resources of the basins are contributory to socio-economic and food security of member countries. Detailed information of each of the basins is discussed.

3.1 Lake Chad Basin

The Lake Chad Basin (Global International Water Assessment, GIWA Region 43) is situated in Central Africa between 6° to 24° N and 8° to 24° E. It comprises a vast expanse of land made up of several catchments that feed Lake Chad. Figure 3.1 shows a general map of the Lake Chad Basin with the GIWA region 43 boundaries. The entire geographical basin covers an area of 2 434 000 km^2 (based on EROS Data Center 2002), or 8% of the surface area of the African continent, shared between the countries of Algeria, Cameroon, Central African Republic (CAR), Chad, Libya, Niger, Nigeria and Sudan (Figure 3.1).

The region is bounded to the north by the Ahaggar Mountains in Algeria. From this summit, the border descends southwards towards the Tibesti Highlands that forms the border between Libya and Chad, and continues to about 19° N near the Djebel Mara volcanic mountains in Sudan. The southern border is defined by the Mongos Hills in CAR and the Adamawa Mountains at about 6° N and further west by the Mandaras in northern Cameroon at approximately 10° N. The Jos Plateau marks the western boundary in the Nigerian sector of the Basin and further north the Aïr Plateau in Niger.

3.1.1 Geographical and Geological Description

The Tibesti and Ahaggar Highlands in Algeria form the highest elevations within the Lake Chad Basin region. Their summits rise to an elevation between 2 500 to 3 400 m above mean sea level. They are built up of basalt and crowned with a series of craters. The Djebel Mara volcanic mountains in western Sudan have an elevation of 3 088 m above mean sea level and these mountains gradually decrease to approximately 300 m above mean sea level towards the Lake

Chad tectonic depression. Most of the interior of the region is a depression with heights not more than 500 m above mean sea level in altitude, the lowest point being about 160 m in the Chad lowlands (UNDP/FAO 1972).

The Lake Chad Basin was formed by extensional tectonic forces during the Cretaceous Period (Burke 1976 in Isiorho & Nkereuwem 1996) with the geological and geo-morphological development of the Basin being conditioned by the slow and 'cool' rifting of the West and Central African Rift System. This has formed a regional hydrological sink (World Bank 2002b) known as the Chad Artesian Basin that consists of the Lake Chad (Chad Syneclise) and the Chari-Logone system (Chari-Logone Artesian Basin) located southwest of the Basin. These sub-systems are underlain by a basement complex in the upper source areas and by a progressively thick sequence of sedimentary deposits towards the Lake (World Bank 2002b).

The Chad Syneclise is part of the major meridional zone of depressions extending from the Gulf of Gabes in the North of Africa to the Karoo aquifer in the south. It borders the Mali-Niger aquifer in the west, the Benue Graben in the southwest, and is surrounded by the Aïr Plateau, the Ahaggar and Tibesti Highlands and the Dahomey-Nigeria and Cameroon massifs. This basin is situated in the intersection of the northeastern and northwestern faults. The water supply of the Chad Basin is drawn from the southern Ahaggar and Tibesti Highlands, the Aïr, Ennedi, Darfour and Ouaddai plateaux and other uplands. In the internal recharge and storage area situated in the Chad Syneclise aquifer, water is present in Paleozoic "Continental Intercalaire", Upper Cretaceous, "Continental Terminal" and Quaternary formations.

The Chari-Logone Artesian Basin is situated southeast of the Lake Chad. It includes the extensive Chari-Logone plain, as an inner recharge area, and the Adamawa, Bongas, Ouaddai and other mountains surrounding the plain, as an outer recharge area. Most significant reserves of groundwater in this basin are found in the "Continental Terminal" sequence and in the alluvium of the Chari and Logone valleys. This water is widely used for economic purposes. Much of the soil in the Chari Basin consists of clay particles which swell together when wet, so that water runs off as rapid sheetwash rather than slow percolation (USGS 2001).

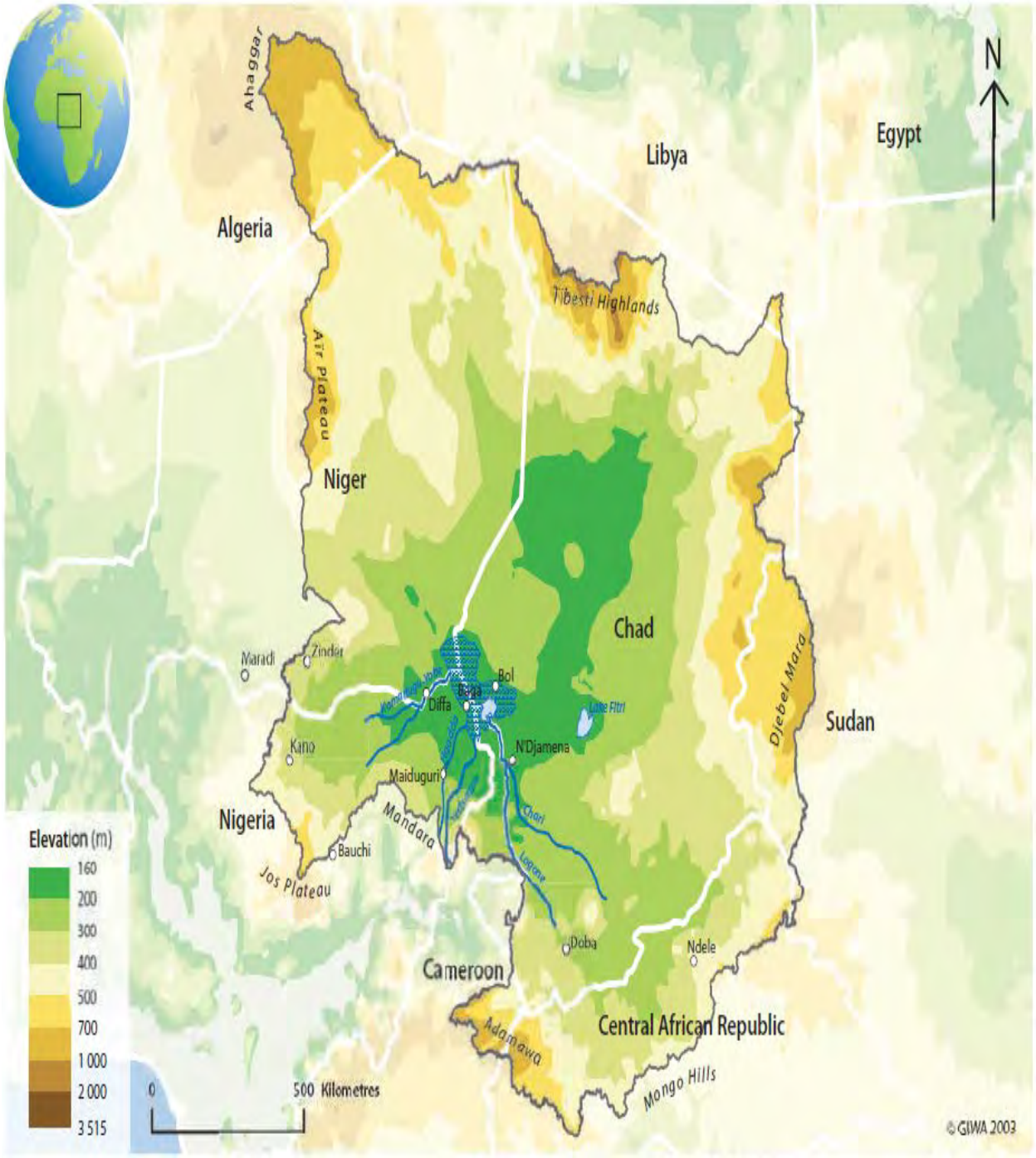

Figure 3.13: Lake Chad Basin
(**Source**:UNEP-GIWA Report No. 43.)

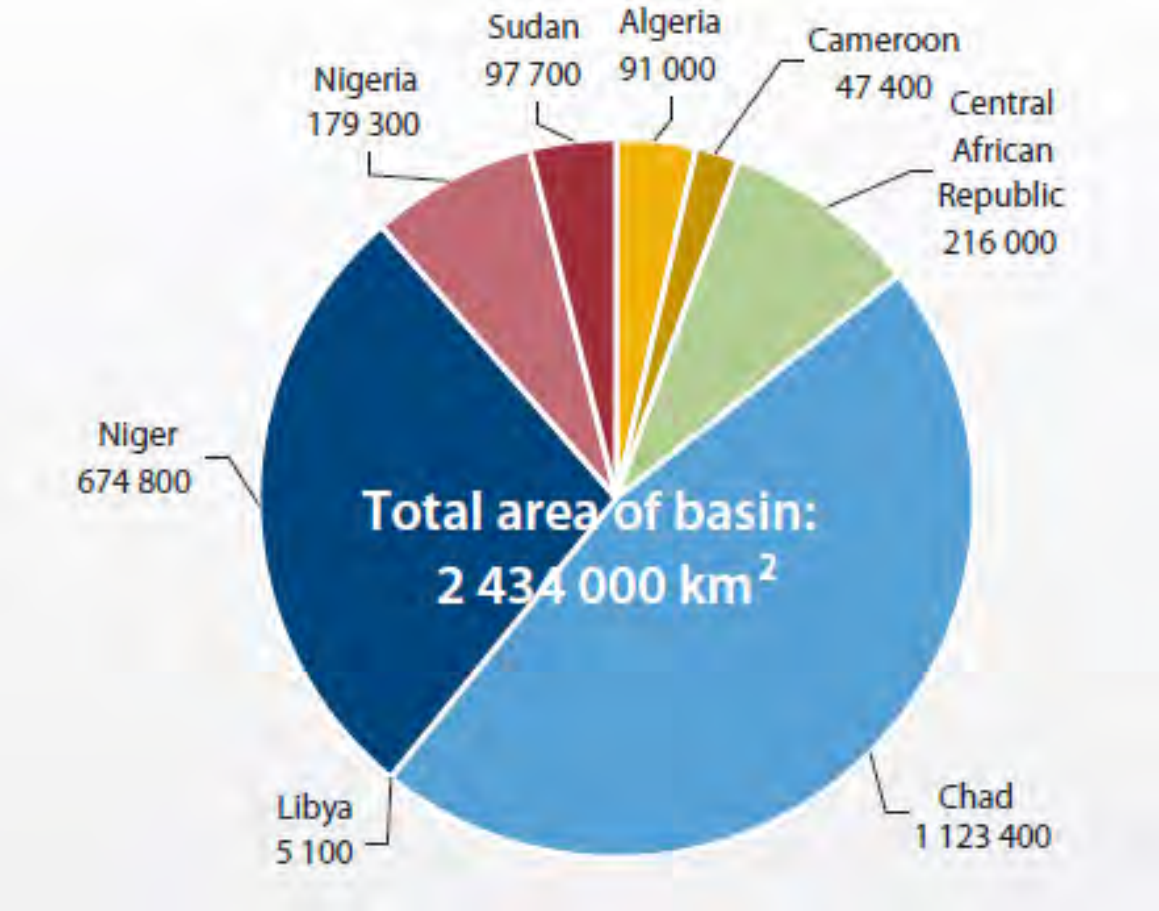

Figure 3.2: Area coverage per country within the Lake Chad Basin (km^2)
(**Source**: Based on HYDRO 1K Elevation Derivative Database, EROS Data Center 2002)

In the southwest portion of the Basin, the Chad Formation is composed of three aquifers referred to as the upper, middle and lower aquifers shared by the four countries bordering the Lake Chad (Niger, Chad, Cameroon and Nigeria). The systematic hydro-geological cross section in Figure 3 shows the Chad formation, which these aquifers are contained within and also demonstrates the hydrodynamic linkages with the Lake Chad. The formation is overlain by aeolian sands, fluvial, deltaic and lacustrine deposits approximately 1 to 6 m thick. Most of the fluvial deposits occur along stream valleys which are made up of two units: the old alluvium and the young alluvium (Hammand & Abdou 1982 in Isiorho & Nkereuwem 1996). The old alluvium consists of deposits of old rivers, while the young alluvium contains recent riverbeds and flood plains (Isiorho & Nkereuwem 1996).

The upper aquifer consists of a quaternary phreatic aquifer that is made up of fine-grained sediments approximately 30 m thick, and is hydrologically connected to Lake Chad (Isiorho &

Matisoff 1990). The phreatic aquifer is not continuous all over the basin area, and recharge conditions are poor. Natural recharge occurs primarily by influent seepage from seasonal streams and perennial rivers. The quality of this groundwater is suitable for domestic consumption of the local population and livestock. This aquifer is separated from the underlying middle aquifer by the lower pliocene aquifer found at depths of between 150 and 400 m, and is approximately 200 m of clay-rich sediment (Kindler et al. 1990). In some parts of the Basin, this aquifer is artesian.

The middle aquifer is a continental terminal aquifer that essentially comprises an alternation of sandstone and clay encountered between 450 and 620 m from the surface, extends from Niger and Nigeria into Cameroon and Chad (Kindler et al. 1990). The suitability of this water for irrigation is debatable because of the cost of abstraction; it is essentially used for domestic water supply to the local population and livestock.

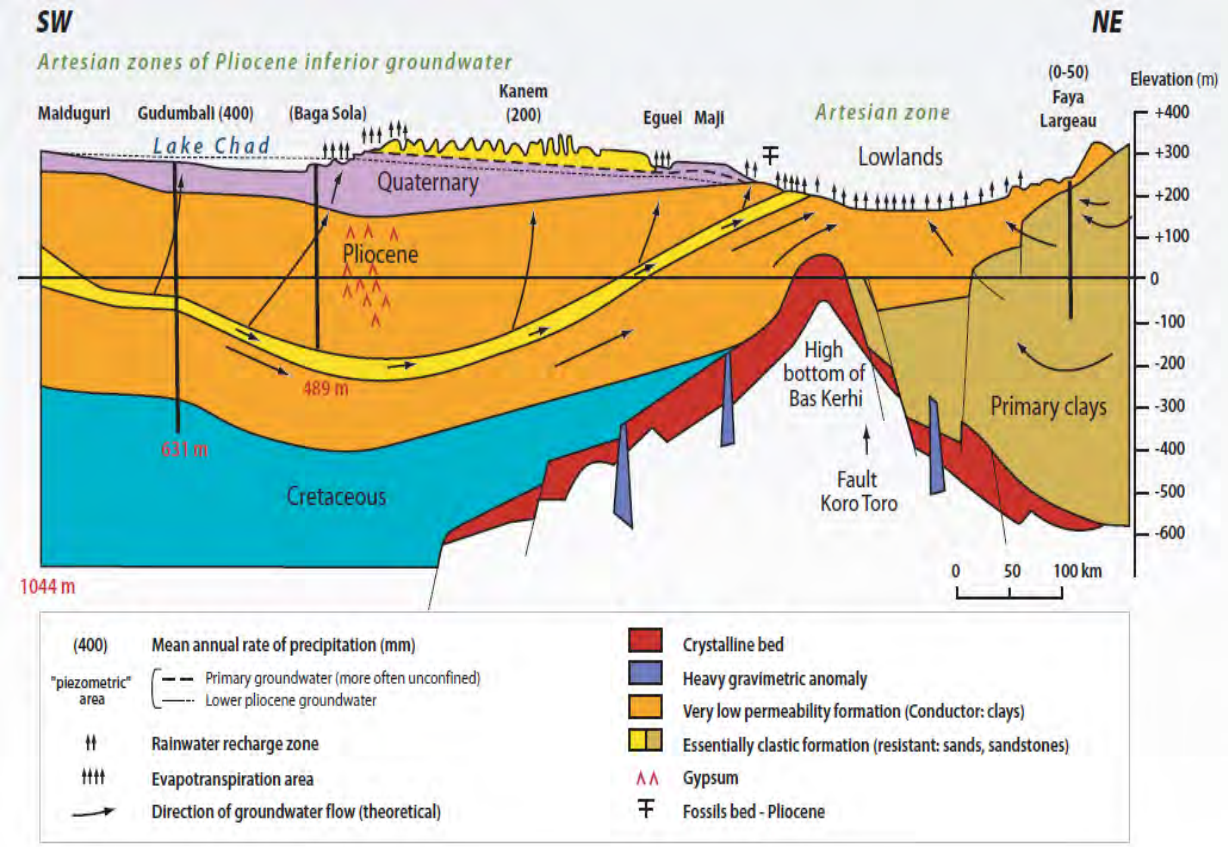

Figure 3.3: Schematic hydro-geological cross section
(**Source**: Redrawn from Schneider 1991)

The lower aquifer is a continental hamadian aquifer that consists of deposited in the cretaceous. There is very little information on this aquifer in the Lake Chad Basin but it is however known to be an important aquifer in the West African region.

3.1.2 Climatic Conditions of Lake Chad Region

The climate of most parts of the region is hot and dry, with rainfall varying between 1 500 mm per year in the southern parts of the region to less than 100 mm in the northern parts of Chad, Libya and Algeria. In the absence of any specific orographic factors, the reduction in rainfall is about 100 mm for each 100 km of distance (Beauvilain 1996).

The Basin is predominantly located in the transition zone between the Sahara desert and savannah grasslands called the Sahel. Rainfall is the single most important factor conditioning the hydrology and the climate in this region. Lake Chad is under the influence of the Inter- Tropical Convergence Zone (ITCZ), which oscillates seasonally between about 15° N and 15° S (Nieuwolf 1977 in Le Barbé & Lebel 1997). North of the ITCZ, high pressure originating from the Sahara prevents rainfall, except during the Boreal winter when occasionally cold air descends from the north. Rain therefore only occurs over the region after the ITCZ has moved past this area towards the north (Le Barbé & Lebel 1997).

Figure 3.4: Annual Rainfall Distribution
(**Source**: ESRI 1996)

From April to October, rainfall occurs but is generally heaviest in August, corresponding with the maximum northward extent of the ITCZ, followed by July and then September. About 90% of the rain falls from June to September (Le Barbé & Lebel 1997). The movement of the ITCZ northern edge is not regular, which often causes the erratic start of the rainy season. Even when the rainy season is well established sudden retreats southward of the ITCZ are not uncommon. Figure 3.4 shows the average annual distribution of rainfall in Chad (1932-1999). Low-rainfall regions are usually also variable-rainfall regions. On the dry, northeast side of Lake Chad, at the town of Bol, rainfall from 1954 to 1972 ranged from 125 to 565 mm per year, averaging 315 mm (USGS 2001).

Annual average rainfall varies from about 500 mm along the southern margins of the actual lake to less than 200 mm near the northern end (Hughes & Hughes 1992). Although rainfall is greatest in July and August the Lake suddenly rises in September. This can be attributed to the fact that rivers provide almost all water supplied to the Lake, so there is a time lag between rain falling in the watershed and reaching the Lake (Holz et al. 1984). Highest lake levels are correspondingly found in December, tapering off slowly for several months (USGS 2001).

The July +30°C isotherm runs across the region. Temperatures are as high as 35-40°C particularly in the northern parts of the region. During the dry season lasting from November to March the basin area is dominated by the Saharan northeasterly winds called the Harmattan.The Lake Chad Basin has a history of drought episodes and in the past 40 years there have been a series of severe drought events. From the middle of the 1960s, rainfall started to drop intermittently but relentlessly until the big drought of 1972-1974. There was then a second occurrence of drought in 1983 and 1984. These droughts have consequently compromised freshwater inputs to the region.

3.1.3 Major Climatic Zones

According to the UNEP/GRID and UEA/CRU Global Humidity Index (Deichmann & Eklundh 1991) based on a ratio of annual precipitation and potential evapotranspiration (P/PET), the climate of the Lake Chad Basin can be divided broadly into five zones:

(i) Hyper-arid zone where P/PET < 0.05

(ii) Arid zone where 0.05 <= P/PET < 0.2

(iii) Semi-arid zone where 0.2 <= P/PET < 0.5

(iv) Dry sub-humid zone where 0.5 <= P/PET < 0.65

(v) Humid zone where 0.65 <= P/PET

The geographic distribution of these climatic zones is illustrated on Figure 3.5.

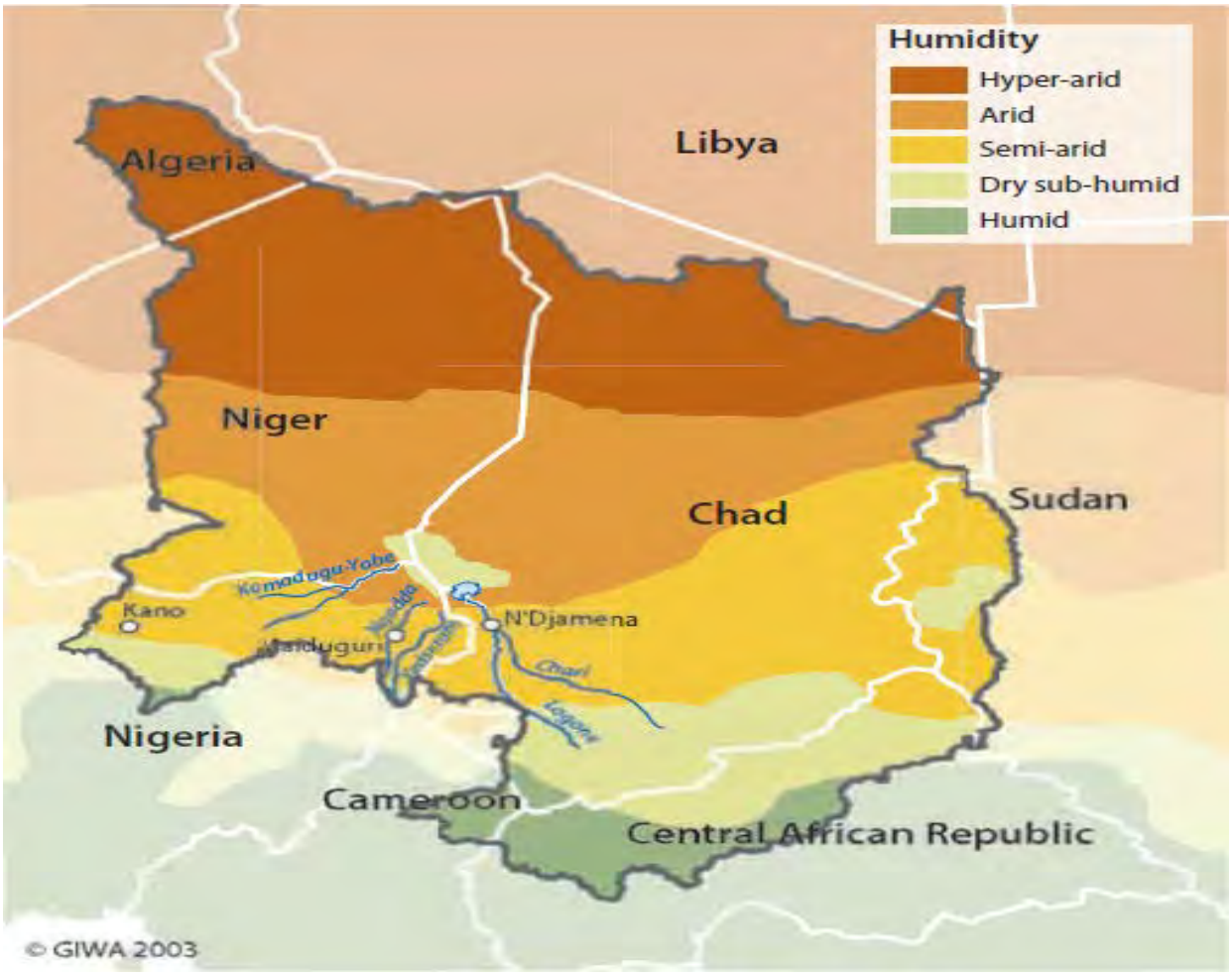

Figure 3.5: The five main climatic zones found in the Lake Chad region
(**Source**: Deichmann & Eklund 1991)

3.1.4 Lake Chad Profile

Lake Chad is a terminal depression with the eight basin countries grouped around it, of which four are in direct contact with the Lake: Nigeria, Niger, Chad and Cameroon. The Lake occupies less than one percent of the drainage basin (Coe & Foley 2001). It is extremely shallow, with a mean depth of 4 m (Carmouze & Lemoalle 1983). Because of its shallow nature, any increase in lake volume resulting from precipitation and outflows result in a substantial increase in lake area and

shoreline. The lake is extremely dynamic, constantly changing size shape and depth and which occurs annually and over decades and centuries. Modern Lake Chad is said to be a remnant of the mega or greater Chad phase (300, 000 – 400, 000 km^2) that occurred about 10, 000 – 5, 000 years ago (UNEP GIWA, 2004; FAO, 2004). Paleo-environmental evidence has shown that the lake dried pout completely around year 1450, 1550 1750, 1850, and 1900 (Holz *et al.,* 1984).

3.1.5 Hydrology of the Lake Chad Basin

The Lake Chad basin is drained by three main river subsystems-the Chari-Logone, the Komadugu-Yobe and the Yedseram/Ngadda (UNEP GIWA, 2004). These drainage systems are shown in Figure 3.6.

The Chari-Logone river subsystem, with a basin area of about 650 0000 km2 and rising from the Cameroon Mountains, contributes over 95 percent of the Lake Chad Basin water. This river system which is about 1 400 in length, has a single annual flood regime occurring at the end of the rainy season, and lasting from August to September (Froese and Pauly, 2003). It feeds the extensive Waza-Logone floodplains (about 8 000 km^2) and the Yaeres in Cameroon. Flood water from the Chari-Logone flows into the lake at its southern extreme and usually takes one or two months to reach the southwest shores. A number of minor tributaries such as the Pende, Vina, El-Beid and Mbere feed the Chari-Logone subsystem. The Maga dam is a major reservoir built on the Chari – Logone system.

The Komadugu-Yobe subsystem has a basin area of about 1 400 km^2 (World Bank, 2002a) but contributes less than 2.5 percent of the total inflow into the Lake Chad. The subsystem, which forms the border between Nigeria and Niger over the last 60 km, is the only perennial river that flows into the northern pool of the Lake Chad. The Jamaáre River which rises from the Jos Plateau and the Hadejia River which flows from around Kano are the major tributaries of the Komadugu-Yobe River system and are the two principal rivers that feeds the Hadejia-Nguru wetlands (about 6,000 km^2) in Nigeria. Peak flows to the wetlands occur in August resulting in extensive shallow flooding.

Like the Waza-logone floodplain, the Hadejia-Nguru wetlands is a major economic hob for pastoralists, fishing, flooded rice production, flood recession farming and a major source of non-

timber and fuel wood resources. The Hadejia River has three major dams built across it- Tiga (1 400 million m^3 reservoir; Challawa Gorge, 972 million m^3; and Hadejia, 1 200 million m^3). A major dam (Kafin zaki, 2 700 million m^3) has been planned for the Jama'are River but construction has not commenced because of lack of funds.

Figure 3.6: Main Rivers in the Lake Chad Basin
(**Source**: UNEP-GIWA Report No.43)

The third major drainage system, the Yedseram/Ngadda river subsystem consists of the Yedseram and the Ngadda rivers- the former rising from the Mandara Hills in Cameroon and the former from Northern Nigeria. The Ngadda river contains the Alau lake located downstream of Maiduguri town in Nigeria.

Decadal variation in the hydrological status of the lake is shown in Figure 7. Clearly, there has been a significant reduction in lake area over the years, leading to what is now popularly known as the **'**shrinking Lake Chad**'**. Water loss from the lake is principally through evaporation and minor

marginal leaks. Lake Chad, like Lakes is principally through evoperation and minor marginal leaks. Lake Chad, like Lakes Malawi and Tanganyika in East Africa, is endorheic – no outlet (Beadle, 1981; Chouret and Lemoalle, 1975). In general, the hydrological regime of the lake is determined, in the main, by prevailing climatic factors, but man's activities such as irrigation and dam construction also make important contributions to the shrinking or drying of the Lake Chad. The argument of Coe and Foley (2001 cited on page 58, UNEP GIWA 2004), that overgrazing has a 'domino effect' on the shrinking of the lake is difficult to substantiate.

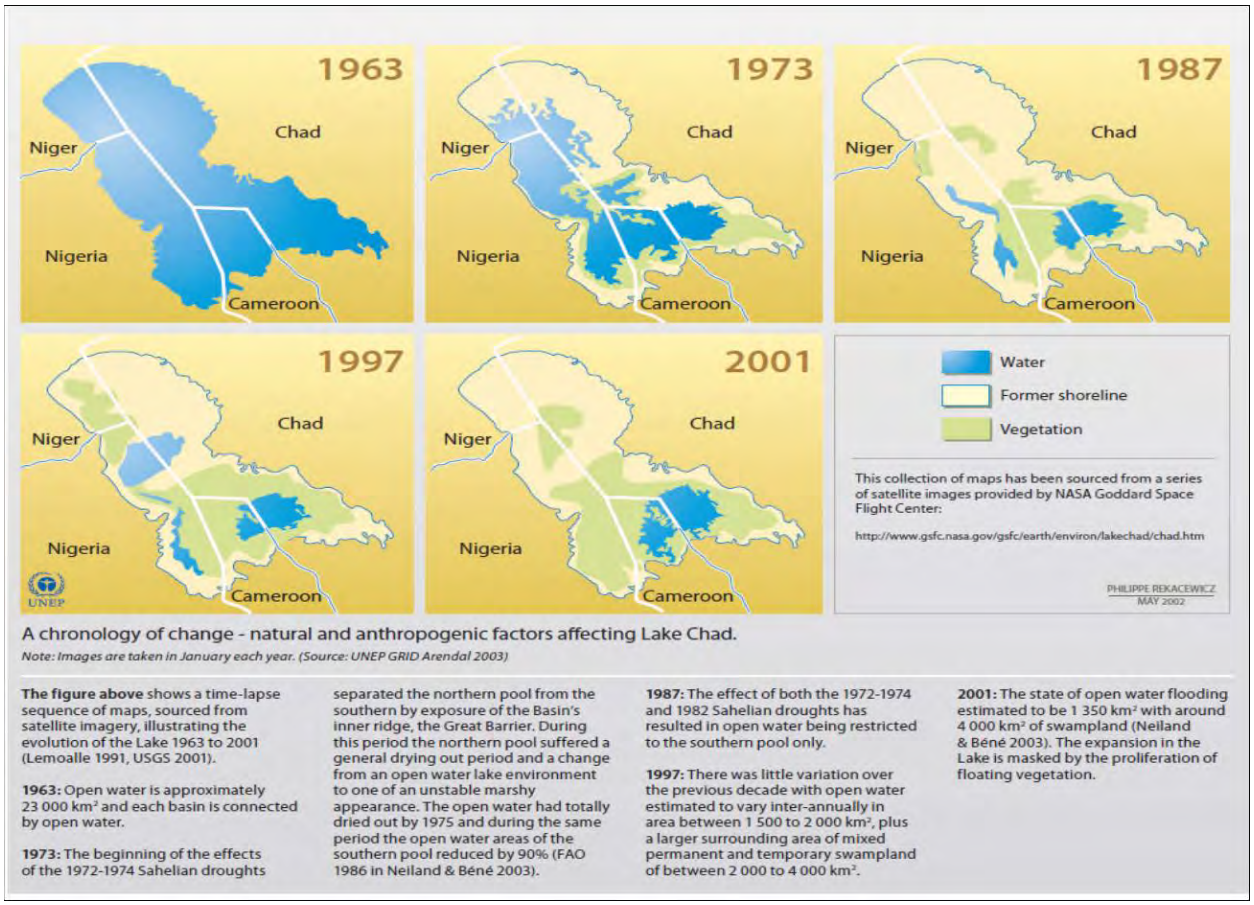

Figure 3.7: Chronology of Lake Chad variability
(**Source**: UNEP GRID Arendal, 2003 in Ovie, 2012)

Figure 3.7 above shows a time-lapse sequence of maps, sourced from satellite imagery, illustrating the evolution of the Lake 1963 to 2001 (Lemoalle 1991, USGS 2001). 1963: Open water is approximately 23 000 km2 and each basin is connected by open water. 1973: The beginning of the effects of the 1972-1974 Sahelian droughts separated the northern pool from the southern by

exposure of the Basin's inner ridge, the Great Barrier. During this period the northern pool suffered a general drying out period and a change from an open water lake environment to one of an unstable marshy appearance. The open water had totally dried out by 1975 and during the same period the open water areas of the southern pool reduced by 90% (FAO 1986 in Neiland & Béné 2003). 1987: The effect of both the 1972-1974 and 1982 Sahelian droughts have resulted in open water being restricted to the southern pool only. 1997: There was little variation over the previous decade with open water estimated to vary inter-annually in area between 1 500 to 2 000 km2, plus a larger surrounding area of mixed permanent and temporary swampland of between 2 000 to 4 000 km2. 2001: The state of open water flooding estimated to be 1 350 km2 with around 4 000 km2 of swampland (Neiland & Béné 2003). The expansion in the Lake is masked by the proliferation o floating vegetation.

3.1.6 Categories of the Lake Chad Basin

Based on its historical hydrological status, the lake has been categorized by various workers into three main phases- Greater or Mega Chad (over 300, 000-400, 000 km^2); Normal Chad (18, 000 – 25, 000 km^2) and Small or Lesser Chad (2000 – 9000 km^2) (Tilho, 1928; Roche, 1973; Beadle, 1981). Not much is known of the Greater Chad, but it is believed that the lake had its largest hydrology at this period, about 10, 000-5000 years ago (UNEP GIWA, 2004) while the Normal and Lesser Chad occurred in the early 1960s and late 1970s, respectivesly (Servant and Servant, 1970; 1973). According to Neiland *et al*. (2005), the lake covered an area of 23, 000 km^2 in 1960 (the normal Chad) and by 1975, the lake had decreased by about 30 percent due to the Sahelian drought of 1972 and 1974.

During the 1970s and 1980s, the hydrology of the lake was further stressed due to dam construction on major effluent rivers as described above. Important dams built for irrigation at this period included the Maga Dam (SAMRY project) on the Logone in Cameroon and Hadejia-Jama'are River/Taga/Challawa Dam construction in the Yobe Basin in Nigeria. In addition, the SODELAC polder irrigation project on the eastern shores of the lake in Chad encroached on important wetlands that were drained and are no longer flooded (Ladu *et al*. 1999; Neiland *et al.* 2005). These human interventions led to the loss of an estimated 200 000 ha of floodplain areas along the lakeshores and rivers, areas that were critical for fish breeding and nursery. The Sahelian drought in 1982 – 84 reduced the water flows even further and by 1990, the Lake Chad covered

less than 2000 km^2 the smallest area this century (Lesser Chad). In addition to this open water area, a swampland covered an estimated 4 000 km^2.

A slight increase in the discharge of the effluent rivers in 1998 increases the floodplain areas and by 2000, it was reported that the Northern Basin had started to experience some flooding. However, the lake continues to remain in the Lesser Chad hydrological condition. A typical annual seasonal variation in level of the lake and that of the River Chari (one of the main inflow rivers) is shown in Figure 8. In the river, water level rose very fast during the rainy season from July, peaked in September/October and thereafter decreased very rapidly also. Lake level peaked slightly later due to the time of arrival of the flood from the river to the lake, and because of its flat nature, lake level rise is not too apparent.

During the Greater Chad period, the 'great barrier' that divides the lake into the Northern and Southern basins was completely inundated making navigation possible on the entire lake. During the Normal and Lesser Chad phases, the barrier obstructs navigation between the two parts of the lake. The Lesser Chad was principally attributed to the drought of 1973, and by the end of 1975 the Northern basin was completely dry while the Southern basin was reduced to a remnant fed directly by the reduced annual flood from Chari River. Highly reduced water level followed by rapid emergence of vegetation caused a dam of vegetation on the great barrier.

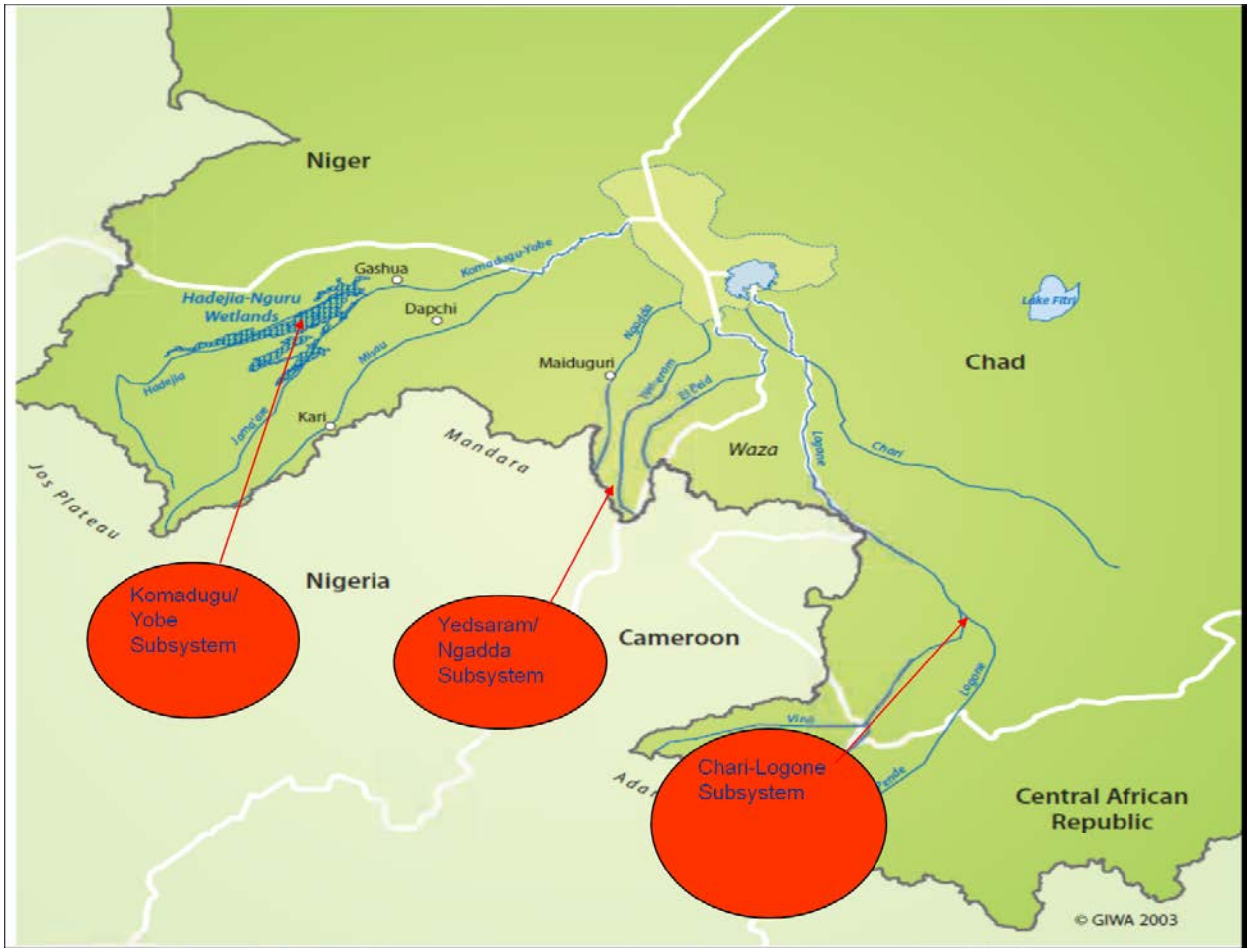

Figure 3.8: Typical Annual Hydrological Cycle of the Lake Chad Basin
(**Source**: Beadle, 1981 in Ovie, 2012)

3.1.7 Socio-Economic Profiles of Lake Chad Basin

Cameroon, Chad, Niger, Nigeria, CAR, Algeria, Libya and the Sudan are the main countries in the LCB, although at the moment CAR Sudan and Libya are far away from the lake and therefore exploit very little of the basin's fisheries and other aquatic resources. Presently, only the first four countries are in direct contact with the Lake Chad. The LCB countries are among the poorest in the world as exemplified by the Human development index (HDI) and the percent of people living below the poverty line of less than 1 or 2 US$ a day. For example, Chad was ranked 155th out of 162 countries on the UN HDI with an annual per capita income of only 200 US$. The Gross National incomes (GNI) of the countries are extremely low except for Algeria and Libya.

Over the centuries the people of this part of Central and West Africa have eked out a living through exploitation of land and its viable resources. Water bodies in the region have not only provided domestic services but have additionally provided access for the people to its aquatic resources such as fish. As droughts and expansion of the Sahel continued, so also has the southward migration mainly of people searching for fundamentals of survival for themselves and for their domesticated animals. The trend has not spared the natural resources from degradation through overexploitation. Drainage systems have been the centre of refuge and at the same time the victim of degradation (Le Barbé & Lebel 1997). Aspects of this nature transcends national borders and in themselves also promote inter ethnic, sectorial and national conflicts. Against this backdrop, it becomes clearer why human settlements are concentrated in the southern parts of the region and not the northern. It also explains why economic developments are centered in these densely settled areas.

The quality of socio-economic data is limited by the fact that data and socio-economic research is country specific rather than basin wide. Regional disparities within the countries must therefore be taken into account. For example Niamey, the capital of Niger, is outside of the Lake Chad Basin but clearly stands apart from other regions in Niger with a higher quality of living, where as Zinder (Niger) is located in the Lake Chad Basin and has the greatest deficit in terms of its peoples poverty and vulnerability, according to infant mortality and child malnutrition indicators (Government of Niger 2002).

3.1.8 Social and Cultural Aspects

According to Kindler et al. (1990), the Basin exhibits a socio-historical unity based on a history shared by the established population groups some of which straddle national boundaries. Many trading circuits remain controlled by the groups who have long considered them their specialty (e.g. the Hausa and Kanuri). There are numerous ethnic groups present in the Lake Chad Basin, many of which are present in several countries; altogether, there are more than 70 ethnic groups, each exploiting the natural environment by a range of activities. The majority of the populations speak several local and an official language. The main languages used in the area reflect the political roles exercised during the pre-colonial period: Kanuri (Niger and Nigeria), Fulfulde (Niger, Nigeria, Cameroon), and Arabic (Chad). These include a very diverse range of ethno-

linguistic groups; in Nigeria alone there are 394 linguistic units (Otite 1990). The French and English colonial powers have also imposed their languages, and legal and administrative systems, upon the traditional ones; customary laws, regulations, and structures still determine land use systems in large measure.

The old Islamicised states (Kanem, Borno, the Peul Empire of Sokoto, Wadai and Baguirmi) are largely responsible for the present distribution of populations in the Basin, including the small groups that took refuge in the Mandara Mountains and the Mayo Kebbi regions. The Western shore of Lake Chad, where the majority of the Basin's population resides, is under the jurisdiction of Borno (one of the 36 states of Federal Republic of Nigeria) and is dominated by the Kanuri ethnic group.

Migration during the latter part of the millennium has brought Shuwa Arabs from the east and Fulani pastoralists from the west and recently during the 1970s Hausa families from across northern Nigeria who was attracted by fishing opportunities at the Lake (Neiland & Verinumbe 1990, Sarch 2001). Most of the countries of the Lake Chad Basin have experienced considerable political instability and a history of domestic and international conflict since 1960 when they gained their independence from the colonial regimes of the United Kingdom and France. Nigeria has had 11 changes of government, military coups and a civil war, Chad has experienced almost continuous unrest and war, and only Cameroon has had a stable government (Neiland & Béné 2003). Outbreaks of armed clashes and rebel activity on islands in the Lake have persisted since the 1970s and are largely associated with the succession of civil wars in the Republic of Chad and the migration of Nigerian fishermen following the receding lake south eastwards. A multi-national 'Joint Patrol' was created in response to these outbreaks and has been monitoring the Lake to prevent further violence (Sarch 2001).

3.1.9 Population Dynamics

Over the last two decades the annual population growth in the region has ranged between 2.5 and 3.0% (World Bank 2002c). The current population within the region is estimated to be approximately 37.2 million people (based on ORNL 2003). The total population has increased by about 11.7 million since 1990 (population estimates for 1990 was 25.5 million people (UNEP

1999). Figure 3.9 shows how the Basin's population is unevenly distributed between the countries. Nigeria, Africa's most populous country hosts an estimated 22 million people (about 59%) of the total population living in the region. Whereas the northern and eastern peripheral countries, Algeria, Libya and Sudan, only have approximately 2.7 million inhabitants in the Basin (about 7%), as it only represents just over 6% of the land area of the Basin (EROS Data Center 2002).

Population densities are greatest in Nigeria and surrounding Lake Chad and decreases in the more arid Northern provinces. For example in the Tibesti Highlands the people are primarily nomadic pastoralists, and population densities are as low as 0-1 people/km2. Figure 3.10 shows the population density distribution in the region. The region is also experiencing rapid urbanization, as destitute rural communities search for an improved standard of living in the swelling southern cities such as Kano (Nigeria), Maiduguri (Nigeria) and N'Djamena (Chad). In Cameroon the population of the northern city of Garoua has more than doubled from 122 600 to 287 000 between 1987 and 2003 (World Gazetteer 2003).

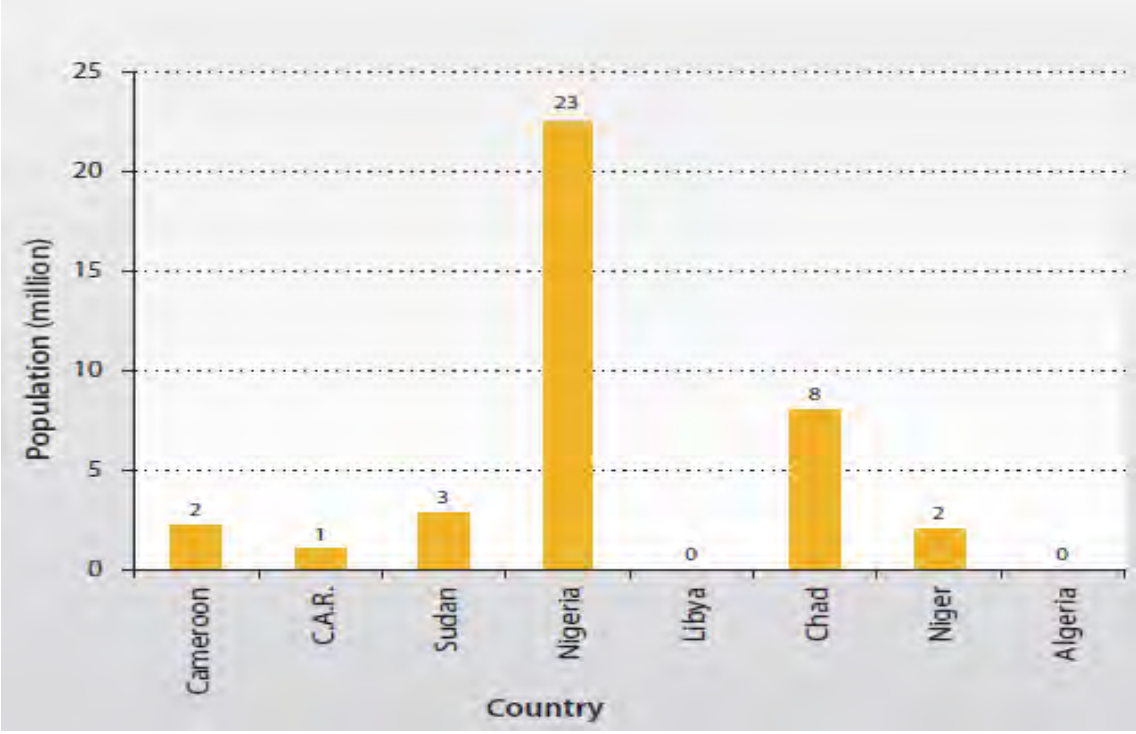

Figure 3.9: Estimated Population of Lake Chad Basin
(**Source**: ORNL, 2003)

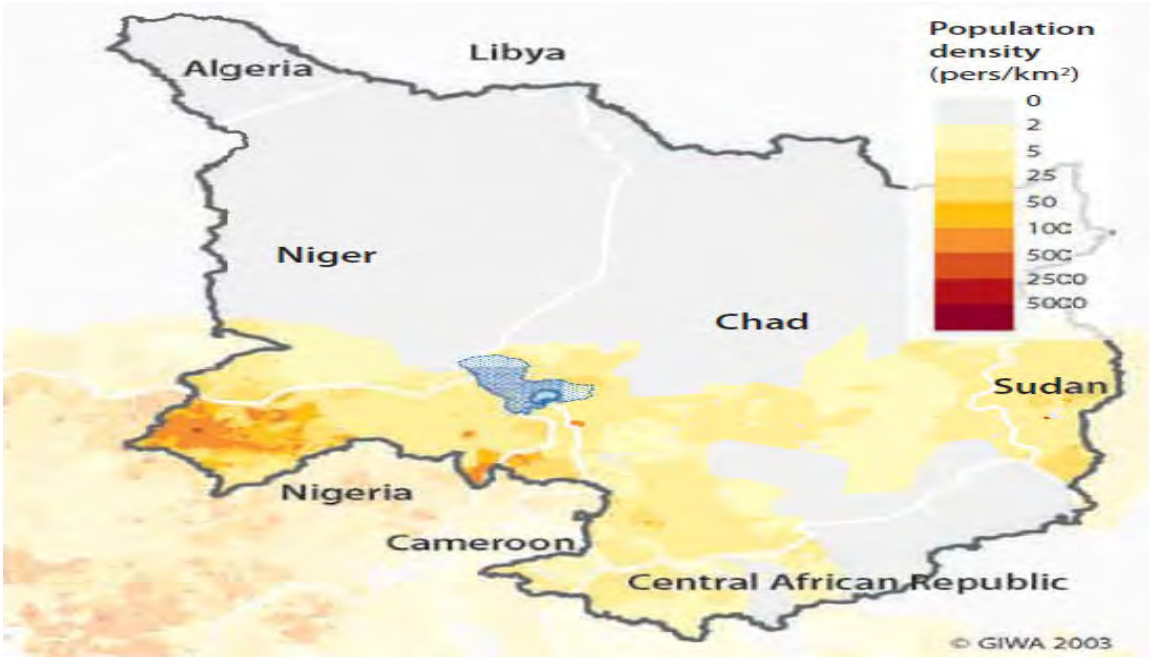

Figure 3.10: Population Density
(**Source**: ORNL, 2003)

3.1.10 Characteristics of the Basin's Population

The Basin's population is characterised by a young age structure, particularly in the southern riparian countries. In Niger for example nearly 50% of the population is under 15 and only 2% is over 65 (World Bank 2002c). The riparian countries of Sudan, Libya and Algeria, located on the periphery of the northern, northwest and northeast borders of the Basin have a larger proportion of over 65 year olds and their population structure is less skewed towards the young. Figure 3.11 shows the population age structures for the countries of the Basin. The Basin's population is also predominately rural. In Chad (46% of the Basin's surface area) approximately 80% of the population is rural (IMF 2003).

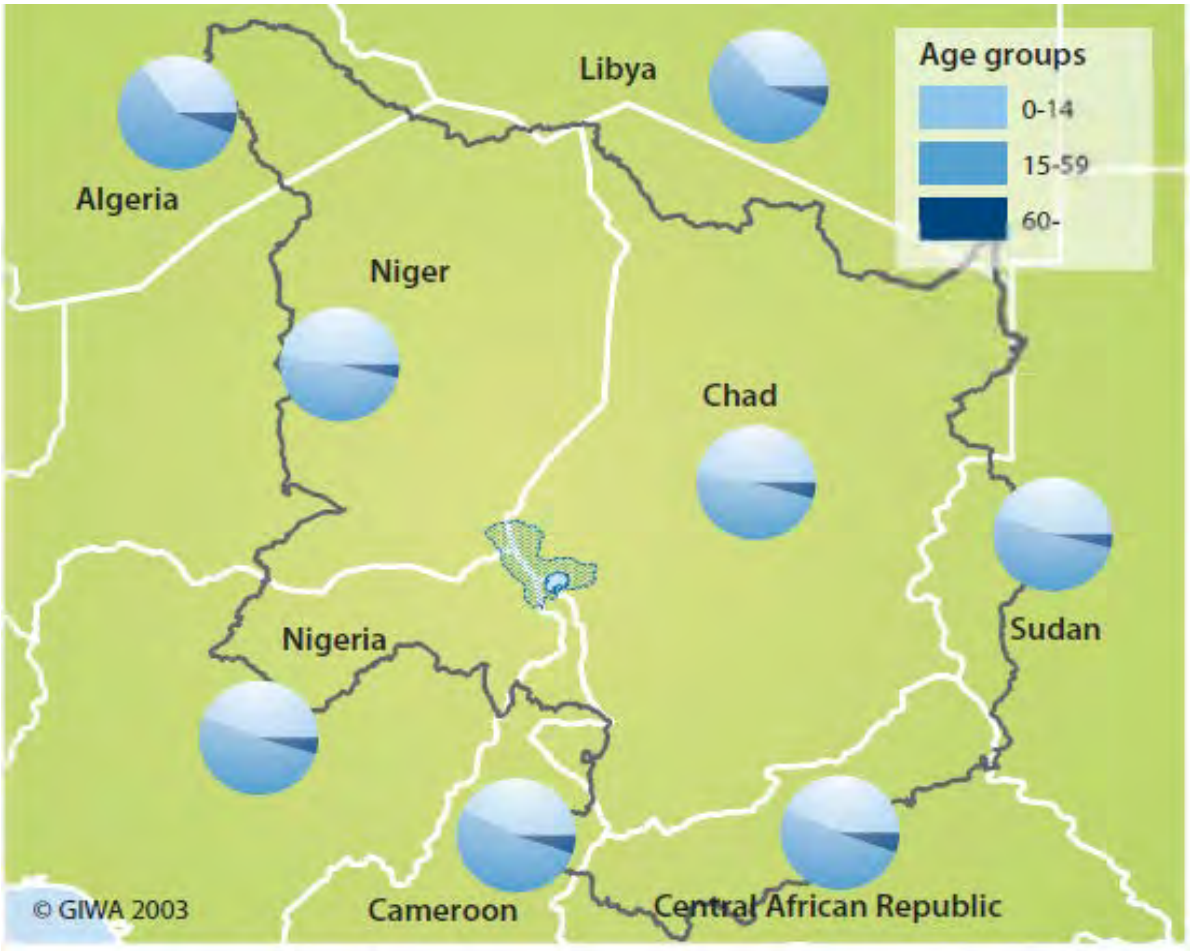

Figure 3.11: Population Structure in the Lake Chad Region
(**Source**: ESRI 2000)

3.1.11 Economic Activities

In the Lake Chad Basin production activities are dominated by the primary sector and tertiary sectors in which technical progress is slow, with a predominance of informal, low productivity activities. In Chad and Niger those working in the primary sector head the poorest households because they make up 78% and 80% respectively of the population but account for only 39% of the GDP (World Bank 2002c, IMF 2003). The primary sector employs more than 80% of the population and comprises primarily of agriculture and livestock rearing (Government of Niger 2002). Table 3.1: shows the regions sources of income.

Table 3.1: Sources of Household's Income at Lake Chad Basins Region

Activity	million USD (billion CFA *)
Fishing	45.1 (26.3)
Rain-fed and flood recessional cropping	26.6 (15.5)
Animal husbandry	14.7 (8.6)
Small irrigated areas	10.8 (6.3)
Large irrigated areas	9.4 (5.5)

**CFA=Franc de la Communauté financière africaine.*
(**Source**: Nami 2002)

The economic activities in the Basin include:

(i) Mining: e.g. Gold mining in Central African Republic.

(ii) Oil: Exploration and exploitation.

(iii) Agriculture: Cotton, groundnuts, cassava, millet, sorghum, rice, onions. Mixed cropping is widely practiced.

(iv) Fisheries: In dams, rivers, floodplains and the Lake Chad.

(v) Manufacturing: Cotton ginning, brewing, leather industry, machinery, milling and food industry.

Generally, the Lake Chad region is relatively less industrialized, however the commencement of oil exploitation in southern Chad may trigger industrial development. The number and sizes of industries also differ per country, but generally, there are few industries compared for example with the rest of West Africa. Agro-industries, textiles and tanneries dominate, whereas heavy industries are relatively few (World Bank 2002b). The majority of industry is focused in the urban areas that are disproportionately distributed with the highest concentrations in northern Nigeria and Cameroon, whilst the lowest are in Chad, CAR and Niger.

3.1.12 Economic Growth

The countries within the region are among the poorest countries in the world. Chad was ranked 184th out of 162 countries on the United Nations' UNDP, Human Development Index (HDI), 2014 The Gross National Incomes (GNI) of the countries is extremely low with the exception being Algeria (no data for Libya). Out of 206 countries ranked by the World Bank in terms of GNI per capita; Chad, Niger, CAR and Nigeria are amongst the 23 poorest countries in the world (World Bank 2002c). Figure 3.12 shows the disparities in GNI between the riparian countries.Economic growth is very slow and variable in the region.

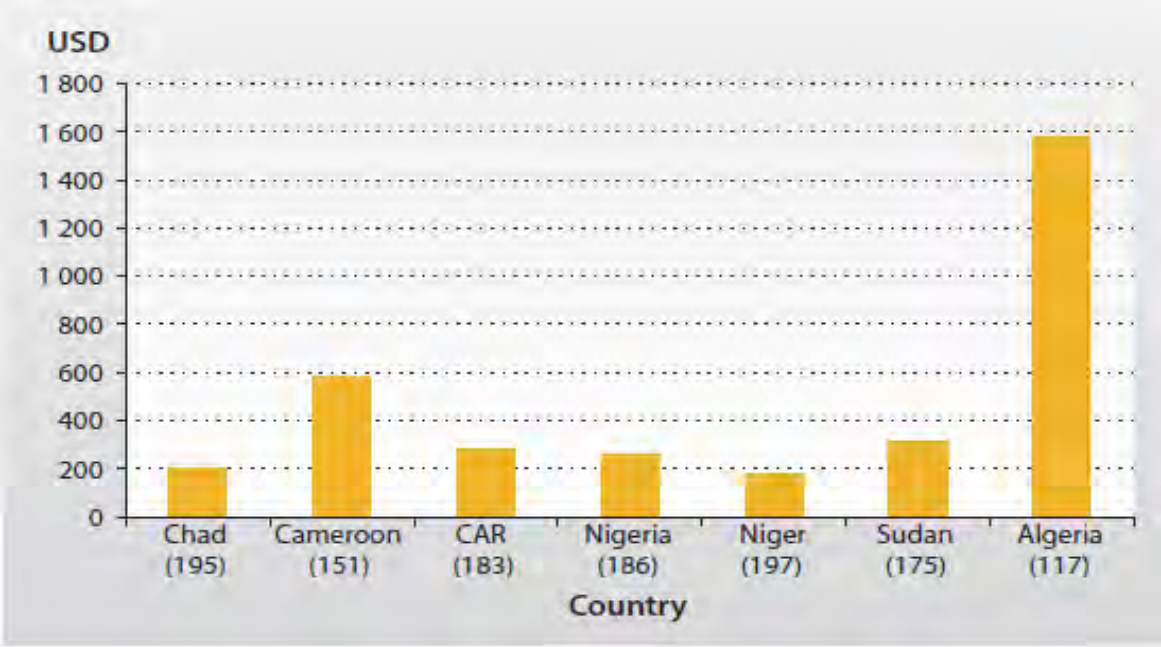

Figure 3.12: Gross National Income Per Capita of Riparian Countries
Note: No data for Libya. Within parenthesis: GNI ranking by the World Bank.
(**Source**: World Bank 2002c)

3.1.13 Water Supply and Use

Water uses in the Lake Chad Basin include domestic, industrial, agricultural (flood cropping and small-scale irrigation), large irrigation projects (e.g. Kano River Irrigation Project), livestock, fisheries and ecological. The majority of freshwater consumed in the region is used for agriculture followed by domestic use. The unindustrialized nature of the region results in very little water being used for industrial processes. In Africa, Nigeria is the sixth largest user of water by volume

(4 billion m^3) (Revenga & Cassar 2002). Figure 3.13 shows the percentage water consumption by sector.

Water for domestic use is mainly obtained using traditional methods. In the Sudan sector of the Basin (West Darfur) over 50 % of water is obtained from dug wells with bucket collection (World Bank 2003a). Women have to travel great distances in order to gather water for drinking, cooking and other everyday activities. The Tiga and Challawa Gorge dams through the Kano City Water Supply (KCWS) supply the large Nigerian urban centre of Kano City for domestic and industrial purposes.Access to safe drinking water in the Basin is very limited. The percentage of people living in rural areas with access to an improved source of water in 2000 ranges from 26% in Chad to 56 % in Niger, excluding Algeria Libya and Sudan (access is above 68%) (World Bank 2002c).

In the Niger sector of the Lake Chad Basin (Agadez, Diffa and Zinder Departments), modern water points only cover 53 % of the population's needs. Water shortages are a regular occurrence in this sector of Niger, because of lack of available supplies and the condition of infrastructure (Government of Niger 2002). Traditional agriculture in the Basin is predominantly rain-fed. The rivers in the Chari-Logone and Komadugu-Yobe sub-systems support flood farming and recessional farming. Farmers in downstream areas therefore depend largely on river flow because rainfall is low and variable. The many large irrigation projects are located predominantly in the Komadugu-Yobe Basin.

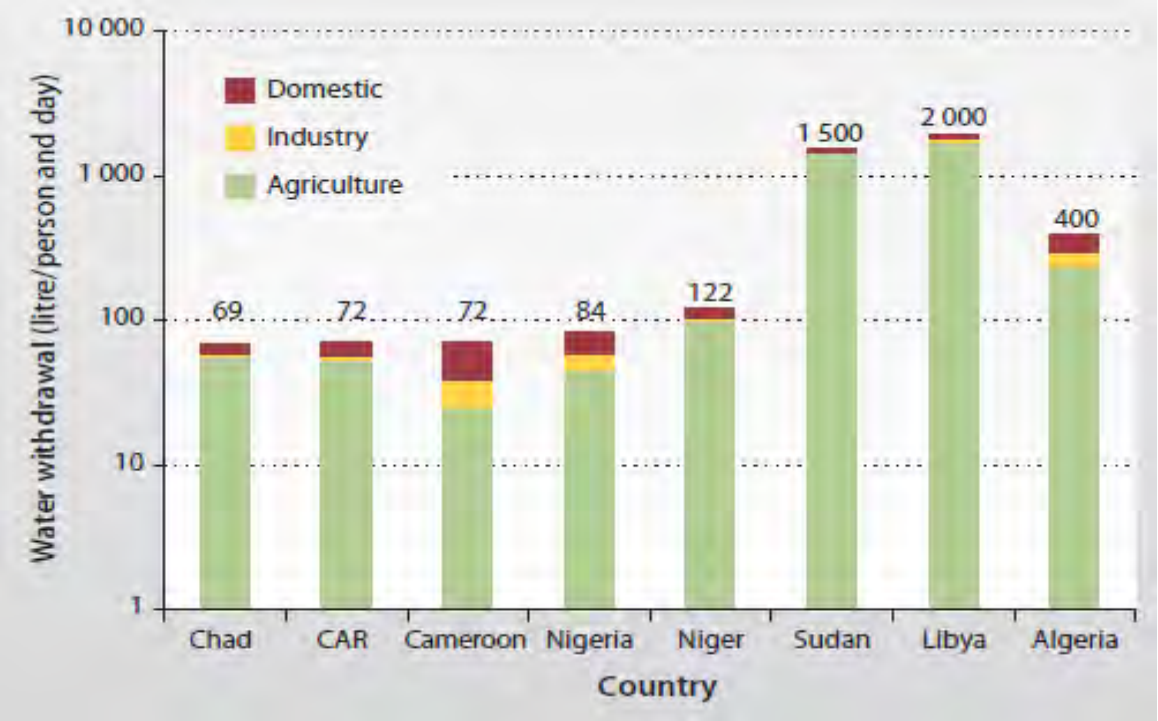

Figure 3.13: Freshwater Withdrawal Per Person Per Day by Economic Sector
(**Source**: World Bank 2002c)

3.1.14 Sanitation

Sanitary conditions for rural dwellers are particularly poor with severely limited waste disposal facilities. For example in Niger, the rural sanitation rate was barely 5% in 1996 and has been steadily declining, with the development of disease vectors in swamps and irrigation facilities and the deterioration of drinking water quality as a result of improper transportation and conservation (Government of Niger 2002).

In Chad no town has a functioning wastewater treatment system and collection networks are dilapidated. Less than 2% of the inhabitants of towns and cities have lavatories with running water while lavatories are practically nonexistent in rural areas. As a result, the poor are frequently exposed to chronic diseases related to poor living conditions and lack of access to water and sanitation. Moreover, water-related chores (which take up to four to five hours a day in certain areas) may, among other things, shorten the time spent on more productive and fulfilling activities (IMF 2003). In the Sudan sector of the Basin (West Darfur), over 50% of the population does not

have access to any type of toilet facility, and 42% use a traditional pit. There are no sewage systems (World Bank 2003).

3.1.15 Infrastructure Related to Water

In the last 40 years there has been considerable development of dam infrastructure in the region which has impounded a large proportion of the Lake Chad Basin's water resources. In northern Cameroon, the 30 km earthen Maga Dam was constructed on the upper part of the Waza-Logone floodplain in 1979 to provide water for the SEMRY irrigated rice scheme and for fish farming (LCBC 1998). The Lake Chad supplied freshwater to Nigeria's South Chad Irrigation Project (SCIP), which had a goal of irrigating 67 000 ha of cultivated land, and Baga Polder Project, which had a goal of 20 000 ha. However, by 1996 only 2 200 ha and 1 000 ha were under irrigation respectively and presently they are both not functioning. The Kano River Irrigation project (KRIP), fed by the Tiga Dam (Komadugu-Yobe) was completed in 1974, water is also released from the dam to supply Kano City (Northern Nigeria).

The Challawa Gorge Dam on the Challawa River (Komadugu-Yobe sub-system) was constructed in 1992 to supply water for the Hadejia Valley Irrigation Project and to provide water for Kano City. Work on the Kafin Zaki Dam on the Jama'are River has been stopped and started many times, and its future is presently unclear. Table 3 shows technical details of the major dams in the Lake Chad Basin.

Table 3.2: Technical details on major dams in the Lake Chad Basin

Details of major dams and reservoirs		Tiga Dam 1974-1991	Tiga Dam 1992	Challawa Gorge Dam 1992	Maga Dam
Storage capacity (million m^3)		1 989	1 429	972	680
Active capacity (million m^3)		1 843	1 283	904	ND
Dead storage (million m^3)		ND	146	68	280
Maximum release capacity (m^3/s)		ND	25[1] / 60[2]	86	50
Catchment area (km^2)		ND	6 641	3 859	6 000
Average annual evaporation (m)		ND	2.14	2.31	ND
Average (1964–1985) annual inflow (million m^3)		ND	914	476	ND
Surface area (km^2)	At 100% storage	180	145	100	400
	At 75% storage	ND	117	80	ND
	At 50% storage	ND	85	60	ND
	At 25% storage	ND	52	35	ND
Annual evaporation losses (million m^3)	At 100% storage	385	310	231	ND
	At 75% storage	ND	250	185	ND
	At 50% storage	ND	182	139	ND
	At 25% storage	ND	111	81	ND
Evaporation losses/ average inflow (%)	At 100% storage	42	34	49	ND
	At 75% storage	ND	27	39	ND

(**Source**: IUCN 1998, Attewill & Lawrence 2002)
Note: ND=No data. 1Actual maximum capacity of the canal valve is 35 m3/s. 2Kano River release gate not provided with control valve and therefore blocked; two smaller release gates not included.

3.1.16 Fisheries and Fishing at Lake Chad Basin

The inland fisheries of the Lake Chad Basin and in particular Lake Chadare among the largest and most productive in the whole of Africa. An estimated 1.7 milliontonnes of fish annually have been landed, resulting almost entirely from skilled,native fishing operations using relatively unsophisticated techniques (mainly gill nets or longlines from canoes) (Stauch 1977, Durand 1980, Sagua 1986 in Neiland & Béné 2003).

The fishing activities within the Lake Chad Basin are a fundamental element of the livelihoods of over 10 million people living in and around the basin area. The system creates a new set of aquatic environments each year, which dictate the local farming and herding production systems (multiple uses). The sustainability of these systems is a key factor of the economic and social stability of the region. Fish from the Lake Chad Basin is traded within all riparian countries and makes an important contribution to the food security of urban centres (Neiland & Béné 2003).

Research suggests that fish demand is evidently attractive enough to encourage large numbers of fishers (full and part-time), estimated to be more than 170 000, and that the combined trade of riparian countries is worth upwards of 23.5 million USD per year (Neiland & Béné 2003).
Eight different types of fishing grounds are exploited across the Lake Chad Basin. Seasonal ponds and receding channels are the most common type of water bodies used, followed by rivers (Logone and Chari), the open waters of the Lake and the permanent ponds and oxbows. A comparison between areas shows that the Yaéré floodplain offers the largest diversity of exploitable water bodies, followed by the Chari delta and the western shores of the Lake (Neiland & Béné 2003).

The fisheries are largely dictated by the intra-annual flood regime of the Chari-Logone and Komadugu-Yobe sub-systems. Flooding influences the extent of the Lake Chad and its fringing floodplains, as well as the river floodplains. Fish move into the floodplains to feed and to breed, and then retreat with the floods to the main channels and open lake, along well-defined channels and outlets. The seasonal fluctuations in Lake Chad's water level provides excellent feeding grounds for fish through the exposing and submerging of the lake shore. The flooding regime represents an important natural asset, which most households at Lake Chad exploit in one way or another. As the flood peaks and begins to subside, fishers have the option to either fish the area of open water remaining at the centre of the Lake or to fish the pools and channels of residual flood water which remain around the villages (Sarch 2001).

Considerable intra- and inter-annual variation in the flooding of the lake shore means that the supply, i.e. the timing, location and amount of resources such as fishing grounds is important determinant of both the productivity of these resources and which groups are able to access them at a given point in time (Sarch 2001). The main fishing season is from October until March (i.e. from the end of the rainy season until halfway into the dry season) while there is a secondary peak in fishing activity at the very end of the dry season when the open water bodies are at their smallest in size and fish are easily caught.

There are six key Livelihood Groups associated with the fisheries, namely: Fishers, Fish Mongers/Processors, Fish wholesalers, Fish retailers, Fish gear dealers and Boat builders. A total of 20 different types of fishing gear are used in the Basin (Neiland & Béné 2003). Apart from the seine net (taurow) which is owned almost exclusively by the richer families but operate

collectively, allFisher groups, disregarding the area, use the same set of traditional fishing gears, i.e. essentially gill nets, traps (Mali traps or goura), hook-lines, cane trap (ndurutu), cast nets, and dip nets (sakama). The diversity and number of each fishing gear used decline by household poverty level. Investments in fishing inputs such as new fishing gears can generate instantaneous surplus, in contrast to farming activities where several months would have to pass before eventual benefits might be returned from the investment (Béné & Neiland 2003).

The inland waters of the Lake Chad Basin harbour a relatively high fish biodiversity and have at times had abundant quantities of fish. Common fish market species include *Alestes baremoze* (Silversides), *Clarias* (catfish), *Tilapiine cichlids*, *Petrochephalus* and the *Lates niloticus* (Nile perch) (Béné & Neiland 2003).

There have been 21 species of fish identified from Lake Chad that migrate 100 to 150 km up the El Beid and Chari-Logone rivers to the Logomatia marshes to spawn (Bénech & Quensière 1989). Several species, such as *Alestes baremoze*, are known to migrate for breeding over distances up to 650 km from the Lake Chad into the Chari-Logone River as far as Cameroon (Durand 1978).

Under the Baseline Report (de Graaf, 2014) fish production in the four countries that directly share water of the lake is around 100,000 tons / year with a total value of direct sales estimated at $ 220 million and a contribution 0.058% to Regional Gross Domestic Product. The number of fishermen is estimated at more than 200,000 (de Graaf, 2014). However, the estimates in terms of overall employment is much higher because about 2 million people (permanents or migrants), living in a radius of about 100 km, derive their revenues from natural resources of the lake (de Graaf, 2014). An estimate of 13 million people depends on the marketing of main products of the lake (IRD, 2013).

The largest fish market in the Lake Chad Basin is Baga-Kawa in Nigeria,near the lake shore, followed by the much smaller markets of Kinassaramand N´Djamena in Chad and Maroua in Cameroon. The majority of all Lake Chad Basin fish regardless of country or origin is directed into Nigeria, although some fish is retained and traded locally within the Lake Chad Basin. Table 4 shows the market characteristics of fish passingthrough the three main markets.

Table 3.3: Fish Market Characteristics of Main Markets of Lake Chad Basin, June 2000 to May 2001

Country market	Total volume (tonnes/dry weight) (wet weight conversion factor 4.5)	Total wholesale price USD (million)	Unit price per kg of fish products (USD)
Nigeria (Baga Kawa)	10 876 (48 942)	20.8	0.52
Chad (Kinasserom)	343 (1 546)	0.8	0.45
Cameroon (Maroua)	1 518 (6 831)	1.9	0.79
Total	**12 737 (57 319)**	**23.5**	**0.54**

(**Source**: Adapted from Neiland & Béné 2003)

3.2 Senegal River Basin

The Senegal River Basin is named after River Senegal.The River is located between latitude 10°30 and 17°30 north and longitudes 7° and 16°30 west. Its main tributaries are the Bafing, Bakoye and Faleme Rivers, which have their sources in the Fouta Djallon Mountains. The basin covers a total of 300,000 Km². Aside River Senegal which account for 10% of the basin, 11%, 53% and 26% proportions of the basin were contributed by three other West African countries namely: Guinea, Mali, and Mauritania. The Senegal basin is managed by the Organization *pour la Mise en Valeur du Fleuve Sénégal* (Organisation for Senegal River Basin Development OMVS).

3.2.1 Description of the Senegal River Basin

According to Ndao (1999), the basin can be divided into upper, the valley and Delta portions which have different topographic and climatologic contexts:

The Upper Basin stretches from the Futah Jallon heights in Guinea as far as Bakel in Senegal. It ensures almost all the river inflows being relatively humid with annual rainfalls ranging between 700 and 2,000 mm. Rainfalls occur between April and October in the basin's mountainous far southern part and give rise to the river's annual floods which take place between July and October.

The Valley constitutes a 10 to 20 km wide flood zone composed of alluvial plains limited by two semi-desertic regions. It stretches from Bakel to Dagana. This agricultural area is fertilized every year by floods of the river. Under a slight slope, the valley presents a number of meanders which forms a whole system of effluents. When going out of its 200 to 400 m-wide main bed, the effluents fills a number of clay depressions called "oualos" on which traditional flood recession

crops are practiced. The bottom of the main bed is characterized by a number of rock or sand shoals that impede navigation during low water periods and in shallow water sections.

The Delta is located downstream of Dagana and constitutes the terminal part of the river. It includes a number of branches but has a single mouth. During dry seasons, salt water from the Atlantic Ocean used to invade this completely flat and vast zone. In this area, the Senegal River is 400 to 500 m wide and is relatively deep; the influence of tides is rather strong here.

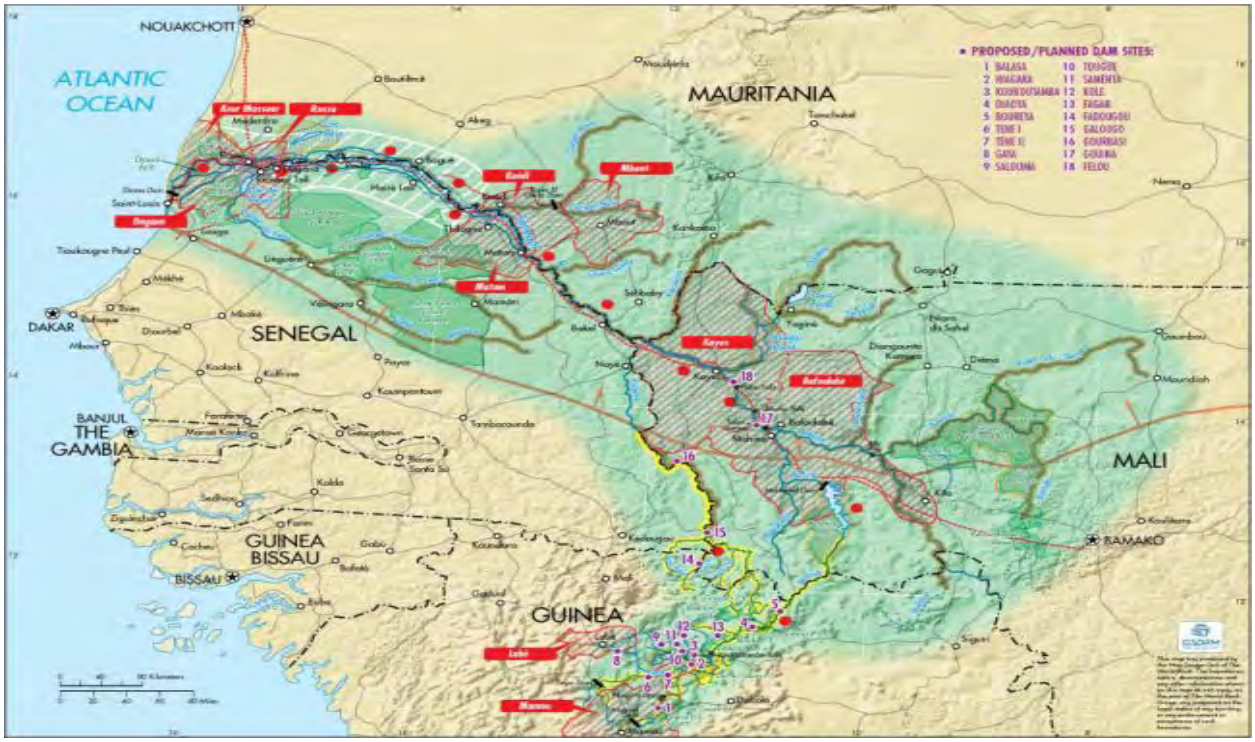

Figure 3.14: Senegal River Basin
Source: UNESCO, 2011

The Senegal River is the second largest river in West Africa. It is formed by the confluence of two smaller rivers, the Bafing and the Bakoye, which occurs near Bafoulabé in Mali, about 1083 km from the Atlantic Ocean. Downstream of Bafoulabé the River flows northwest, crossing the arid lands of western Mali. About 200 km further downstream, the Falémé River gushes into the Senegal River. From this point on the Senegal River forms a natural border between Mauritania and Senegal flowing westwards towards the Atlantic Ocean. All three main tributaries of the Senegal River (the Bafing, Bakoye and Falémé) have their sources in the Fouta Djallon Mountains of Guinea and in the southwestern part of Mali. Several other small tributaries, originating in Mauritania, also discharge into the Senegal River. One of them, the Karakoro River, enters the

Senegal River at more or less the same point as the Falémé River. About 200 km further downstream, the Gorgol River enters the Senegal River. Downstream from Bakel, the River does not have any more important tributaries. The slope of the streambed decreases gradually until the River is essentially flat in the valley and the delta. This area is characterised by a broad flood plain and many depressions supplied by the river flow: Lake Guiers, Lake R'kiz, Three Backwaters and Djoudj. The Senegal River discharges in the Atlantic Ocean downstream from St Louis City.

The Senegal River Basin presents many geological, topographic, climatic and hydrological contrasts due to its extension between latitudes 11° N and 18° N (OMVS, 2002). The eastern and the southeastern parts of the Basin consist of geologic formation from the Precambrian era (Fouta Djallon Mountains), characterised by impermeable rocks such as schists and granites, and clay soils. The topography is undulating and the elevation can exceed 1000 m. To the west, elevations are relatively low and can be below sea level.

The Senegal River flow is controlled by two dams, the Diama and the Manantali. The Diama Dam is located 30 km upstream of the city of St Louis. It was built in 1986 in order to stop the dry season intrusion of seawater along the river bed. In fact during dry years, saltwater could penetrate as far as 100 km inland, which makes the whole delta unsuitable for agriculture use (Gac 1986a & 1986b). The construction of the Diama was supplemented by the damming of the upper left and right bank located between Rosso and Diama.

The second dam, the Manantali, was completed in 1988 and is located in Mali 1 200 km upstream from the Senegal River outlet. Its storage capacity is 12.8 km^3. It was built on the Bafing River, which supplies approximately 60% of the annual flow of the Senegal River in a reservoir (Gac 1986a,b). The major development objectives assigned to the two dams are (SGPRE 1994, OMVS/SOGED 2003):

1. Regulate the River's discharge at a rate of 2 500 m^3/s during the rainy season to allow the traditional flood-recession farming;
2. Regularisation of river flows to 300 m^3/s at Bakel;
3. Irrigate 375 000 ha of former floodplain for two crops per year,especially for rice production;
4. Produce hydropower (800 GWh per year);

5. Provide a 1 500 km transport line network to assure energy delivery to inter-connected networks in the three member states;
6. Make the River navigable all year round between Saint Louis at the river mouth and Ambibédi in Mali (about 900 km).

3.2.2 Climatic Regime of the Senegal Basin

The climatic regime in the Basin can be divided into three seasons: a rainy season from June to September, a cold and dry season from October to February, and a hot and dry season from March to June. Rainfall in the Basin can be as high as about 2 000 mm per year. In the valley and the delta, it is generally low and exceeds rarely more than 500 mm per year (Finger & Teodoru 2003). Flooding can occur during the high flow period between June and October. During this high water period, the River overflows its banks and floods the broad alluvial plain of the middle valley. This has enabled farmers to grow crops during the dry season, after the waters have receded and the low-water period has started. In areas of low rainfall, the River's annual flood is a necessity to life. The flow rate of the River depends mainly upon events in the upper basin in Guinea, which is, hydrologically speaking, the most active part of the Basin. The total annual discharge leaving Guinea is estimated at about 8 km^3, with an increase as a result of the inflow of the different tributaries of up to 20 km^3 by the time the River reaches the meeting point at the juncture of Mali, Mauritania and Senegal (SGPRE 1994). The mean annual discharge and volume of the main tributaries

3.2.3 Physical Characteristics and Hydrology

The Senegal River basin covers a surface area of about 300,000 square kilometres (km^2). The high plateaux in northern Guinea represent 31,000 km^2 (11 percent of the basin), 155,000 km^2 are situated in western Mali (53 percent of the basin), 75,500 km^2 are in southern Mauritania (26 percent of the basin) and 27,500 km^2 are in northern Senegal (10 percent of the basin). The basin has three distinct parts: the upper basin, which is mountainous, the valley (itself divided into high, middle and lower) and the delta, which is a source of biological diversity and wetlands. Topographical, hydrographic and climatic conditions are very different in these three regions and seasonal temperature variations are extensive. The hydrology of the basin is discussed below.

*1. **Rainfall***

The river's flow regime depends, for the most part, on rain that falls in the upper basin in Guinea (about 2,000 mm/year). In the valley and the delta, rainfall is generally low and there is rarely more than 500 mm/year. During the 1970s (drought years), there was significantly less. This greatly accentuated the interannual irregularity of floods, which, before the dams were built, could vary six-fold between the wettest and driest years. The climatic regime in the basin can be divided into three seasons: a rainy season from June to September, a cold, dry off season from October to February, and a hot, dry off season from March to June. In the river, this creates a high-water period or flood stage between July and October, and a low-water period between November and May to June.

*2. **Surface Water***

The three main tributaries of the Senegal River produce together over 80 percent of its flow. The Bafing alone contributes about half of the river's flow at Bakel. The two largest tributaries on the right bank, above Bakel, the Gorgol and the Oued Gharfa, supply only 3 percent of the water in the Senegal River that flows into the Atlantic Ocean at Saint Louis. At Bakel, considered to be the reference station on the Senegal River due to its location below the confluence with the last major tributary (the Faleme), the average annual discharge is about 690 cubic metres per second (m^3/s), which corresponds to an annual input of around 22 billion cubic metres (bm^3). The annual discharge ranges between a minimum of 6.9 bm^3 and a maximum of 41.5 bm^3.

The total capacity of the Manantali dam, built on the Bafing River, is 11.5 bm^3 of water for a useful volume of around 8 bm^3: it is the largest in the basin. Its purpose is to attenuate extreme floods, generate electric power and store water in the wet season to augment dry-season flow for the benefit of irrigation and navigation. The Diama dam, located 23 km from Saint Louis near the mouth of the Senegal River in the delta, sits astride the territories of Mauritania and Senegal. Its threefold purpose is:

1. To block seawater intrusion and thereby protect existing or future water and irrigation wells;
2. To raise the level of the upstream water body, creating reserves to enable irrigation and double cropping of around 42,000 hectares at an altitude of 1.5 metres above sea level (m.a.s.l) and 100,000 hectares at an altitude of 2.5 m.a.s.l.; and

3. To facilitate the filling of Guiers Lake in Senegal and Lake Rkiz and the Aftout-es-Saheli depression in Mauritania

4. Groundwater

The deep aquifers are, for the most part, represented by the Maestrichian fossil formation and the Continental Terminal formation. The alluvial aquifer is the principal shallow aquifer. It is present in all of the flood plain at various depths, generally less than 2 metres, and has an average thickness of about 25 metres. This aquifer communicates in places with a discontinuous network of lenticular aquifers in the permeable strata interbedded in the alluvium. These aquifers are recharged by the river and by all of the tributaries, distributaries, ponds and lakes in the flood plain. On the edge of the valley, the aquifers tend to deepen, usually with a steep slope, but this is highly variable from one place to another. The water level in the alluvial aquifer varies with the seasons and river level, along with the general hydrological regime in the valley. Since the dams were filled, both the volume and duration of floods and the geographic distribution of the flooded areas have been disrupted, significantly modifying groundwater recharge and the piezometric surface. Reducing the volume of the floods and building dikes significantly reduces the area of natural recharge zones (infiltration ponds). On the other hand, flow regulation during low water periods (maintenance of a minimum flow) and irrigation of large surfaces, rice paddies in particular, increases groundwater recharge during part of the dry season in some areas.

5. Water Quality

In the Senegal River basin there is, at present, no database for water quality similar to those that exist for quantity and discharge, both of which have been monitored since 1904. There are, however, time series and locally monitored data, generally collected by national water supply companies in Mali, Mauritania and Senegal and within the framework of research carried out by universities, training institutes, cooperative agencies, etc. These data indicate, in some places, a degradation of surface water quality. This deterioration would be caused primarily by eutrophication due to a reduction of the flow velocity and oxygenation of the water caused by the new dams and dikes, the proliferation of water weeds, and chemical and biological pollution related to the discharge of wastewater and pesticides into the river. Furthermore, even if there are, as yet, no figures to confirm it, small alluvial gold-washing activities in the upper basin are a threat to water quality because of the products used (such as mercury and flashlight batteries).

Groundwater in the Senegal River basin is generally salty in areas where there used to be seawater intrusion before the Diama dam was built. The alluvial aquifer has a relatively homogeneous salinity, whereas the lenticular, fluvio-deltaic aquifer formations have a slightly more heterogeneous salinity. As a result, there are large and sometimes abrupt variations, with concentrations rising from 1 or 2 grams (g) per litre to more than 150 g/litre. On average, salinity decreases as one move away from the centre of the delta (more than 10 g/litre) towards the edge (10 to 0.15 g/litre). The aquifers have a higher load in high areas (with an average of 30 g/litre) than in depressions, which are regularly flooded (13 g/litre). However, the saltiest water is found in depressions such as the Aftout-es-Saheli sebkhas in Mauritania and the Gandiolais lagoons and Ndiael wetlands in Senegal. The pH values also vary (but not with salinity), with a high acidity in and depressions influenced by the acid sulphate deposits of the ancient mangroves. The Sodium Absorption Ratio (SAR) of the aquifers is generally high, which means that there is a risk of alcalinization of soil horizons in contact with these aquifers.

Figure 3.15: Water Pollution Due to Domestic Activities

Table 3.4: Hydrological Characteristics of the Senegal River basin

Parameter	Dimension
Surface area of the basin	300,000 km^2
Annual precipitation	660 mm/year
Annual runoff (Bakel station)	
Before	1985 698 m3/s
After	1985 412 m3/s
Annual discharge (Bakel station)	
Before	1985 863 m3/s
After	1985 416 m3/s

Source: UNESCO, 2011

3.2.4 Socio-Economic Characteristics

Fishing activities play an important role in Sénégal for social and economic reasons. With 600,000 direct and indirect jobs, the sector alone accounts for 15% of the labor force (Direction des Pêches Maritimes, 2006). It also contributes to food security being the main provider of protein in the country (Direction des Pêches Maritimes, 2008). The coastal fisheries support fish trade, employment and provide valuable contribution to the economy of the region. The financial support received from development partners (African Development Bank, World Bank, JICA, French Development Agency, European Union, etc.) have resulted in the development of the fleet and the effort level as well as infrastructure. The financial supports received by the people are very important to the livelihood of families remaining in the villages, especially during periods of difficulty, as with droughts or floods. Some of these emigrants return to their villages during the rainy period for seasonal work.The enormous socio-economic potential of the Senegal River basin was identified long ago by colonialists and some resources were already being developed long before the countries gained their independence in the 1960s.

The Senegal River basin has a total population of around 3,500,000 inhabitants, 85 percent of whom live near the river. This value includes approximately 16 percent of the total populations of the three OMVS member states – Mali, Mauritania and Senegal – plus the population of the Guinean portion of the upper basin. The population within the basin is increasing at a rate of about 3 percent per year, which is slightly higher than the individual averages for the three member states.

Figure 3.16: Fisherman at Gambia River: Use of Monofilament Net which is not allowed

A large ethnic diversity also characterizes the basin's population, with, among others, Peuls, Toucouleurs, Soninkes, Malinkes, Bambaras, Wolofs and Moors. However, there is massive emigration among the young towards the major cities and to Europe.

Figure 3.17: Fish market products sold by the floor

3.2.5 Biological Diversity

The stark contrast in landscapes in the Senegal River Basin is a reflection of the basin's contrasting climate conditions. This leads to significant differences in fauna and flora status between the highlands upstream of Bakel and the river valley downstream.

In terms of flora, notable differences occur between the upper basin and the lower basin. In the upper basin, which generally corresponds to the Fouta Djallon highlands, the type of vegetation found there is a function of the type of ecosystem in place. Hence, the gallery forests of the dry forest ecosystems are marked by persistent deciduous species such as *Mitragina stipulosa, Alcornea cordifolia, Raphia gracilis, Uapaca somon* and *Cola cardifolia*. In forest islands, the most frequent woody species are: *Ceiba pentandra, Adansonia digitata, Cassia sieberiana, Cola cordifolia, Parkia biglobosa* and *Vitellaria paradoxa*. Today, the forest cover of the Fouta Djallon Massif extends over 13% of the region or 800,000 ha of dry dense forest and 50,000 ha of patches of forests, remnants of the former dense cloud forest.

The Sudano-Guinean savannah ecosystems are marked by species such as *Andropogon ascinodis, Sorghastrum bipennatum* in the grassland savannah. The shrub savannah is notable for the presence of *Hymenocardia acida* and *Andropogon gayanus*. In the woody savannah, the most frequent woody species are: *Parinari excelsa, Erythrophleum guineensis, Parkia biglobosa, Isoberlina doka* and *Daniela oliveri*. Mountain ecosystems, specifically at high altitude, are found in the Fouta Djallon central plateau and have many headwaters. The floral composition of these ecosystems is: *Afzelia africana*, *Trema guineensis, Parinari, Fagara macrophyla* and *Erythrophleum guineensis*.

Freshwater ecosystems, including lentic and lotic ecosystems, also contain interesting flora diversity with lower plants or thallophytes (bacteria, mushrooms, algae and lichens) and higher plants or cormophytes (bryophytes, pteridophytes, angiosperms and gymnosperms). This floral potential is in clear regression following increases in population and livestock, which causes overuse and resorting to unsustainable pastoral and hunting practices. Close to 140,000 ha of forests are destroyed annually for agriculture. Of the 88 plant species considered native, 36 are considered under threat of disappearing (FAO, 2004).

The Upper Basin

In the upper basin, mammals such as large ungulates, rodents and primates live in the savannah ecosystems as well as small antelopes. The forest ecosystems are hosts to species such as the lion (*Panthera leo*), the Guinean baboon (*Papio papio*) and various colobi (*Colobus sp*.). In the gallery forests, most of the vertebrates are birds and reptiles. In terms of invertebrates, this ecosystem is also rich in frondicolus and xylophagous insects.

The mountain ecosystems are characterized by particular and varied wildlife: vertebrates include mammals (chimpanzee, red colobus, bongo), birds (fracolins, white-necked Picathartes) and reptiles (green mamba, *Dendroaspis*). The existence of invertebrates must also be noted, including an abundance of insects. In terms of fish fauna, the Guinean part of the upper basin numbers close to 30 species of fish divided between 15 families.

3.2.6 Aquatic Invertebrates

Aquatic vertebrates include fish, frogs, freshwater turtles and hippopotamuses. The most frequently caught fish are mainly from the genus *Tilapia, Sarotherodon* and *Clarias*.The aquatic invertebrates represented by the Guinean part of the Basin separate into three categories: the shellfish (crabs, shrimp and mollusks); the entomocoenoses or aquatic worms such as the leech *Hirudo medicinalis* and insects belonging to the diptera, trichoptera, ephemeroptera plecoptera, odonata, coleoptera and heteroptera insects. Nevertheless, this rich wildlife diversity is subjected to various threats. Expansion of human settlement sites, cultivated land and mining operations reduces fauna and flora habitats while bush fires and poaching decimate wildlife species. Recently the fauna and flora of the Senegal River Basin has seriously decreased. In the upper basin, although the fauna is still rich and diversified, it has sharply declined. Due to its richness and avifauna, the Senegal River delta remains one of the most important wetlands along the immediate border of the Sahara Desert. All along the river, the decreasing fish fauna population continues to be diversified despite profound changes in the river regime due to the dam

3.2.7 Agriculture

The first major attempts to control the Senegal River discharge were made in the 1940s in order to grow rice in the delta (at Richard-Toll in Senegal). But it was not until 1973 that the State

Company for Agricultural Development (SAED, Société d'Aménagement et d'Exploitation des Terres du Delta du Fleuve Sénégal) decided to increase this activity by building dikes around 10,000 hectares of flood land and created, in 1975, an irrigated area of 650 hectares.

Thereafter, small irrigated areas were rapidly created as a means to combat the drought cycles in the 1970s that made it almost impossible to grow rainfed and flood recession crops. On the left bank, the surface area of community-based irrigated fields grew from 20 hectares in 1974 to 7,335 hectares in 1983 and 12,978 hectares in 1986. Irrigated agriculture rapidly expanded after the new dams were filled (between 1986 and 1988). Today, irrigation is still the motor of development in the basin, notably in the valley and in the delta, due not only to improved technology, but also to the wider variety of produce grown (rice, onions, tomatoes, potatoes, sweet potatoes). About 100,000 hectares of land are now cultivated in the basin: 60,000 hectares during the rainy season (June-September) and 20,000 hectares during the dry season (March-June).

Riparian communities use both rain (July to October) and the nutrient-rich, moist floodplains after floods (October to March) to grow crops. Flood-recession agriculture is dependent on the annual flooding of the floodplain and is carried out on the riverbanks and alluvial plains once the floodwaters have receded. Rain-fed agriculture is practiced on higher land adjacent to the floodplain and is dependent on local rainfall. Historically, it is the least predictably successful of agricultural practices because of the highly variable rainfall.

Pastoral production: The floodplains provide seasonal grazing for large herds of ruminant livestock, which move in from higher land during the dry season (March to June). They browse shrubs, grasses and grain stubble, particularly nutrient-rich sorghum stubble, after crops have been harvested and, in turn, add manure to the fields. Small remnant ponds and marshes in the floodplains provide them with drinking water.

3.2.8 Fisheries

The basins fisheries have significant contribution to the socio-economic life, food security, employment and export revenues of the member countries and the main fish supply are from the basin. Indeed, fishing activities play an important role in Sénégal for social and economic reasons. It was estimated that in the early 1970s, close to 10,000 fishermen were working full time and as many working part time, accounting for a total of 6.1% of the active population in the basin at the

time (Reizer, 1974). However, in Senegal, between 30 000 to 40 0000 people are involved in inland fisheries;several types of professionnals: Fishermen, artisanal fish processors, boat building, fish sellers, fish traders, and there is an important community of foreigners coming mainly from Mali and the republic of Guinée.

Fisher-folks fish in the rivers in the dry season and on the floodplains once floodwaters cover them. With the rising floodwaters, fish migrate out of the river onto the floodplains in search of nutrient-rich feeding, and spawning grounds. The volume of fish available in any year depends on how much of the floodplain was inundated and for how long.Approximately 8000 canoes were estimated. The motorisation rate is about 10 %, (low for the country) and there are two types of embarcation. The casamançe type (monoxyle) and The Saint Louisien type (pirogue à quille).

Over the years, the fisheries potential has been profoundly modified, not so much in terms of biological diversity—fish species inventoried before the great ecological crisis of the 1970s are for the most part still present in the river—as in available stocks. Even in terms of stock, noted changes vary depending on river reaches: a 50–70% decline for stocks downstream of Diama; stock increases in the Diama reservoir and the Lac de Guiers; substantial deceases in the middle valley (particularly following disturbances in the flood cycle of the alluvial plain, which is a preferred area for fish reproduction). Today the Manantali reservoir is Mali's third largest fishing area after the Niger Interior Delta and the reservoir at the Sélingué dam. Despite these contrasts in evolution, fishing is still an important activity today throughout the basin where it is the main source of income for more than 6300 fishermen. Close to 2000 fishermen depend on fishing as a supplementary source of income. These fishermen are divided as follows: 79% in Senegal, 16% in Mauritania and 5% in Mali3 (Roche International, 2000).

For populations living near the river, in the valley and the delta, income from fishing, in terms of the work force that it employs, is the largest economic activity in the basin after agriculture. However, the future of this sector is in question because for several years now, there has been a steady drop in the tonnage of fish caught throughout the OMVS regions. Some observers link this to the river development projects (dams, dikes) and to their impact on the environment (significant decrease in salinity, proliferation of floating water weeds and eutrophication). For example, an

annual net loss of 11,250 t of fish per year were lost as a result of dam construction associated with Lake de Guiers (FAO, 2001)

3.2.9 Fish Species

There are 141 species of fish recorded in the Senegal River, most of which are native; however, there are no endemic species of fish in the Senegal Basin. Among the larger native benthopelagic taxa are: the 170 centimetre (cm) North African Catfish (*Clarias gariepinus*), the 149 cm Electric Catfish (*Malapterurus electricus*), and the 92 cm African Carp (*Labeo coubie*).

Some of the larger native demersal fishes of the Senegal Basin are: the 204 cm Aba (*Gymnarchus niloticus*). The 200cm Nile Perch (*Lates niloticus*), the 183cm Sampa (*Heterobranchus longifilis*), and the 150cm Cornish Jack (*Mormyrops anguilloides*). Pelagic native fishes in the Senegal River include the 65cm True Big-scale Tetra (*Brycinus macrolepidotus*) and the 16cm Ansorge Fangtooth Pellonuline (*Odaxothrissa ansorgii*). The exploitable fishing potential, including the Lake Guiers, which supplies between 6500 and 9000 Tons (FAO, 2008). In summary, aboutm130 aquatic species known. Predominant species are**:**Tilapia du Nil (*Oreochromis niloticus)*, Capitaine (Lates *niloticus*), Silure or Catfish(*Clarias, Heterobranchus*) ,Crustaceans-*Fresh water shrimp,* Algae-in inland water, mainly microalgae(Chlorella, etc.).

Figure 3.18: Aquatic Weed Obstructing Fishing Activities

Figure 3.19: Aquatic Plants

3.2.10 SocioEconomics

The demand for fish products occurs at two levels: the domestic and exterior. The contribution of fish to the satisfaction of the animal protein needs is dominant in Senegal, although difficult to quantify. There is a wide variation between the coasts and inland; the average consumption per capita per year is estimated at 28 kg. However, since the devaluation of the CFA franc in 1994, there is a clear pressure on prices noble species face increased exports. For domestic distribution, the central fish market of Dakar seems to be the most important. It receives products from all regions and countries in the sub-region (including Mauritania and Guinea). It is also a platform of redistribution of these products to markets, internal and secondary markets of Dakar. Factors affecting demand for fish products are:

1. The annual population growth estimated at 3 percent on average Senegal;
2. Urbanization;
3. The evolution of income;
4. Relative prices compared to export.

Considering that urbanization and income growth, induced growth economic, should lead to an annual increase in demand at constant prices greater than population growth. However, demographic factors and economic in countries where Senegal's fish is exported are the same as

Senegal, and in these countries the strong demand should push prices up.

Export competition should increase the average demand at a rate slightly higher than the population growth, or 4 percent per year. In this hypothesis, domestic demand would continue to rise. Whereas this assumption, and assuming that the proportion of losses after landing remains unchanged, the total demand for fish products should evolve as follows (in tonnes fresh equivalent). Ultimately, the stagnation of production, combined with population growth, risk lead to a reduction in fish consumption per capita.

Table 3.5: Socio-Economic Data in the Member States

Parameters	**Senegal River basin**	**Mali**	**Mauritania**	**Senegal**
Population (million inhabitants)	3.5	11	3	10
Annual growth rate (%)	3	2.97	2.9	2.8
Urbanization rate (%)	NA	41	53	51
Farmland (ha)	823,000	NA	NA	NA
Irrigated land (ha) – national total	NA	78,630	49,200	71,400
Part in basin	4,000	44,449	67,830	
Cattle (x1, 000 units)	2,700	6,427	1,394	2,927
Sheep and goats (x1, 000 units)	4,500	15,986	10,850	8,330
Fish catch (t/year) 26,000 to 47,000	100,000	620,000	395,000	

Source: UNESCO, 2011

Table 3.6: Trends in Demand For Senegalese Fish Products

Destination / Year	**1996**	**2003**	**2008**
Domestic Markets	218000	287000	349000
Africa	40000	53000	64000
Europe, Asia, America	105000	105000	105000
Request products landed in Senegal	363000	445000	518000
Losses after landing	54000	66000	77000
Foreign catches in Senegalese EEZ			
Not landed	49000	49000	49000
Total	**466000tons**	**60000tons**	**644000tons**

Source: FAO - World Bank

3.3 Niger River Basin

The Niger River is one of the major rivers in Africa and in the World. In Africa, Niger River is the third longest and fourth largest river. It has a length of about 4 200 Km and an area of about 2 113 350 Km^2 (Table 3.6), but only 1 500 000 km^2 is hydrologicaly active, (Dessouassi, *et al.,* 2010; Ayaa, 2012). It is less than River Nile (the longest river in Africa and in the world) and River Congo/Zaire (the second largest river in Africa). However, in the world, River Niger is the 9th largest river system. It is one of the major seven Trans – Boundary Rivers Basin in West – Africa, and largest of all, (Farley and Farmer, 2013).

Table 3.7: Major River Basin in Africa with their area, length and location

Basin Name	Area of Basin (Km^2)	River Length (Km)	Region
Congo	3 699 100	4 667	Central Africa
Gambia River	69 800	1 100	West Africa
Incomaputo	77 400	810	
Juba – Shibelli	803 600	1 658	Eastern Africa
Komati River	44 800		Western Africa
Kunene	110 000	1 050	
Lake Chad	2 388 700	1 400	West and Central Africa
Senegal	490 000	1 800	West Africa
Volta	414 000	1 610	West Africa
Zambezi	1 400 000	2 650	Central andSouthern Africa
Lake Victoria	180 950		East Africa
Limpopo	414 800	1 750	Southern Africa
Niger	2 113 350	4 200	West and Central Africa
Nile Basin	3 038 100	6 700	East and North Africa
Okavango	725 000	1 100	Southern Africa
Orange	850 000	2 300	Southern Africa
Ruvuma	151 700	800	

Adapted from: African River Basin (2007)

3.3.1 Drainage

Its drainage basin is located between latitude 28°N in Algeria and extends to 4°N in the Gulf of Guinea (south-east of Nigeria), where it empties into the Atlantic Ocean, after joining the Benue River flowing from north-east Nigeria. Also, from west to east, the basin ranges from longitude 11.5° West of Fouta-Djallon highland of about 800 m altitude in Guinea to 15° East in Chad. The active watershed of the Niger River of about 7.5% of the continent covered nine West and Central African countries. These countries as shown in Figure 3.15 are: Benin, Burkina Faso, Cameroon,

Chad, Côte d'Ivoire, Guinea, Mali, Niger and Nigeria, while the inactive basin of the Niger River covers Algeria, (NIGER – HYCOS, 2006). These countries may be divided into two main parts as:

1. Niger River main course countries: Guinea, Mali, Niger and Nigeria.
2. Niger River tributaries countries: Cote d'Ivoire, Burkina Faso, Benin, Chad and the Cameroon.

3.3.2 Regions of Niger River Basin

The regions in Niger River Basin are divided into four areas with many tributaries joining the River as one move from one area to another. Figure 3.17 showed the Niger River with its four different regions. These regions are:

1. The Upper Niger River Region
2. The Inner Delta Region
3. The middle Niger River Region
4. The lower Niger River Region

The Upper Niger River Region

This region is the source of the Niger River. It is located in the Fouta Djallon Massif, of Guinea near the border with Sierra Leone. This region is described as the 'water tower' of the Niger River and offers significant potential in terms of regularizing river discharge. Joining with several tributaries (e. g Tinkisso, Niandan, Milo and Sankarani, etc), it flows across the interior plateau of Guinea flowing north-east towards the border with Mali. Just after the border it is joined by another tributary which also originates in Guinea, then flow north-east towards the inner delta in Mali, where it is joined with an important tributary called the Bani River that has its sources in Côte d'Ivoire and Burkina Faso.

The Inner Delta Region

This region is located in Mali. Its total area can be up to 30 000 Km^2 during the wet season as a result of many tributaries, channels, swamps and lakes connected to it. The delta area is swampy and the soil sandy, which accounted for massive production of rice in Mali providing irrigation for about 70 000 hectares of land. Also, about 90 000 tonnes of fish is being caught per year in this region. Likewise, during the dry season it provides pasture and water for millions of cattle, sheep and goats. Nevertheless, the river 'loses' about 65 % of its potential flow between Ségou (at 900

km from its source) and Timbuktu (at 1500 km) due to seepage and evaporation. The addition of the Bani tributary, which joined the Niger River at Mopti (at 1 150 km), is not enough to balance the 'losses' in the inner delta, as the total flow further downstream still decreasing instead of increasing. The average 'loss' is estimated to be 31 km^3 / year.

The Middle Niger River Region

In this region, Niger River enters Niger Republic, after forming a great bend, by initially flowing toward north – east then turn toward south-east. Also, in this region there is loses of water but not as much as that of inner delta region. The water loses in this region is also due to evaporation as in inner delta region. In this region, the Niger River receives water from six tributaries originating in Burkina Faso. These tributaries are: Gouroual, Dargol, Sirba, Gouroubi, Diamangou, Tapoa.

The Lower Niger River Region

In this region, Niger River enters Nigeria; joined with many tributaries and its annual mean flow increases compare with the level it enters Niger Republic. It forms a confluence with Benue River (flowing from Cameroon) at Lokoja in Nigeria resulting to over 450 % increase in its flowing speed. Niger River is dammed in this region by Nigerian government at Kainji and Jebba for hydroelectric generation, and has resulted to rapid expansion of industries in the region, (FAO, 1997; NIGER – HYCOS, 2006).

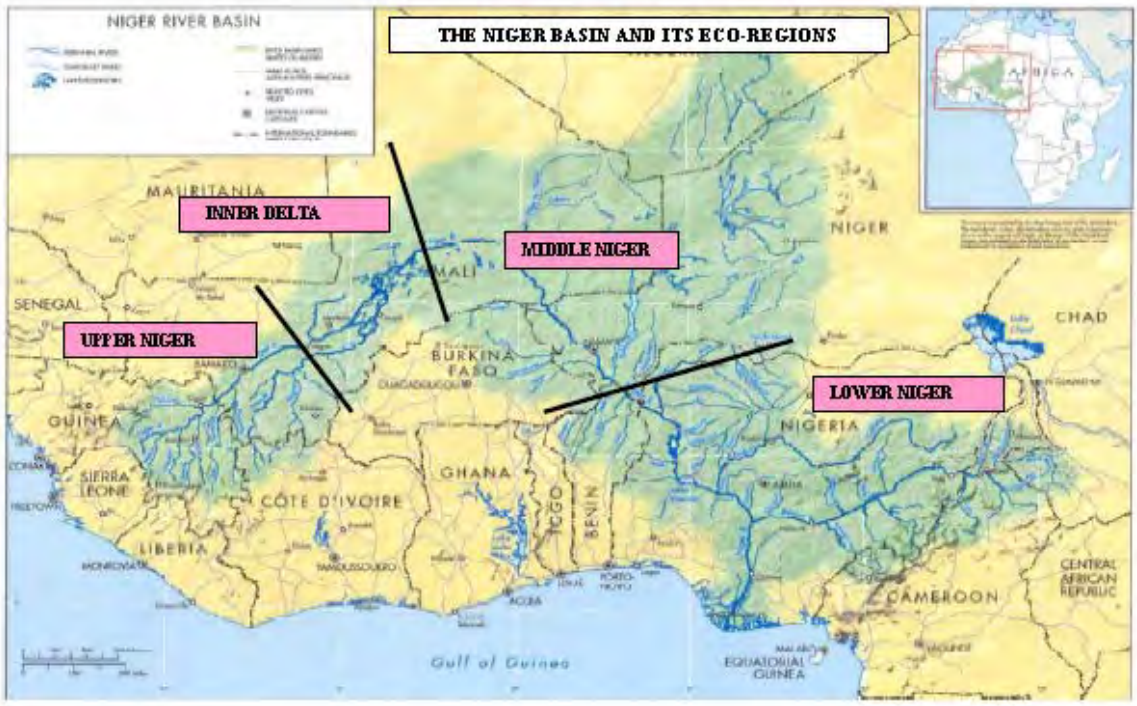

Figure 3.20: The Regions of Niger River Basin
(**Source**: NIGER – HYCOS, 2006)

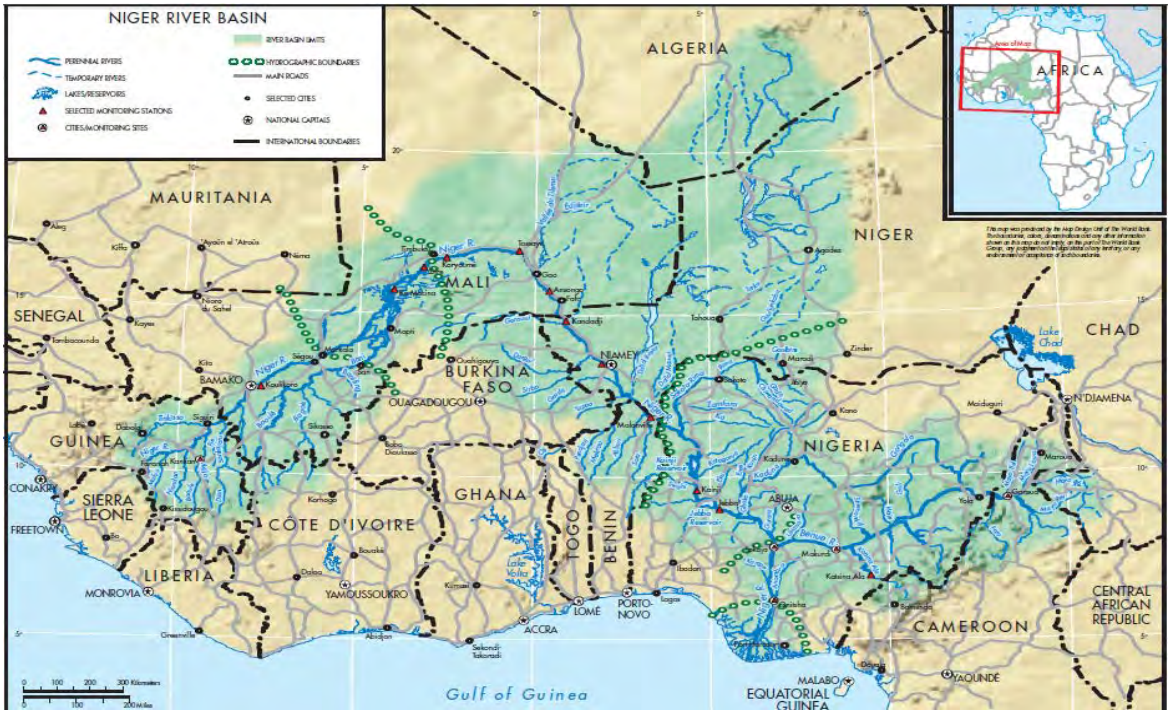

Figure 3.21: Countries covered by Niger River
(***Source:*** *Cody McCann and McKinney, 2012)*

3.3.3 The Niger Basin Authority

In 1963, having realised that cannot continue to rely upon individual effort to development if they are to meet up with the challenges of achieving sustainable management of Niger River resources, seven of the ten riparian countries came together to sign an Act to establish River Niger Commission (RNC), in Niamey. The aim of this commission was to promote cooperation between the member states and to ensure integrated development, particularly in the areas of navigation, energy, water, agriculture, forestry, transportation, communication and industry. However, River Niger Commission (RNC) did not achieve her aims and objectives as stated. Therefore, on the 26th January 1979 at Lagos, the Summit of Heads of State of riparian countries decided to transform River Niger Commission (RNC) into Niger Basin Authority (NBA). The NBA was further strengthened in 1987 to absorb all the River Niger Commission (RNC) assets, liabilities and programs (United Nation, 1984; Newton, 2007).

The Niger basin Authority (NBA) signed into existence on 21st of November in Faranah, Guinea, by its member countries showed in Figure 3.19, aims to promote 'cooperation among Member States and to ensure an integrated development of the Niger Basin in all fields, by developing its resources, particularly in the fields of energy, water resources, agriculture, animal husbandry, fishing and fisheries, forestry and forestry exploitation, transport, communications and industry'. The cooperation among the riparian countries could be through data sharing, joint ventures to build new infrastructure, joint management of existing infrastructure, and/or sharing of benefits and costs accruing from use of the services and use-sectors of the river. Niger Basin Authority is very involved in Trans-boundary integrated water management and in the environment challenge of the African continent. Therefore, communication between the nine riparian countries is so necessary otherwise there would be threat of tension between these states. For instance states located in downstream would be wronged if states located in upstream use too much water, and could be tempted to assert to water supply, (Ayaa, 2012).

Figure 3.22: Niger River Basin Countries
(Source: NIGER – HYCOS, 2006)

The long term objective of NBA is "to promote cooperation among the member countries and to ensure integrated development of the basin in all sectors through development of resources, notably in the fields of energy, water, agriculture, livestock, fishing, fish-farming, forestry, transport and communications and industry." (NIGER – HYCOS, 2006)

The main objectives Niger Basin Authority (NBA) are:

1. To harmonise and coordinate national water management policies, in order to ensure an equitable policy as regards sharing of the water resources among Member States.
2. To formulate, in agreement with the Member States, the general policy for the development of the Basin which shall be consistent with the international status of the River Basin
3. To execute and implement an integrated development plan of the Basin
4. To design and conduct studies, research and surveys within the Basin
5. To initiate, monitor an orderly and rational regional policy for the utilization of the surface and underground waters in the Basin.

6. To formulate plans, the construction, exploitation and maintenance of structure and projects realized within the general objectives of the integrated development of the Basin (United Nations, 1984)

The principal Niger Basin Authority (NBA) decision making and consultative bodies constitute the following:

1. The Summit of Heads of State and Governments: This is the supreme body that gives guidance and makes decisions for Niger Basin Authority (NBA). They make policy and control the operations of the executives for the purpose of achieving the objectives of the Authority. The Summit meets every two years in ordinary session in the Member State holding the presidency.
2. The Council of Ministers: This is endowed with supervisory responsibility of the activities of the Executive Secretariat. They report to the Summit. They prepare the meetings of the Summit and examine all the problems and deal with the matters. They meet once in a year with several extraordinary sessions. The tenure of the Chairman of the Council last for two years.
3. The Technical Committee of Experts: They have the responsibilities of preparing the sessions of the Council of Ministers and gives reports and recommendations to the
4. Council of Ministers: The Executive Secretariat: It heads by an Executive Secretary, appointed on the recommendation of the Council of Ministers to the Summit of Heads of State and Government for a period of four year, which can be renewed only once. Each Member State may nominate a candidate for the post of Executive Secretary. The Executive Secretary is responsible for the administration of the Authority and all of its structures in order to implement the decisions made by the higher organs. This is done with a view to achieving the objectives of the Authority. The Executive Secretariat has its headquarters in Niamey, Niger, (United Nations, 1984; Ayaa, 2012; NIGER – HYCOS, 2006).

3.3.4 Means of Financing Niger River Basin

Niger River Authority (NBA) is being financed by the contribution of each member state to sponsor the operating budget of the Niger Basin Authority (NBA). The 1980 Article of Niger Basin Authority stated that 'The operating budget of the Executive Secretariat of the Authority

shall be financed by contributions equally shared among the Member States' (United Nations, 1984). However, According to African River Basin (2007), the contribution is based on a sharing formula that was agreed upon by the states and which was last reviewed in 2000. Nigeria has the largest share of contribution of about 30%, while Chad had the least share of contribution of about 1%. Meanwhile, Niger Basin Authority (NBA) also seeks financial support from external donors.

Table 3.8: Niger River Basin: Total Surface Area (2 273 946 Km2) by Percentage shared among the ten Riparian Countries with their Rainfall

Country	Total area of the Country (Km2)	Area of the Country within Basin (Km2)	% of Total Area of Basin	% of Total Area of Country	Average annual Rainfall in the Basin Areas (mm)		
					Min.	Max.	Mean
Guinea	245, 857	96,880	4.3	39.4	1240	2180	1635
Cote d'Ivoire	322, 462	23,770	1.0	7.4	1316	1615	1466
Mali	1,240,190	578,850	25.5	46.7	45	1500	440
Burkina Faso	274,000	76,621	3.4	28.0	370	1280	655
Algeria	2,381,740	193,449	8.5	8.1	0	140	20
Benin	112,620	46,384	2.0	41.2	73.5	1255	1055
Niger	1,267,000	564,211	24.8	44.5	0	880	280
Chad	1,284,000	20,339	0.9	1.6	865	1195	975
Cameroon	475,440	89,249	3.9	18.8	830	2365	1330
Nigeria	923,770	584,193	25.7	63.2	535	2845	1185
Niger basin		2,273,946	100.0				

Source: FAO, 1997

From Table 3.7 above, it can be seen that Niger River effect is minimal in Mali, Algeria and Niger with regards to having less than 500 mm average annual rainfall in the basin areas. Mali has 440 mm; Algeria has 20 mm while Niger has 280 average annual rainfall. Therefore,NIGER – HYCOS (2006) regards them as essentially inactive areas of the basin, because of inadequate renewable water resources. However, Mali and Niger are almost entirely relying on the Niger River for their water resources. For example, about 90% of water resources of Niger come from the Niger River and other rivers from neighbouring countries (Burkina Faso and Benin Republic).

Moreover, the most important areas of the Niger basin are located in Mali, Niger and Nigeria with each of these three countries has approximately 25 % of the total area of the basin. Also, the quantity of water entering Mali from Guinea (40 km^3/yr) is greater than the quantity of water entering Nigeria from Niger (36 km^3/yr), Nigeria still has average annual rainfall of about 1185 mm being the fourth with the highest average annual rainfall in the basin but the first with the maximum annual rainfall of about 2845 mm.

3.3.5 Advantages of Niger River to member Countries

1. **Support of livelihood:** Niger River support the livelihood of the people living around the basin. The people around the basin depend on the River for agricultural production (cultivation of rice, wheat etc.) and fishing activities. Also, the basin provides good pasture for cattle, sheep and goat grazing. These improve the livelihood of the people living around the basin.

2. **Supply of drinking water:** The River is a good source of portable and drinking water for the member countries. Water from the River can be treated and supply for the domestic use of the countries. This indirectly will reduce or eradicate the incident of water borne – diseases.

3. **Creation of Dams:** Niger River provides opportunity for the member countries to create dams for their domestic use, i.e. for either electricity production or irrigation. For example, in Nigeria, Niger River is dammed at Kainji, Jebba and Shirroro for the purpose of hydroelectric production. The electricity generated from this dam amount to about 22 % of Nigeria's total electricity output. Also, there is Lagdo dam in Cameroon, in Dabola dam on the Tinkisso River in Mali, are constructed for the same purpose. The Sotuba/Bamako Dam and the Markala Dam are constructed on the Niger River constructed for the purpose of irrigation.

4. **Scientific Research:** Niger River provides member countries opportunities to make research at university or institutional level into water resources, the environment, hydrobiology and fisheries. This will in turn improve the economy and wealth of knowledge of the country involved in the research.

5. **Modification of Climate:** The effect of Niger River is pronounced on the weather and climate of the riparian countries. Temperature and rainfall of the riparian countries depend on the River, which account for appreciable amount of rainfall experience in the area expect for Mali, Niger and Algeria.

6. **Means of Transportation:** Niger River provides active means of transportation for the people living around the River. This also contributes to the development of their economic activities. At present only about 6 000 Km of the Niger River is navigable. Before entering Nigeria, the river is navigable as follows:

1. Kouroussa (Guinea) to Bamako (Mali): 370 km
2. Koulikoro (Mali) to Ansongo (Mali): 1280 km
3. Niamey (Niger) to mouth (Nigeria): 1140 km
4. Garoua (Cameroon) to mouth (Nigeria): 980 km (Olomoda, 2007).

3.3.6 Niger River Fisheries

The fish communities of the Niger River belong to the nilo-sudanian province. The UpperNiger and Central Delta include 130 to 140 species (Daget, 1954; Lévêque *et al*., 1990) which are distributed into 62 genera and 26 families. In the middle Niger, the last inventories may register 98 species, distributed in 22 families (Coenen, 1986; Daget, 1962 and Bacalbasa-Dobrovici, 1971). Among these species, 83 are regularly fished while 15 are very small size and/or very rare species. In the lower Niger, 160 species have been inventoried in the Kainji Lake (Ita, 1978; 1993, Balon and Coche, 1974) among which 9 fish families are of economic importance. On the River Benue, 113 species were collected in the Mayo-kebbi (Blache *et al*., 1964) versus 128 in the Benue River (Stauch, 1966). Until recently, the fauna of the Niger Delta was largely ignored, due to the inaccessibility of the riverine and swampy areas. The Delta has a higher diversity of freshwater fish than any equivalent region in West Africa. As of 2002 there are a total of 311 freshwater fishes in the rivers and lakes in Nigeria, (Laë, *et al.,* 2003).

3.3.7 Distribution of species into ecological classes

Quensière, (1994) grouped fishes in freshwater ecosystem into two major categories, based on various behavioural and physiological adaptations that help them to survive:

1. Migratory fishes: They exploit environmental variability and exhibit a high fecundity and a short breeding period at the beginning of the flood. As spawners concentrate in few sites and fishes later disseminate in the whole river, genetic mixing is enhanced. Some species such as *Hydrocynusbrevis* and *Bagrus bayad* are short distance migrants while others such as *Alestes baremoze, Alestesdentex* or *Brycinus leuciscus,* are long distance migrants.
2. Opportunistic species: They are less mobile and show various behavioural and physiological adaptations that help them to survive in the anoxic environments of the floodplains. Some species have anatomical features such as lungs (*Protopterus annectens, Polypterus senegalus*), arborescent respiratory organs (*Clarias anguillaris, Heterobranchus bidorsalis*), supra-branchial organs (*Ctenopoma kingslaye*) or highly vascularised intestines (*Heterotis niloticus, Gymnarchus niloticus*). Other species show physiological or behavioural modifications including breathing from the water surface – film (Cichlidae, *Hemisynodontis membranaceus*). These species generally have low fecundity but can breed several times a year. Survival of the young is improved by various degrees of parental care ranging from territorial behaviour associated with nest building to mouth brooding. The relative abundance of these two groups depends on the variability of the hydrological cycle both in space and time (Lowe-McConnell, 1975).

3.3.8 State of the Fishery

Fishermen modify their fishing methods according to a space and time diagram based on the hydrological cycle (Laë, *et al.,* 2003). They can be classified into three main groups (Laë *et al*., 1994):

1. Artisanal Fish Harvesters: They use rudimentary gears (two hands nets, harpoons) and only fishing in ponds and channels. They are many but fishing is for them a minor activity, devoted to self-consumption. This group is generally composed with Malinké in Guinea, Rimaïbe, Marka and Bambara in Mali, Haoussa and Zarma in Niger.
2. Sedentary fishermen: They live in permanent villages or camps. They are scattered all over the fishing communities along the route of the river and its distributaries. They practice indifferently traditional fishing during fall or low water season and more standard techniques like gill nets or seine. They usually have secondary activities and are from Bozo or Somono origin in Guinea and Mali, Sokoto or Sorko in Niger.

3. Migrant fishermen: They are bozo in Mali, Ijaws, Itsokos, Urhobos, Ilajes, Adonis, Junkuns and Hausawas in Nigeria. Fishing gears and techniques are modern and specialized ones. As they are always moving far from their villages, they cannot conduct other activities. In Mali they have to pay a royalty (maaji) for fishing (Fay, 1989; Kassibo, 1990) but in Nigeria entry into the fishing activities is free even if they like the local fishers join in the fishers' cooperatives within which they participate actively in the management and or co-management of the aquatic resources with the Local Water Chiefs called 'Bulamas' or 'Sarkin Ruwa'. Fish is always processed and marketed in order to reduce fish losses. One notes a control of the water bodies by the sedentary fishermen and the farmers in opposition with the extensive space strategies developed by migrant fishermen.

In Niger, fishing is active during all the year. During the 1960's, there were roughly 1,500 active fishermen (Daget, 1962; Bacalbasa-Dobrovici, 1971) but they were 2,600 in 1980 (Sheves, 1981; Price, 1991). From 1983 to 1985, fishing effort declined by 50 % due to the Sahelian drought and relatively high fishing pressure (Malvestuto and Meredith, 1989). As it was in Mali fishing effort doubled during the 1970's. In the lower Niger, the number of fishermen in freshwater ecosystems is estimated at 10 000 on the Niger River, 6 300 on Kainji lake, 3 900 on Lagdo reservoir and 5 140 on the Benue River (Ita, 1984; Van der Knaap *et al*., 1991; Welcomme, 1985).

3.3.9 Gear and Catch Levels, Composition

Fishing gears mainly used on the Niger River can be grouped into two main categories:

1. **The active fishing gears are:**
1. Hunting fishing gears (harpoons mainly used in ponds in process of draining),
2. Launched or pushed nets (triangular nets, two hands nets, cast nets, frequently used by occasional fishermen),
3. Seines: small seines handled at the time of low waters by 1 or 2 men or large seines (purse seines or beach seines) from 400 to 1,000 m total length operated by a 20 fishermen team;
4. **The passive fishing gears are:**
5. Gill nets (assembled with synthetic pieces, these mono or multi – filaments nets are specifically assigned for fishing at the surface, at medium depth or just above the bottom). Fixed nets or drift nets, with small or large meshes, are adapted to target specific species.

6. Traps (among them, small traps used in low water height and large traps that are 5m long and 2 m height. The latter are used during the fall for damming entirely some river arms),
7. Lines (baited lines just fishing above the bottom and unbaited multi-hook lines that forms a dam for demersal fishes), (Laë, *et al.,* 2003).

In the Central Delta, catches was distributed between small traps (15.7 %); cast nets (14.9 %), multi – hook lines (10.6 %), large (7.8 %) and small seines (4.3 %). These catches were produced in order by migrant fishermen (59.2 %), sedentary fishermen (36.1 %) and farmer fishermen (4.7 %). 76 species were recorded in the fish landings, but a great number seems to be insignificant (Laë, 1995). Only, 17 species accounted for 85 % of the fish landings. Among them are Cichlidae with the highest percentage (26.6 % of the catches), *Oreochromis niloticus* (10.2 %), *Tilapia zilli* (8.3 %), *Sarotherodon galileus* (6.2 %) and *Oreochromis aureus* (1.9 %). Clariidae were also well represented with 18.7 % of the landings (*Clarias anguillaris*). The rest of the captures were distributed between Characidae (13.6 %) of which *Brycinus leuciscus* (6.2 %), *Hydrocynus brevis* and *forskali* (5.2 %), *Alestes* (2.2 %) were the principal representatives, Bagridae (11 %) with *Chrysichthys* (5.4 %), *Bagrus* (2.8 %) and *Auchenoglanis* (2.7 %), Cyprinidae with *Labeo* (5.3 %) and Centropomidae with *Lates niloticus* (3.8 %), Laë, *et al.,* (2003).

Fishermen are only one group of predators for fish stocks that are also submitted to birds' predation. In Nigeria, 74 species of aquatic birds are associated with the lake Kainji and the littoral zones and open water support most of the birds, with *Sarotherodon galilaeus*, *Oreochromis niloticus* and *Chrysichthys nigrodigitatus* forming part of their diet (Okaeme *et al*., 1989; Ita, 1993). In the Central Delta, birds are omnipresent and fish predation is obviously far from being negligible. This aspect is evoked by Welcomme (1979) who estimated that the birds could represent the first source of predation in the floodplains.

3.3.10 Historical Fish Catch, Actual Fish Catch and Trend

Although historical data are rare, it is all the same possible to point the main transformations occurred since about fifty years (Laë, *et al.,* 2003). In the 1940's, fishing was free and profitable, fish was abundant and the number of fishermen was relatively low (Daget, 1949). For instance, Blanc *et al*. (1955) recommended intensifying fishing in the Central Delta in order to reduce the

number of adult fishes and to support juveniles' growth. Later fishing pressure intensified strongly due to an:

1. Increase in the number of fishermen (doubling of fishermen population every 20 years)
2. Intensification of the individual fishing activity related to synthetic nets import (according to Durand, 1983, the use of nylon could have 20 multiplied fishing effort),
3. Absence of control due to the weakening of traditional authorities (Fay, 1989).

The total catches on the Niger River and its tributaries are estimated to about 300 000 tons. Fish catches (Figure 3.20) in Guinea (maximum of 4 000 tons) and Niger (maximum of 16 000 tons) are insignificant compared to Malian (maximum of 133 000 tons) or Nigerian (maximum of 161 000 tons) fish landings. From 1950 to 1970, the growth of fishing on the Niger River increased in annual fish landings from 80 000 tons to 200 000 tons. Thereafter fish production showed large fluctuations with a general downward trend from 209 000 tons in 1973 to 167 000 tons in 1991.

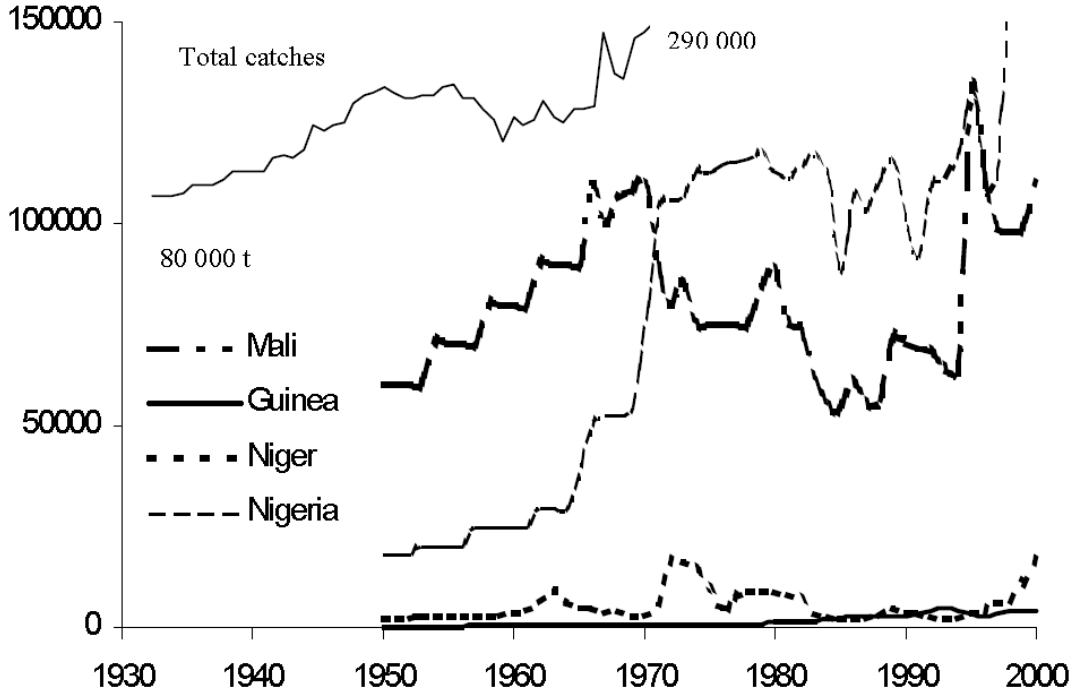

Figure 3.23: Annual fish landings (metric tons) in continental waters of Guinea, Mali, Niger and Nigeria. Insert gives total fish landings in the Niger basin from 1950 to 2000
(**Source**: Laë, *et al.,* (2003) from FAO statistical data)

This drop in catch was directly linked to the decrease in flooded area and more generally to the drought period that prevailed in West Africa (Laë, 1992b). Since 1995, total fish landings are once again increasing (288 000 tons) mainly due to flood improvement in the Central Delta. In Niger, in the 1960's annual fish landings were about 4 000 – 5 000 tons with a catch per fisherman of 2.7-3.3 tons (Daget, 1962; Bacalbasa-Dobrovici, 1971). In 1978, before strong dryness years, total catches were closed to 7 000 tons (Talatou, 1995) and then dropped in 1983, 1984 and 1985 to 1 600 tons, 1 200 tons and 900 tons respectively (Malvestuto and Meredith, 1989). This was undoubtedly the severe effects of the Sahelian drought. Since 1985, official statistics fluctuate from 2000 tons to 4000 tons depending on freshwater input and more recently (1999 and 2000) to more than 10 000 tons (FAO, statistical data).

In Mali, yields showed a rising trend from 40 kg / ha in 1968 to 120 kg / ha in 1990 due to an increase in productivity caused by the shift of the fishery to younger and smaller fish (Laë, 1995). This was a consequence of increasing fishing pressure resulting from a floodplain area reduction and a fishing activities concentration. Environmental and anthropogenic modifications would be at the origin of a lowering of the average sizes of capture corresponding mainly to a rejuvenation of captured fish: average catch lengths of long life-cycle species collected in the 1950's and 1990's (Daget, 1952; 1956; Laë *et al*., 1994) such as *Alestes dentex*, *Alestes baremoze* and *Tilapiazillii* show a clear sliding of length frequencies towards lower values

CHAPTER FOUR

POTENTIALS, MAIN CONSTRAINTS, VISIBLE AND INVISIBLE PROSPECTS OF INLAND FISHERIES DEVELOPMENT

4.1 Lake Chad Basin

4.1.1 Characteristics of the Fisheries Sector

The Lake Chad Basins fisheries sector is organized around four activities: industrial fisheries, maritime artisanal fisheries, inland fisheries and aquaculture. In 2003, inland and maritime fisheries landed around 168,000 tonnes of fish, 93,000 of which came from maritime artisanal fisheries and 75,000 tonnes from inland fisheries. A few years ago, industrial fisheries produced around 10,000 tonnes. In 2003, it landed between 7,000 and 8,000 tonnes whilst aquaculture produced about 5,000 tonnes that same year. The annual national production was therefore estimated at 180,000 tonnes in 2003 of which at least 93% came from artisanal fisheries (Ngoke *et al*, 2005).

In 2003, the annual requirements for the population were around 298,000 tonnes for an average annual consumption per capita of 17.9 kg (NGOKE *et al*, 2005). In order to meet its deficit, the country imports around 126,000 tonnes of fish every year. For the most part, these imports come from Senegal and Mauritania and 90% are horse mackerel, mackerel and sardine, cheap species particularly valued by those who are destitute.Official exports which concern essentially crustaceans caught by industrial fisheries are insignificant (NGOKE. *et al*, 2005).

4.1.2 General Constraints to Fisheries Development at Lake Chad Basin

The following are the observed constraints to the development of the fisheries sector of the LCB:

1. Low level of professionalization in the artisanal sector;
2. Inadequatelocal manpower and high dependence on foreign personnel
3. Fraudulent exports;
4. Lack of adequate stakeholders involvement in decision-making processes;
5. Inadequate and high cost of production tools;
6. Product transportation and processing;
7. Restrictive technical production conditions;
8. Competitive management;

9. Poor markets organization;
10. Insufficient access to credit;
11. High post-harvest losses;
12. Insecurity due to incessant terrorists attack on fisheries areas leading to destruction of lives and properties;
13. Climate change negative impact –desertification and shrinking of LCB water bodies, loss of fishing grounds and fish productivity;
14. Absence of motor-able roads to fishing grounds;
15. Post harvest fish loss resulting in economic losses and massive smoking of the harvested fishes;
16. Non completion of proposed management plans.

The combination of these factors has caused the sector's contribution to GDP to stagnate and has increased poverty among fisheries-dependent populations.Thus, within the poverty reduction strategy framework, the government has developed a sectoral fisheries strategy focusing on management and on increasing the value of what currently exists (NGOKE *et al*, 2005).

4.1.3 Fishery Sector of River Basin Member Countries

Fishing activities have for long constituted a major socio-economic activity for theriparian populations of the River Niger basin, most especially in Mali, Niger andNigeria. Recently, fish production has decreased seriously because of the reductionof water resources resulting from the persistent drought in recent years, (Olomoda, 2007).

4.1.4 Republic of Mali

Fishing is carried out on virtually all the water collections of the national territory of Mali: rivers, lakes and ponds. There are, however, three major production areas in Mali. They are: the Inner Niger delta (Figures 4.1 and 4.2), Lake Sélingué (one of the tributaries of Niger River) and Manantali. The central delta region of River Niger has the highest fish potential among the three major Rivers in Mali. It covers an area of 20,000 km^2, contributing about 80% to Mali's fish production. The Niger River Inland Delta showing in Figure 4.1 - constitutes one of the largest wetlands in the world and is situatedin the sahelian zone in Mali. It is located between 13° 30^0 and 17^0 00^0 latitude North and 2° 30^0 and 5° 30^0 longitude west, (Diarra,*et al.*, 2004).

The Sélingué dam on the Sankarani River (140 km in the southwest of Bamako) is mainly used for hydropower. In Lake Selingue, the average fish production is estimated to be about 4 000 t/year.Fisheries constitute an important source of revenue for the people living around the Delta and also contribute 4.2 % to Mali's GDP. The annual fish production varies between 45 000 to 100 000 tons. This depends on the extent of the floods in the Delta. Flood determines the reproduction, the growth of the juveniles andadult fish. Therefore, fishermen concentrate their efforts after the peak of the floods when thequantity of fish is at its maximum and it becomes easier to catch these fish with the recession ofthe floods.

The fish production of the Central Delta was estimated to be about 100 000 tonnes in the 1960s, (Daget 1973). The fish fauna of the inner delta is composed of about 130 species, of which the dominant families are *Mormyridae, Mochokidae*, and *Cyprinidae*. Many of the fish have life cycles that take advantage of the habitats and resources associated with the floodplain with species migrating upriver and downriver as well as laterally out on to the floodplain as the water rises (Quensière 1994).But, severe drought conditions in the entire Sahelian region in 1973substantially affected the flooding ofthe Niger River and consequently affected fish production in the area. In 1990 – 1991, the fish production in the Central Delta had decreased to 50 000 tonnes, a 50 % decline with respect to the pre – drought period.

Location of Inner Delta

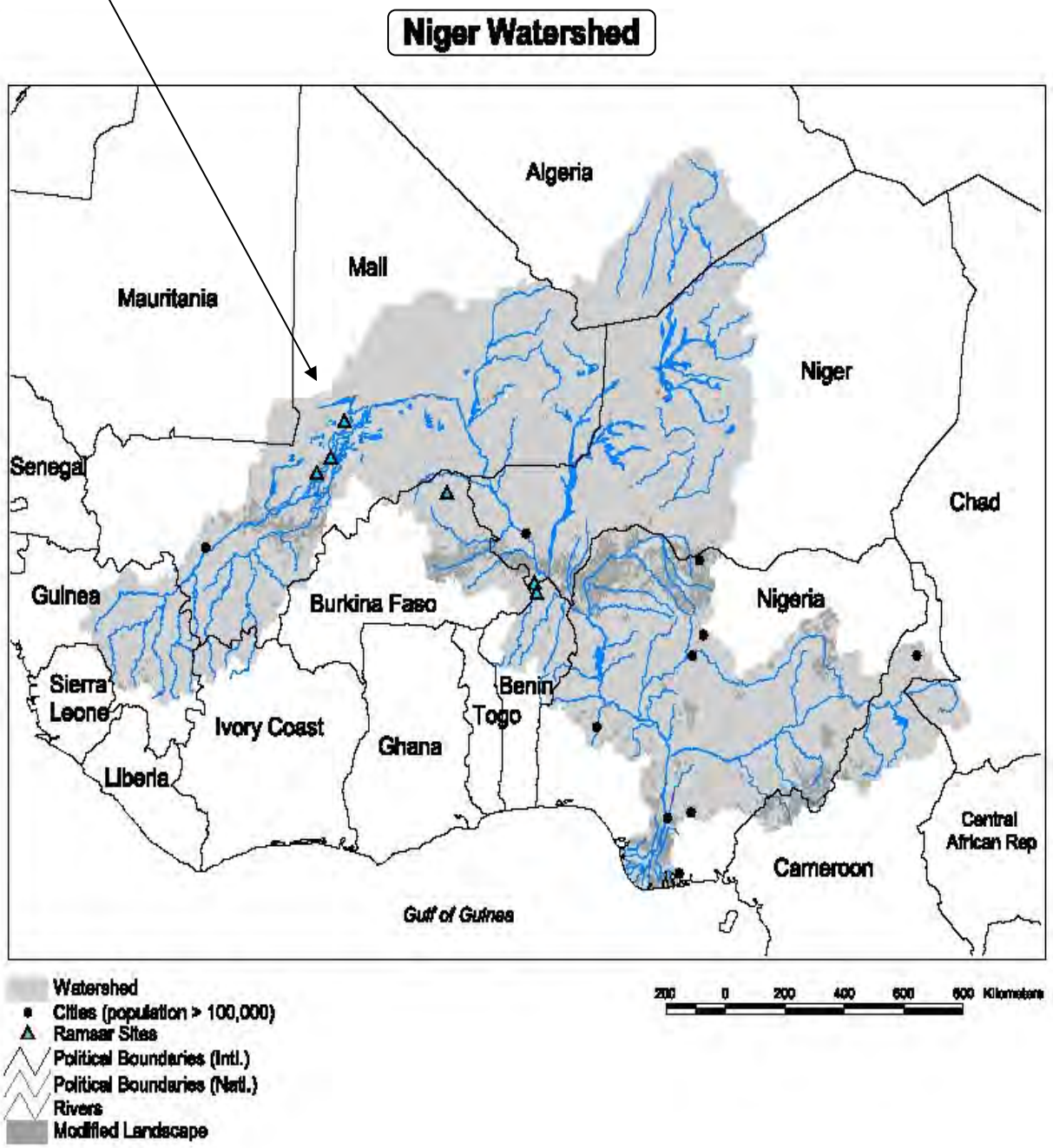

Figure 4.1: Location Map of the Inland Delta of the Niger River in Mali
*(**Source:** Passchier, et al., 2005)*

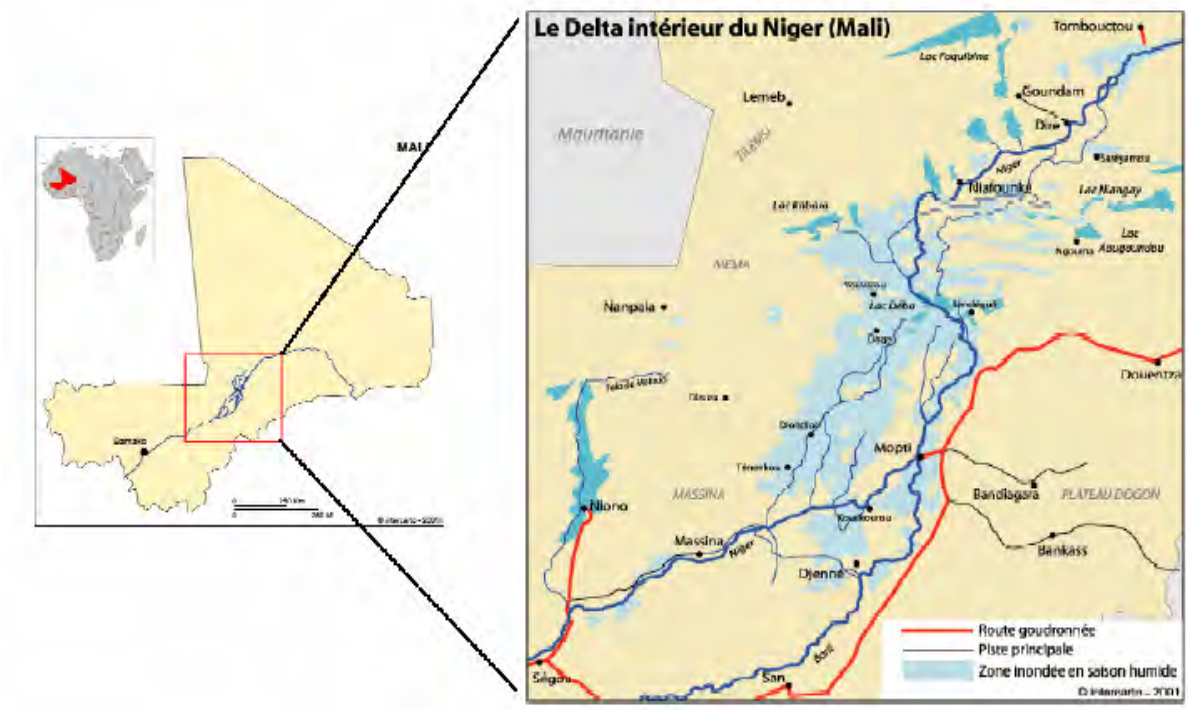

Figure 4.2: Map showing the detail of Inner Delta Region of Mali.
***(Source:** Marie-Laure de Noray, 2003)*

However, after the abundant floods of 1994, the annual fish production tripled. Approximately, 100 000 tonnes of fish were captured in the delta, three times the amountof fish captured in 1993, despite the droughts in the 1970's and 1980's. The traditionalproduction systems in this ecosystem take this variability into account and peasants havedifferent strategies to cope. They have a great mobility of labour, so they make use of the resourceswherever they are available in this ecosystem. Also, families in the delta region have more than oneprofessional activity, which allows them to select those activities in a given year that are likely to secure them sufficient revenues or food (Diarra,*et al.*, 2004).

Three main categories of fishermen can be identified in the central Niger delta, depending on the time devoted to fishing, the amount of fishing gear (capital invested), and the way of life of the communities concerned. First, is the *farmer* – fishermen (rimaïbé, bambara, marka, songhaï), they are the type of fishermen that fish occasionally at subsistence level (personal consumption). They live majorly on agriculture as a profession. The second category is *the sedentary professional fishermen* (bozo and somono), these are those who fishing represents a full – time economic activity, but who have not fully severed their ties with the land. The third category is the *migrant*

professional fishermen (mainly bozo), these are those who devote most of their labour power to fishing in order to maximise their investments in the sub-sector.Fishing boats are majorly made of planks nailed together, estimated to be about 25,000 and are rarely motorised. The use of gears and fishing methods employed by fishermen in the delta region vary with the season. They use gill nets, fish traps (durankoro), cast nets and long lines. Seines net are also used for flood recession fishing and during collective fishing, (OCAR, 2004).

Fish consumption is estimated at around 10.5 kg /year/inhabitant, whereas that of meat is about 7.8 kg/year/inhabitant. The number of fishermen is estimated on average at 70 000, grouped into about 33,000 households of seven members on average. About 260 000 persons are concerned by fishing, representing 3.6% of the whole Malian rural population (around 7.2 million). Taking into account jobs generated upstream and downstream of the fisheries sub-sector, the minimum estimate is 285,000 jobs in total, i.e. about 7.2% of the working population,(OCAR, 2004).

4.1.5 Republic of Niger

Republic of Niger, covers a surface area of 1 287 000 Km^2 and is locatedbetween longitudes $0^0 16^0$ and 16^0 East and latitudes $11^0 01^0$ and $23^0 17^0$ North. Republic of Niger has Niger River and its right bank tributaries as her main source of surface water with average quantity of flowed outwater to be about 31 billion m^3 per year, while surfaces liable to flooding is estimated to be 63 000ha.The length of Niger River is estimated to be 600 Km, (Republic of Niger, 2000).

4.1.6 Fishing

The richness of Republic of Niger waters in fishes is a major advantage for the food security ofthe country because fish, in many cases, is the main source of animal proteins. Theexploitation and development of fishery resources contribute equally, in a decisive way,to the GDP and to the balance of payments; therefore it is useful in poverty control.Niger surface waters in which fishing activities are carried out are over about 600 000 ha.

Niger River fluctuates from year to year with respect to seasons. The itchy- fauna of Niger River in Republic of Niger is represented by 112 species and this fish production has been very variable these last years. For example, fish production has passed from 20,000 tons in the 1970's to 5,000 tons in 1986, whereas the normal potential is estimated at 30,000 tons peryear.

Republic of Niger has important water potentials; this resource appears as a limiting factor because of its insufficient exploitation. Beyond 1973 drought, it is noted, among others, that the silting up of lakes and riversaccelerated up streams by deforestation, wind and hydrous erosion, anarchicoccupation and without thinking of the flooding plains, which are the areas for fish reproduction.This degradation,combined with the effect of construction of dikes(for irrigation purposes) and the absence of coherent policies and regulations of water resources uses and fisheries managementat the national level has resulted in the constant decline of fish production since 1981 (16 400 tons in 1972; 8,000 tons in 1980; 6,000 tons in 1982; and between 2,000 and 4,100 tons/year since 1990) (FAO, 2002).

The last ichtyobiological studies carried out on the Republic of Niger part of the Niger River in 1962, 1971 and 1987 confirmed the persistence ofspecies diversity with a decrease in their abundance. This confirmationestablishes that drought conditions alone do not make some species disappear although several ofthem have become rare in their captures.Fishing activitiesare partly relying onseasonal floods of alluvial plains for fish stocking and reproduction which can bejeopardized by the discharge modification or hydro-agricultural lands development, (Republic of Niger, 2000)**.**

Moreover, the fishing activities of fishermen of Niger River also place undue pressure on the fish production in the ecosystem. The low catches and the necessityto recover the high costs of the fishing gears force them to use prohibited gears and tofish during closed season with obviousnegative effects on the resources, (FAO, 2002)

Anothermore worrying phenomenon is the infestation of lakes and rivers by invading plants. Itis the case of the water hyacinth in Niger. The negative impacts all these factors placed on the aquatic habitat is the disappearance of eight (8) fish species from the landings of the Niger River fishermen. This is a great loss for the fish (biological) diversity of Niger. If actions are not taken immediately (without wasting any time longer) toreverse the trend, Niger is risking to lose the contribution of the fishing sector to thenational economy, estimated every year, on average, at more than twelve billionfrancs CFA/year.

Actions to be taken are:

1. Preservation of river banks
2. Preservation of plantations
3. Preservation of integrated developed Lands
4. Water hyacinth control and
5. The implementation of the law N°98-042of 29 December 1998 relating to fishing

Regarding fish exploitation, it is essentially traditional and seasonal. Numerous Water Management Plans indicate high fish potential, which are often under exploited andfaced with series of challenges including:

1. High evaporation;
2. Gradual silting;
3. Overrunning by water plants suchas water hyacinth *(Echornia crassipes), pistia stratoites nymphea* sp;
4. Anarchicoccupation of the banks;
5. Lack of adequate management measures;
6. Limited accessibility for fish exploitation;
7. The remoteness of fish landing sites;
8. Indiscriminate use of fishing gear which are not selective and often destructive, thus making the renewability of the stock difficult, (Republic of Niger, 2000).

Nigeria

The River Niger enters Nigeria from Niger Republic about 162 km north of Kainji Lake. The Sokoto River joins the Niger River about 75 km downstream, having altogether about 470 000 ha of seasonal flood plains on the Niger/Sokoto system, with some multipurpose reservoirs. Sokoto River forms a confluence with Rima River in the Argungu area. The most active fishing takes place during the dry season (January to April). During the wet season months (May to September) fishermen engage in farming and do fishing part-time. This local government area is noted for its Fishing Festival which has gained both national and international recognition.

Another major tributary of the Niger is the Kaduna River. It has its source from Jos – plateau flow toward northwest direction and then southward to join the Niger downstream of Wuya at Pategi. It

covers a distance of about 575 km and drains an area of about 66 300 km^2 of diverse topography. The Niger River is dammed at Shiroro with a surface area of about 312 km^2.

Commercial fish catch statistics of Niger River along Jebba to Lokoja obtained in November/December 1985 showed the numerical predominance of *Tilapia* (25.6%) followed by *Synodontis* (24.8%) and *Labeo* (8.3%), *Citharinus* (6.3%), *Schilbe* (6%), *Mormyrus* (5.6%), *Bagrus* (5.2%), *Alestes* (4.6%), *Gymnarchus* (3.3%), *Clarias* (2.6%), *Lates* (2.5%), *Heterotis*(2.2%) and *Chrysichthys* (1.4%). Other species of lesser economic importance included *Auchenoglanis, Clarotes, Malapterurus, Heterobranchus* and *Distichodus*, (Ita, 1993).

4.1.7 Effect of Niger River Dam on Lake Ndakolowu

Lake Ndakolowu (Lake Tatabu) is a floodplain lake of the River Niger downstream of Jebba Dam. It is located between 9° 12' –9° 14'N and 4°52' –4°58'E, about 24 km from Jebba. It is one of the most badly affected floodplain Lakes by the damming of the Niger River at Kainji in 1968 and at Jebba in 1983, and the subsequent water control from these dams. This resulted in drastic reduction of the floodplains downstream of Jebba Dam up to Lokoja and beyond.

In 1971 the surface area of the Lake was estimated at 9 km^2 and by 1977 it was reduced to 6 km^2. By 1979 the area was much less than 6 km^2 and after the completion of Jebba Dam in 1983 the open water area of the lake was completely obliterated and the lake was reduced to pockets of overgrown swamps. In April 1988 the lake completely dried up, with terrestrial vegetation covering the entire area, leaving a few ponds here and there. However, between April and June 1988, the embankment along the Niger River was excavated down to the level of water in the river in order to permit inflow of water, along the 6km channel, into the Lake during the flood. The experiment was successful and in September 1988 the Lake was restored with increased fish landings, (Ita, 1993).

4.1.8 Kainji Lake

Kainji Lake was the secondand the largest dam on the Niger River, constructed between 1962 and1968. It has a maximum surface area of 1 300 km^2, length of 137km, width of 24km and depth of 60 meters, (Abiodun, 2002; Laë, *et al.,* 2003; Omojowo, *et al.,* 2010).

Kainji Lake (Figure 4.3) is in the Guinea savannah vegetation zone of the north-western Nigeria. Kainji Lake is located between longitude 9^0 50^0 and 10^0 55^0 East and Latitude 4^0 20^0 and 4^0 45^0 north, (Omojowo, *et al.,* 2010).

The construction of Kainji Lake has a negative effect on the fish population of Niger River in Nigeria. It was recorded by Otobo (1978) that fish catches between Jebba and Lokoja decreased by 50% in the three years period from 1967 to 1969. Also, there are changes in the fish community composition with a decline of Characidae, Mormyridae and Clariidae and an increase of the predatory species like *Lates niloticus* or some Bagridae species (Sagua, 1978).

The annual fish yield of Kainji Lake from year 1995 to year 2001 is shown in Table 4.1 below.

Table 4.1: Statistics of annual fish catch in Kainji Lake (1995 – 2001)

Year	Annual yield (metric ton)
1995	34 474
1996	38 346
1997	28 753
1998	28 851
1999	16 351
2000	13 375
2001	13 361

(**Source**: Abiodun, 2002.)

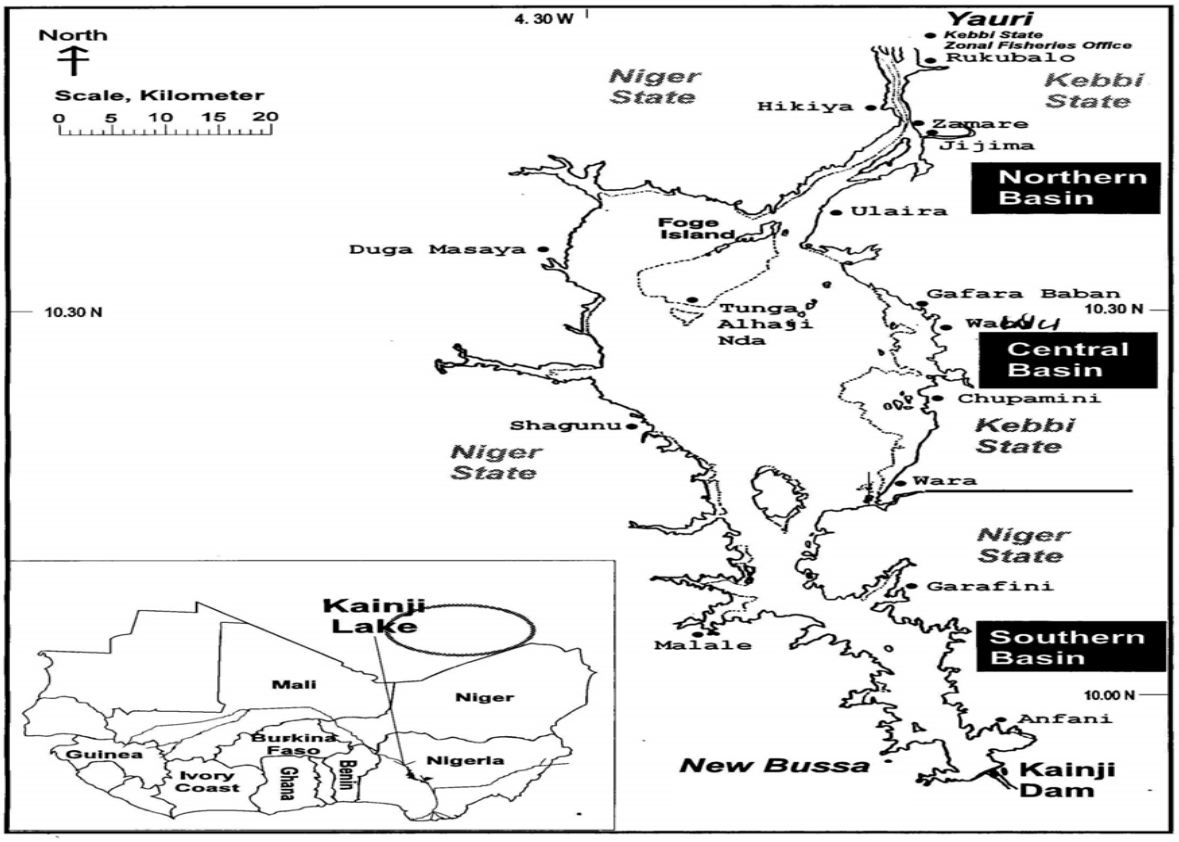

Figure 4.3: Lake Kainji in Nigeria
*(**Source:** Omojowo, et al., 2010)*

4.2 Senegal River

The Senegal River has multipurpose use, as it is critical to local populations who rely on it for energy production, land irrigation, and potable water. Its importance in the region is heightened by its location at the Sahel, which is plagued by drought, poverty, and underdevelopment and access to a water resource. Fishing, in terms of the income of the work force that it employs, is undoubtedly the largest economic activity in the basin after agriculture, notably for populations living near the river in the valley and the delta. Today, however, the future of this sector is in question because for several years now there has been a steady drop in the tonnage caught throughout the OMVS region (i.e. the basin area shared by Mali, Mauritania and Senegal). Some observers link this to the river development projects (dams, dikes) and to their impact on the environment (significant decrease in salinity, proliferation of floating water weeds, eutrophication, etc.).

4.2.1 Constraints/Challenges to Fisheries Development in Niger River Basin

The constraints and challenges to fisheries Development is similar in all of the three basins. With the expanse of length and area attributed to the River Basins, it is expected that the Basins should yield its maximum potential opportunities. The increasing intensive and indiscriminate exploitation by the rapidly, expanding human population have adversely altered flood plain ecology with consequence on itsfisheries. When combined with natural stresses such as droughts, have- resulted in reduced productivity and low carrying capacity. And yet adequate scientific information on most of theflood plains are scanty to ensure long-term sustainability of fishery resources at levels whichpromote optimum utilization and maintaining availability for present and future generation. Some factors that hindered the productivity of the Basins are highlighted below:

1. ***Overfishing***

FAO has confirmed that most inland capture fisheries are overfished or are being fished at their biological limit (FAO, 2003). This has led to substantial change in the fish populations inhabiting rivers and lakes and to changes in fish catch. Inland fisheries are characterized by large numbers of small species and small individuals, and small numbers of large species and large individuals (McDowall, 1994). Because of their small numbers and lower growth rates these large fish are more prone to depletion (Allan *et al.,* 2005), especially where they are the focus of targeted fisheries. However large and medium sized fish dominated the 1940s catch, while the current catch is dominated by small fish (Allan *et al.,* 2005). This was observed in Africa's floodplains fisheries, especially the Ouémé in Benin (Figure 5) (Welcomme, 1971) and Niger in Mali (Laë, 1995).

1. ***Causes of Overfishing***

1. ***Destructive fishing practices:***Destructive fishing practices refer to the use of fishing gears in ways or in places such that one or more key components of an ecosystem are altered, destroyed, devastated or ceases to be able to provide essential ecosystem functions. It can also be seen as fishing practices that not only exploit fish resources with intention of making profits using small effort, but also damage the habitat in the process. Examples of destructive fishing practices are: use of chemical e.g. Gamalin 20, ghost fishing, wrong use of fishing gear (in terms of method and place), and use of explosive e.g dynamites, (Ajagbe, 2014).

2. Open Access in Capture Fisheries: The notion that rivers, lakes and other freshwater bodies are common or public properties grant open access in capture fisheries. Unrestricted entry into the fisheries has resulted in heavy fishing pressure and over exploitation of the stocks. Lack of enforcement of extant regulations in artisanal fisheries is a common problem in developing countries due mainly to lack of manpower, equipment and political factors; (Ifunanya, 2010).It can also cause fishing down the trophic levels of food webs and increases in the incidences for Illegal, Unreported and Unregulated (IUU) fishing (AUC – NEPAD, 2014).

Two types of overfishing that occurs in many water bodies are:

Growth over-fishing: This is a condition when the young fish are caught before reaching their maturity age.

Recruitment over-fishing: This is caused by excessive exploitation of mature and immature fishes which cause the occurrence of significant decreasing of mature fish. This situation will disturb stock recruitment due to limited number of mature and immature fish (Setyohadi *et al.*, 2013).

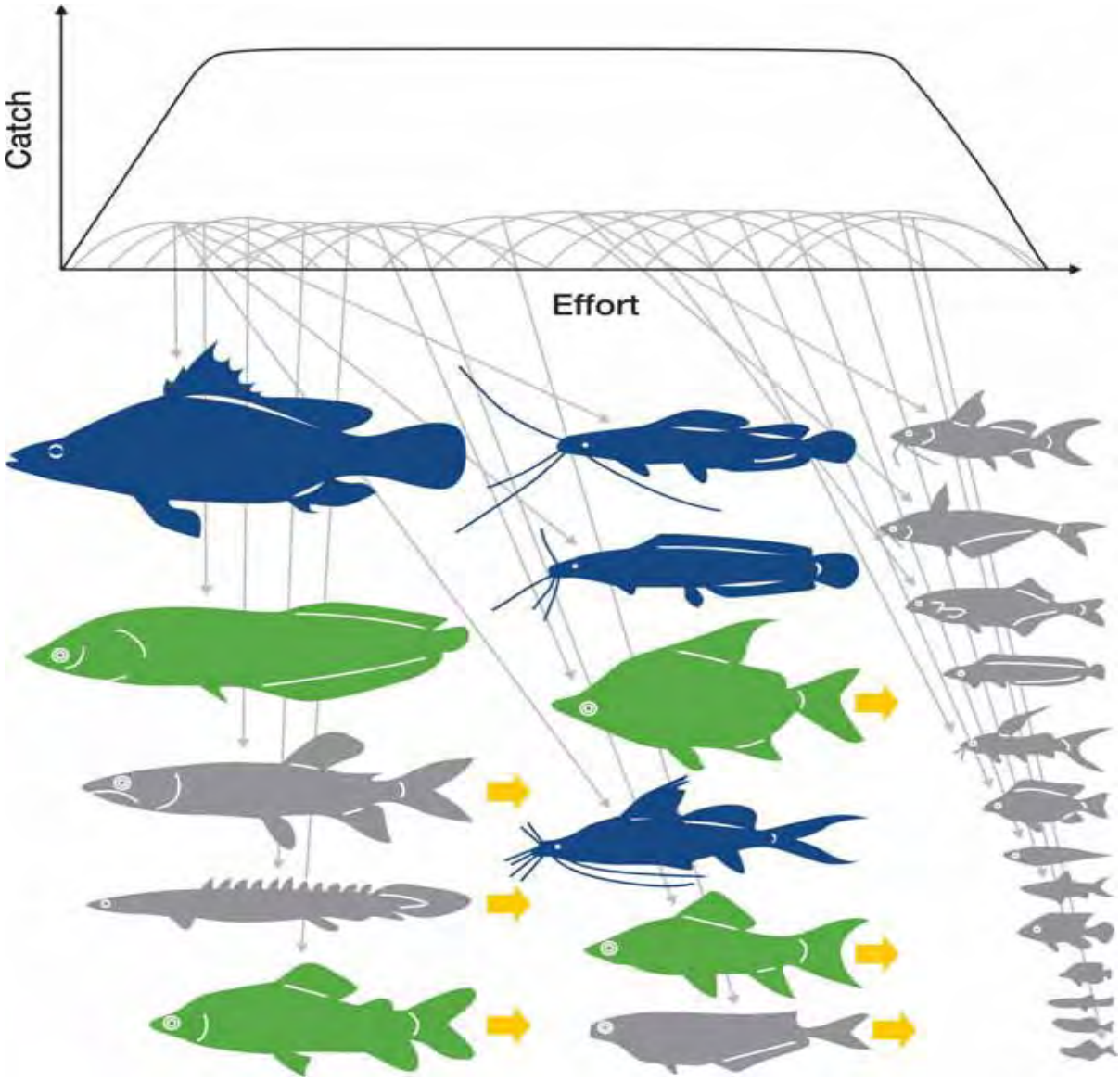

Figure 4.4: Illustration of fishing down using the Ouémé River in West Africa
As the fishing effort increased, catch switched from larger to smaller species and individuals. Species shown in blue disappeared from the fishery and the population sizes of species shown in green were severely reduced. Yellow arrows show species that now breed at smaller size. (Source: Welcomme, 2001).

3. Socio-Economic Condition of the Fisher Folks

Many fishermen / women are poor and marginalized, having few rights of tenure over resources of their livelihoods and few other livelihood options. Many traditional fisher folks do not have the skills necessary to access more lucrative sectors of the economy. For many millions of people, fishing is the only available source of income and animal protein,the situation has forced them to

use prohibited gears and tofish during closed season with obviousnegative effects on the resources, (FAO, 2002).

4. **Increasing Demand for Fish and Fish Products**

The demand forfish and fish products continue to be on increasing rate. This is due to some factors like:

1. Growing populations;
2. Being a cheap source of animal protein;
3. Increasing knowledge of the medicinal benefits of fish;
4. The emergence of an affluent middle class;

5. **Anthropogenic Activities**

Increasing intensity of anthropogenic pressure leads to declines in fish species and diversity, increase of trophic level. SUSFISH Consortium (2015) established that anthropogenic pressure onfisheries varies according to how much fisheries management occurs. Also, that fish size and fish community diversity is associated with the degree and quality of management. It is confirmed that fish taxa can be used as bio-indicators of the impacts of anthropogenicpressures either in the positive or negative sense. For example, *Auchenoglanis* generaand*Hydrocynus* genera could be used as sentinel genera because it is not found in areas of highanthropogenic impact. *Clarias* sp. and *Sarothorodon* sp. increase with pressures, unlikeother species, e.g. *Alestes* sp. and *Schilbe* sp., which are sensitive and decrease in number aspressures rise. *Hemichromis* and, especially, *Tilapia*, correlate positively with hydromorphologicalpressure, but they respond negatively to chemical impacts.Some identifiedanthropogenic threats to aquatic species in West African Catchments are:

1. Habitat Loss or Degradation;
2. Agriculture;
3. Mining;
4. Wood Harvest;
5. Human Settlement;
6. Dam;
7. Invasive Alien Species;
8. Pollution of Water Bodies;

9. Effect of climate change- siltation of River Niger leading to reduced water areas for fishing activities and fish harvest.

10. **Impact of Dam Construction**

Many dams in the Basin have been constructed without prior coordination and consultation with various countries or even with the stakeholders within the same country (Niger Final Brief, 2003). In the construction of dams, the detrimental impacts of the dams on fish biodiversity, stocks and the fisheries in general is always ignored, because environmental impact assessments (EIA) may not be carried out. In Niger River there are about four dams constructed in the Basin. They are:

1. Selengue Lake: It was constructed in 1980 at upstream of Bamako in Mali, as an hydro-electric dam. It has a surface area of 400 km2 and water retention during the flood is estimated to be123 m^3/s;
2. Markala Lake: It was constructed in 1943, at about 250 km downstream of Bamako in Mali. It is a water reserve dam was built in Markala, in order to irrigate by gravity a N-E depression which was formerly an arm of the Niger;
3. Kainji Lake: It was constructed in August 1968; with a surface of the lake is about 1,300 km^2. It is hydro-electric dam;
4. Lagdo reservoir: The upper course of the Benue River was impounded in 1982 for hydroelectric power generation, irrigation and fisheries. The surface of the reservoir would be of the order of 700 km^2 (Laë, *et al.,* 2003).

Consequently, dams have increased the occurrences of waterborne diseases, aquatic macrophytes (e.g. water hyacinth), deforestation, population displacement, and decreased of fish stock. Laë, *et al.,* (2003) reported the emergent aquatic macrophytes in the Kainji Lake. The macrophyte reported include *Echinochloa stagnina*, *Cyperusdistans*, *Pistia stratiotes, Nymphaea lotus, Lemna paucicosta, Phragnites karka, Ipomoea aquatica,Sacciolepis africana* and *Ceratophyllum demersum*, of which *E. stagnina* form the major component.

Obot (1984) compare the percentage of covering of macrophyte in Kainji Lake. In 1971, 0.5% of the Lake surface area was covered with macrophyte but it was8.9 % in 1977. Macrophyte cover is detrimental to fish due to lowered dissolved oxygen, inhibition of phytoplankton production and restriction of the larger fish. More than 50% of the world's large rivers have been fragmented by dams on their main channel, and 59% have fragmented tributaries (UNEP, 2010).

Dam construction can be a barrier to upstream migration of fish, thereby preventing brood stock from reaching their spawning grounds during the breeding season. The dam may also prevent downstream migration for the fish which could also affect spawning and recruitment. This in turn diminishes the production and catch of fish dependent upon this wetland productivity. Also, dams constructed for hydro electric power generation bring a great degree of severe mortality or damage to fishes passing through the discharge structures through abrasion against dam walls, turbine blade mangling, rapid pressure changes, water shearing effects and nitrogen super saturation in the stilling basin (Bernasckek 2001).

River channelization and dredging both remove aquatic habitats directly and alter flow and flood patterns, hence reducing the availability of floodplain habitats. Construction of roads and other infrastructure have similar impacts, reducing wetland connectivity, and diminishing the capacity of aquatic ecosystems to absorb floodwaters and remove pollutants. Water abstraction for irrigation and urban-industrial uses also reduces downstream flows, so diminishing the availability of feeding and breeding habitats, and exacerbating problems of water quality in many locations. Dams also replace the flowing river and its associated aquatic habitats with more static reservoirs whose fisheries are generally less productive than the river fisheries they have replaced, and which benefit different sectors of society (Jackson and Marmulla, 2000; Hoeinghaus *et al.,* 2009).

Soil erosion and silt run-off into the river during dam construction are the main potential environmental impacts on fisheries. OCAR, (2003) confirmed that there is a major danger and risk that the River Niger will become extinct if the silting that has been observed in the last few years continues in this alarming manner. This is because, the combination effect of these create limnological problems of low transparency, poor water quality and impairs the nursery or breeding habitats of fishes (Bernascek 2001).

Limnological problems that often arise in dams include thermal stratification during the dry season. This results in deoxygenation of hypolimnion (the lake bottom) which can reduce the water quality thereby decreasing fish stocks. Turbidity resulting from sediments trap or release from the reservoir can create severe problems of fertility, productivity and pollution for the fish and water body.

To this end PREM (2005) advocated that proposed construction of Fomi (third) dam in Mali should not be encouraged and recommended because of itsindirectdownstream losses in terms of declines in fish production which estimated to be up to 37% (Figure 6). It was confirmed that about 300 000 people in the Inner Niger Delta depend on fisheries for their livelihoods, and as the Niger's discharge has declined, so has the productivity of delta fisheries.

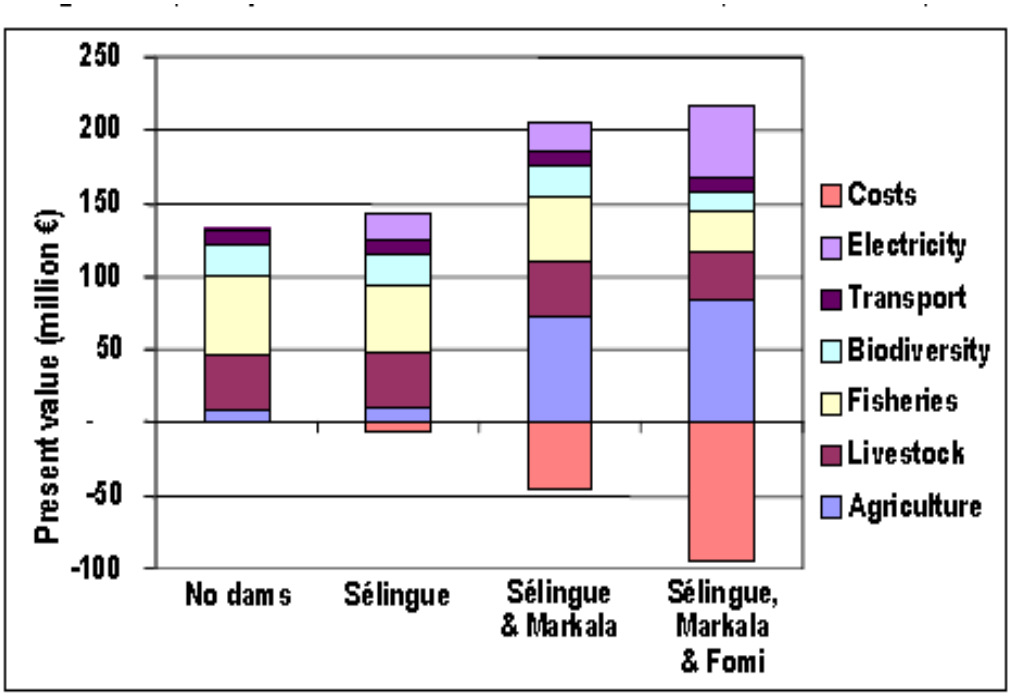

Figure 4.5: The Compound Effects of Dam Construction on Fish Production in the Inner Niger Delta (Source: *PREM, 2005)*

5. **Pollution**

Freshwaters are exposed to both pollution andeutrophication. Pollution arises from the dischargeof toxic materials such as industrial and miningwastes into the water, and is usually directly lethal tofish or serves to discourage them from living in affected habitats. Eutrophication is primarily causedby the discharge of nutrients into the water either bynatural processes or human activities, including agricultureand domestic waste disposal. Excessive build up of nutrients however,especially in lakes, can change the nature of the phytoplankton,reduce dissolved oxygen concentrationsand eventually render the environment unsuitable formany species of fish. Many industrial companies take the opportunity of sufficient water available along the Basin to site their company and in turn rivers and some lakes were usedas open sewers.

6. **Climate Change**

Higher temperatures can cause a range of physiologicalchallenges for fish species. For example, temperature can increased metabolic rate, raise oxygen and food requirements, raise gill ventilation can lead to increased uptake of aquaticpollutants, and higher temperatures can alsoimprove survival of parasites and bacteria. This situationis aggravated by the fact that water retains lessoxygen at higher temperatures. The combination of these challenges may reduce fish survival, growth and reproductive success (Halls, 2009;Welcomme*et al.,* 2010), although, the degree of the impact on individualfisheries are unknown presently.

Also, the effect of hydrological changes caused by climate change is detrimental to fish productivity in Niger Basin. Forexample, the Sahelian drought of the 1980s is estimatedto have reduced the fish catch in the InnerNiger Delta by 50% (from 90,000 tonnes per year to45,000 tonnes), while the Markala and Selingué damsreduced catch by 5000 tonnes (Laë, 1992).

7. **Invasive Fish Species**

The introduction of non-native (alien) invasive speciescan result in major ecological changes in freshwatersystems, including the extinction of native species. Alien species can impact natural fisheries in severalways, including through environmental disturbance,predation, competition, introduction of disease, andgenetic contamination or hybridisation (Welcomme,2001).

8. **Mismanagement of Bye-CatchResources**

Waste characterize as by-catch is a major challenge of Niger Basin fisheries productivity. An unknown percentage of fishermen daily catch that are not marketable because of their size, are return dead into the River. This contributes to reduction of the River fish productivity. Also, many people living around the River lack knowledge of how to live friendly with their environment. Most of the time people living around the River contribute to the River pollution, although presently it may be seen to be at insignificant level. But, aggregate of their actions has a long term detrimental effects.

9. **Inadequate Fish Processing Facilities**

Fish is known to be a highly perishable aquatic resource. Fish begins to spoil, deteriorate and decompose as soon as being caught and taken out of water. Fishing activities takes time and many times, fishing is done far away from the shore (in the deep). Therefore, fish need to be preserved to

maintain freshness till the time fishermen will come back to the shore and sell their catch or process it further as the case may be. But, in many cases there are no such facilities to preserve fish to maintain freshness. In most cases a larger percentage of the catch may have started to spoil and deteriorate before fishermen will get to the shore and these will be taken as waste. Fish processing facilities are majorly limited to smoking and smoking with traditional smoking kiln. This limited the number of fish to process at a particular time and rest may be wasted. Even, the shelf life of smoking fish is limited, meaning that fish cannot be preserved for a long period of time. Dried fish although has a longer period of shelf life than smoking fish but, the process is tedious, time consuming and solar radiation dependent. This may lead to reduction in the quality of fish at the end product. Canning of freshwater fish is not so common. Canning process is capital intensive and majorly most fishermen in the Niger Basin are poor and may not be able to afford the facility. Therefore, post – harvest fish wastes is enormous in Niger River basin. Bolorunduro(1996) as cited by Imaobong and Mandu, (2013)observed that despite the subsistence of the nature of capture fisheries in Nigeria, as much as 50% of post-harvest loses has been recorded.

10. **Aquatic Weeds Menace**

Aquatic weeds infestation in some parts of the River Niger Basin has hampered fishing activities as well as reduced income of the fisherfolks who depends on the lake for their sustainance.

11. **Insecurity**

Insurgency of terrorist activities has paralyzed fishing operations due to fear of loss of lives and properties.

12. **Inadequate Government Regulation (Management Policy)**

In most parts of Niger River stations, there is low or inadequate government regulation that will direct mode of fishing operations in the River. There is no such regulation that will specify the type of gear to use at a certain part of the River and at certain season. There is no such law that regulate period of fishing, number of fishermen to fish at a particular time and how often should they fish at particular period of time. Therefore, many fishermen fish selfishly, greedily and with the thought to harvest all available fish in the River at once without thinking of tomorrow. They compete with themselves. So most often, they harvest more fish than what they need, able to sell or process. Therefore, there will be surplus that will lead to waste.

4.2.2 Restrictions to Management of the Basins

The following factors impair the proper management of the lake as well as the development of management approach for sustainance of the Basins:

1. Poor supply of logistics e.g. project vehicles,outboard engines;
2. No policy on training and administration for staff;
3. Poor research and development-zero research programme;
4. Inadequate fishermen organization and challenges of organizing them;
5. Inadequate manpower to train and carryout developmental research in member states. (no University offering fisheries training programme in some member countries);
6. Inadequate fund for training fisheries management personnel in some member countries.

4.2.3 Constraints/Challenges to Fisheries Development in Senegal Basin

The issues and challenges of the water bodies ranged from the fisheries, fisheries management, effect of climatic change on fisheries, socio-economics, conflict and its management as well as concluded projects on the basins among others**.** Since the last decades, inland fisheries is generally facing depletion of ressources in member countries. In senegal, in 2000, the production was estimated to 54.407 tonnes corresponding to 16, 700 bimillions F CFA (cf Résultats généraux de la pêche continentale, 2001).

Nowadays, catches are estimated in between 32 000 et 42 000 tonnes per year (Enquête cadre UEMOA, 2012). Saint Louis, Sédhiou et Matam provinces recorded the higher catches with respectively 36%, 29% et 25% of national production. Ziguinchor représentes about 65%. Some of the identified challenges include:

1. Loss of flooded plains and nurseries;
2. Increase of salinity, leading to the loss of biodiversity;
3. Dams impacts located on rivers;
4. Increase of aquatiques invaded plants (le Typha, la salade d'eau douce etc.);
5. High Chemical (industrie, agriculture) and domestic pollution of inland waters;
6. Dryness and of several water bodies; some also became sandy;
7. Artisanal boat are old and not enough;
8. Engines and fishing techniques are not selective enough
9. The law (code) applied in terms of inland fisheries is obsolete; loi 63-40 du 10 juin 1963);

10. Fisheries administration is not covering all continental areas (not enough agents);
11. Lack of complete statistical data (some areas are still not covered and the data not recorded);
12. Lack of basical infrastructures for fish processing, transportation, storage and conservation;
13. Low training level and technical skills;
14. low organization level of professionals;
15. Reaserch is not enough involved in inland fisheries matters;
16. Inland waters stocks (ressources) are not known / no stock assessment studies;
17. Lack of interest of credit institutions towards inland fisheries activities
18. Lack of harmonization of laws relevant to inland fisheries for shared resources ;

4.3 Lake Chad Basin

However, several constraints hamper the sector's development, in particular:

(i) The low level of professionalization in the artisanal sector;
(ii) A sector where foreigners have the upper hand which leads to fraudulent exports;
(iii) A lack of involvement of stakeholders in the decision-making process;
(iv) The high cost of purchasing production tools;
(v) The difficulties in product transportation and processing;
(vi) The restrictive technical production conditions;
(vii) The competitive management of natural resources;
(viii) The poor organization of markets;
(ix) The insufficient access to credit;
(x) High post-harvest losses (15-35 %).

The combination of some factors has caused the sector's contribution to GDP to stagnate leading to increased poverty among fisheries-dependent populations.Thus, within the poverty reduction strategy framework, the government has developed a sectoral fisheries strategy focusing on management and on increasing the value of what currently exists (NGOKE *et al*, 2005).

4.3.1 Ecology and Fisheries

Since the 1972/73 drought, there has been a considerable reduction in the number of fish species. The drastic environmental changes which have affected the region have also impacted on the

composition of the fish resources and turn on the catch composition recorded by fishers (Neiland *et al*., 2005). During the dry period (1972 to 1978), natural selection operating on the fish communities favoured marshy species (eg.Such as*Clarias* catfish, Tilapia, Cichclids and *Heterotis* spp) that physiologically and behaviorallyarewelladapted to survive this unstable hostile environment of low water, high temperaturesand low dissolved oxygen that now dominate the ecosystem.

The freshwater sardine (*Alestes*) and the catfish (*Clarias*) are the two dominant and abundant fish species in the Lake Chad Basin. According to Neiland *et al.* (2005), before 1970, the small Sardine-like fish called *Alestes baremose*, was an important componentof the fisheries of the Lake Chad Basin. Feeding entirely on zooplankton throughout its life cycle, *Alestes*was abundant in the zones of the reed bed islands and the archipelago of the Lake and wasalso found in the open waters. During periods of rising river levels and flooding (October-December), huge numbers of *Alestes* would migrate into the Rivers Logone and Chari andinvade the surrounding floodplain to breed in the shallow waters. With the subsequentdecrease in water levels, a few months later, the adult and juveniles would retreat into themain channels and eventually into the lake. The annual cycle of migration of both adult and juveniles, which is adapted to the hydrological patterns, is crucial to the maintenance of the stock of *Alestes* in the LCB System.

The setting of fishing nets along river channels and in the floodplain areas of northern Cameroon, in particular, was also timed to coincide with this pattern of migration, and as a result, this species made up a large part of the catch in these seasonal riverine fisheries.

Since 1970 to date, the fisheries of the LCB have witnessed a significant decline in catches of *Alestes*. Instead, the fisheries are now dominated by *Clarias* catfish. One of the main reasons for this is the change in environmental conditions of the LCB. The recent Sahelian drought periods, decline of river flows, the reduction in the size ofthe lake and the emergence of a large area of swampland in the north and south basins havenot favoured fish such as *Alestes*. The life cycle and migration of *Alestes* has been severelydisrupted. Instead, highly resilient and fast breeding omnivorous fish, such as *Clarias* have taken their place.*Clarias* is well adapted to the new swampland conditions as it can evenbreathe air, through auxiliary gills under hypoxic conditions in the low water season. *Alestes*remain a minor component of the river fisheries in the region at present.

Ecologically, typical lacustrine (open water) species such as *Lates, Gymnarchus,Distichodus* and *Hydrocynus* have either completely disappeared or are highly reduced/restricted to the small portion of open water of the lake, larger river channels and floodplain lakes of the Logone and Chari. Major fish species are shown inTable 4.2, and as isevident, marshy species currently dominate the fisheries.

Over the past 40 years, the Lake Chad has experienced fluctuations in climatic and environmental conditions that have led to significant changes in the distribution of aquatic habitats. Most notable, as a consequence of the Sahelian drought of 1972 to 1974 and 1982 to 1984, which produced a lasting modification of the lacustrine hydrology, there has been marked changes in the taxonomic composition, distribution, diversity and production of the fisheries (Benech et al., 1979; 1983; Jolley *et al*., 2002). Despite these changes, the Lake Chad and its wetlands, unlike other continental fluvio systems, have displayed an exceptional performance in terms of productive capacity and resources available to fishermen (Sagua 1991; Jolley, 2002)

Table 4.2: Percentage Composition of Major Fish Species in the Lake Chad Basin

Genera	Baga-Kawa, Nigeria	Kinnassarum, Chad	Mean value
Alestes	0.43	3.27	1.85
Auchenoglanis	-	1.78	0.89
Bagrus	-	2.54	1.27
Clarias	50.05	23.02	36.54
Distichodus	-	0.01	0.01
Gymnarchus	0.01	17.0	8.51
Gnathonemus	-	-	-
Heterotis	18.89	25.17	22.03
Hydrocynus	-	3.25	1.63
Hyperopisus	-	0.42	0.21
Labeo	0.01	0.21	0.11
Lates	-	4.36	2.18
Mormyrus	2.07	0.35	1.21
Peterocephalus	-	0.53	0.27
Petersius	-	-	-
Polypterus	-	0.38	0.19
Protopterus	2,90	-	1.45
Schilbe	-	-	-
Synodontis	0.01	0.69	0.35
Tilapiine cichlids	25.37	16.95	21.16
Total	**100**	**100**	**100**

(**Source**: Jolly et al., 2002.)

4.3.2 Socio-Economic Considerations

The fisheries of the LCB, comprising harvests from the lake itself, the rivers andfloodplains, are among the largest and most productive in continental Africa (Neiland,2005). These fisheries have played, and will continue to play crucial roles in the regional and national economies with annual fisheries production of about 100 000 tonnes and an annual fish trade that is worth over US$54 million (Neiland *et al*., 2005). In addition the fisheries contribute significantly to household income, food/ nutrition security and employment, and provides an important safety-net for rural communities for whom the risks involved with relying exclusively on agricultural production are high (Ovie *et al.*, 2000; Béné *et al.*, 2003a; Neiland and Béné, 2004).In times of economic crises, such as crop failure, artisanal fisheries provide alternativeand vital sources of livelihoods to rural households. The fisheries provide employment,income and food/nutritional security to over 10 million people in and around thefishing communities, while at the same time generating secondary

employment for fishprocessors, fish sellers, transporters and numerous ancillary market–based actors (Bénéet *al.*, 2003a; Ovie *et al.*, 2007a and 2007b).

Overall, the fisheries make an important contribution to underpinning thelivelihoods of thousands of rural households in the LCB, where fishing and farmingare the mainstay occupations. Throughout the year, local populations are alternatelyor simultaneously fishers, farmers and herders, and each part of land is potentially afishing ground, a grazing area and a cultured field of arable crops, depending on theflood cycle (Béné *et al*., 2005). Sagua (1991) estimated the number of rural households engaged in fishing activities in the LCB to be as high as two hundred thousand (200,000) persons.

Fish markets and fish trade are important and age long cultural component of the ruralpeople of the Lake Chad Basin, contributing significantly to national and regional economies of theriparian countries and the wider society. Fishtrade has contributed profoundly to subsistence livelihoods and poverty alleviationin the region.There are two major components to the fish trade in the LCB. First, is a local tradewithin each country, with fishers and local merchants supplying both fresh and someprocessed fish to local markets within villages and towns. This trade does not involvelong distance or cross border transportation and occurs in close proximity to fishinggrounds and landing sites. The second component of the fish trade involves longdistance cross border transportation of processed (smoked or sundried) fish to distantmarkets far from fishing grounds. For example, a large proportion of fish productsfrom Cameroon, Niger and Chad are moved by their nationals into Doro Baga fishmarket in Nigeria on a weekly basis. From Doro Baga, the fish product is trucked to distant Southern Nigeria wholesale/Retail fish market – a distance of over 1000km. Over 80-90% of the fish products from the basin end up in these Southern Nigeria fish markets as shown in Table 4.3. This long distance cross border fish product trade is a more recent development which emanated in the past fifty years with the growth and expansion of urban cities and markets, better infrastructure, most especially road, and through the entrepreneurial activities of merchants.

A number of in-depth donor-driven fish market trade studies of the Lake Chad Basin was undertaken and funded by EU, DFID, FAO, DFID/FAO- Sustainable Fisheries Livelihoods Programme SFLP, WorldFish to mention a few. Thesestudies which were multi-institutional and multi-disciplinary in design, involved all theriparian countries of Cameroon, Central African

Republic, Chad, Niger and Nigeriaworking in parallel or simultaneously. Empirical data from the most recent studies onfish market trade with respect to fish volume and value and fish product destination are presented in Table .4.

The total volume (weight) and value (money) of fish traded in the Chad Basin from September 2002 to September 2003, under the DFID/FAO-SFLP study was 119,034 tonnes and approximately US$54m, respectively (Jolley *et al.*, 2002; Ovie*et al*., 2007a and b). Assuming an auto-consumption of about 15-20 percent, the annual production and value would range from 136,889 to 142,841tonnes and US$62 - US$64 million, respectively(Jolley*et al*., 2002). Nigeria accounted for about 40 percent of thetotal annual basin production.

The combined Southern Nigeria urban markets of Onitsha, Enugu, Lagos, Ibadan, Ilorin, Benin and Ondo (Figure 4.5), take the bulk of the fish products. In these markets, unlike in the Chad Basin, fish trade is predominantly women-driven,providing them with much needed income their empowerment in fulfillment of thethird objective of the Millennium Development Goals (MDGs).Overall, therefore, the fisheries and markets are huge, contributing enormously tothe regional and local economies and, consequently, to food security and sustainablelivelihoods.

Table 4.3: The Fish Trade in the Lake Chad Basin measured by Fisheries Information Monitoring System (FIMS) 2002-2003

Country	Volume of fish traded (tonnes, wet weight)	Value of fish traded (US$000's) (%)	Main markets
Cameroon	24,800	8,000 (15)	Local, Urban, Nigeria
CAR	530	254 (< 1)	Local, Urban, Chad
Chad	10,873	6,400 (10)	Local, Urban, Nigeria
Niger	37,840	14,800 (27)	Local, Nigeria
Nigeria	45,864	26,000 (48)	Loacl, Urban, Southern Nigeria
Total	119,034	53,854 (100)	

(**Source**: Adapted from Neiland and Béné (eds) (2004))

4.3.3 Climate Change and Fisheries

The issue of climate change/global warming and the threat it poses to small-scale and commercial fisheries and aquaculture has been acknowledged (Daw *et al.,* 2009). Environmental change, either due to anthropogenic green house induced gases ornatural climatic variability is impacting

fisheries and other natural resources, throughenvironmental and biodiversity changes. In the Lake Chad basin (LCB), these changeswhich occur at both national and regional levels, have not only constrained livelihoods,but have also exacerbated community vulnerability in an environment that is alreadyimpoverished.

UNEP (2004) acknowledged that the LCB, the lake itself and the naturalresources and services they hold for the riparian communities are under threat fromenvironmental, hydrological and biophysical changes due to anthropogenic climatechange, natural climatic variability and anthropogenic stream flow modification. Thesefactors have combined to account for the drastic reduction of water in the LCB andthe lake itself leading to loss of fishing, agriculture and pastoral grounds; with severeimplications for riparian livelihoods in terms of income generation, employment andfood/nutrition security. Over the years, communities in the LCB have had to adoptdifferent livelihoods strategies and portfolios in response to significant changes inhydrology and ecology manifested through reduced hydrologic cycle and surfacerunoff/underground water.

FAO (2004), the LCB is unique in the sense that "nowhere else inthe world is such a large freshwater reservoir found so far from seas and oceans and insuch a hot and arid climate. The lake has always been a point of attraction for human,animals and plants, all of which have had to learn how to leave in balance with a fragileenvironment that is changing over time in response to both slow and fast variables".The natural resources of the LCB are of strategic socio-economic importance not onlyto the immediate riparian communities but also to the wider national and regionaleconomies (Béné *et al*., 2003b; 2003c; Neiland *et al*., 2005).

This strategic importance,perhaps, informed its selection for this case study. In terms of fisheries, the LakeChad and its floodplain/wetlands represent the single most important Inland water fisheries ecosystem in both West and Central Africa (Neiland, 1998; Jolley *et al.,* 2002).
Regionally (Nigeria, Niger, Cameroon and Chad combined), about 150 000 tonnes offish, valued at about US$54million (whole sale value) are landed annually (Jolley *et al.*,2002; Béné *et al*., 2003b; Neiland *et al*., 2003; Ovie *et al.*, 2007b). A nodal fish market,capturing processed fish products from the riparian countries, has been established andoperational on a weekly basis in Doro Baga on the Nigerian shores of the lake. Thismarket has informally acquired an international status.

Since 1972, the fisheries, agriculture and livestock resources of the LCB have been greatly influenced by the massive environmental changes that have occurred in theregion. In particular, the huge reduction in lake area of over 25 000 km^2 in the 1960s to 2 500-6 000 km^2in the 1980/1990s (Neiland *et al*., 2002), has greatly influenced the livesof the rural population of about 37 million that are dependent on the natural resources of the basin. The severe droughts of 1972 – 1974 and 1981 – 1982 that largely accounted for this scenario and believed to be due to climate change, manifested in significantsocio-economic and ecological disruption (Béné *et al*., 2003a). Certainly, there is needto focus on this all-important sahelian water body because of the huge benefits it isdelivering to the riparian communities and the wider society.

Climate change effects causing increased evapo-transpiration and reducedprecipitation will have serious impacts in river flows and dynamics as well as lake levelsand temperatures. Reduced river discharge is expected to result in enormous losses inaquatic biodiversity globally by 2070 (Xenopoulos *et al.*, 2005). Reduced discharges arefor example known to disconnect main river channels from floodplains and wetlandsthat are necessary for many species to complete their life cycles (Xenopoulos *et al.*,2005). As the survival of many aquatic organisms is tightly linked to temporal variationin flow (Poff *et al.*1997; Bunn and Arthington, 2002), small variations in discharge can have dramatic effects on the success of breeding migration and annual recruitment (Dudgeon, 2000).

Aside from reduced precipitation, the huge evapo-transpiration inthe LCB (2 000 mm/annum) compared to annual rainfall (200-300 mm) (Chouret and Lemoalle. 1975) is of major significance to the overall hydrology and fisheries and other natural resources of the basin. The declining *Alestes* fisheries of the Chari Logone (an important pelagic commercial fisheries of the LCB in the 1970s, is a case in point. The systematic reduction in rainfall and river flow the Chari-Logone and the Komadugu-Yobe River subsystems has almost wiped out this important source of income and food /nutrition security for the poor riparian communities of the basin.Interactions between reduction in flow, temperature increases and human inducedimpacts such as industrial pollution, eutrophication, channelization/water abstractionfor irrigation and other physical modifications of rivers as is currently occurring in the LCB will further stress fish stocks (UNEP GIWA, 2004; Matthew, 1998; Ficke *et al.*,2005) and aquatic communities and thus ecosystem structure and function (Schlosser*et al.*, 2000; Ficke *et al.*, 2005; FAO, 2004).

It is also expected that climate change will lead to increased toxic algal blooms and secondary infections of fishes (Steedman, 1991). Increased temperatures are known to exacerbate the bloom of certain blue green algae that have been implicated in mass fishkills in reservoirs, lakes and flood plains. Though of high human health benefits, theproliferation of the blue-green algae, *Spirulina,* in wadis (salt or brackish water pools)in the Chad Basin is noted for "excluding any other living organism" as it thrives inhigh temperature and high pH environment (FAO, 2004).

Spirulina is a high value natural dietthat has sustained local people in the basin for centuries not only as a vital food sourcebut also as a means of income generation. The health importance is legion: lowering ofcholesterol levels; enhancement of immune system; effective in the treatment of obesityand heart disease; prevention stress, arthritis and anaemia, osteoporosis and cancer (FAO, 2004).

The incidence of parasite transmissions are also associated, not only with hostcondition and the presence of intermediate hosts necessary for the parasites life cycle,but also with water quality and temperature effects (Marcogliese, 2001). The immunefunction of fish is compromised by the presence of stressors, including crowding, hightemperatures and osmotic stress associated with elevated salt concentration due tolow water volume in the LCB. For example, rates of bacteria infections in aquaculture systems often peak at high temperature (Wedemeyer, 1996). Climate change has been predicted to alter host parasite dynamics by changing transmission opportunities andhost susceptibility (Roessig *et al.*, 2005).

Observed thermal effects on parasites, fishes, and water quality suggest that globalwarming may well increase the virulence of certain fish pathogens and the transmissionof certain parasites (Ficke *et al.*, 2005). Parasitism and disease outbreaks can causeincreased fish mortality, slower growth rates and lower marketability and economicreturns of fish (Harvel *et al*., 2002).Any impacts on fish biodiversity will also have serious consequences for livelihoodsand well being of the fisheries dependent communities, and the implementation ofeffective conservation and policy measures to stem the expected impacts of climatechange are urgently required.

4.3.4 Potential Impact of Climate Change on Fisheries of Lake Chad Basin

Influence of reduced river flows and basin levels on the productivity of LCB fisheries due to increased temperature and reduced rainfall is an important issue on the LCB fisheries.Higher temperatures and reduced rainfall would combine to reduce the extent of floodplain or wetland areas that are critical for fish breeding and nursery. Climate changehas been predicted to impact freshwater fisheries through incremental changes intemperature, nutrient levels and lower dry season water volumes, leading to changesin sex ratios and altered time of spawning, migration and peak abundance (Daw *et al.*, 2009).

The level of river discharge has been described as an index of ecological space andhabitat heterogeneity for fish survival, growth and reproduction (Xenopoulos, 2003).Oberdorff *et al*, (1995), Poff *et al*. (2001) and UNEP GIWA (2004) have indicated apositive correlation between enhanced river discharge, lake and floodplain areas andspecies diversity. While experimental tests linking the effects of river discharge onspecies diversity are difficult and currently lacking, several studies suggest that droughtand reduced river flows have marked adverse effects on community composition,diversity, size structure of populations, spawning and recruitment of fish (Poff *et al*.,2001; Lake, 2003).

The Chari-Logone river systems, including minor flows from the El Beid and theKomadugu-Yobe River are the major sources of water to Lake Chad and will be mostaffected if temperatures rise and rainfall decreases. Variations in river flow would leadto disturbances in flood pattern including extent, timing and duration.Such a scenario is already occurring in the LCB based on time series trends ofthe transition from the ‘mega’ to the current ‘lesser’ Chad phase. Declines in rainfalldue to climate change scenarios and human stream flow modification due principallyto dams, have led to reduced river flows and shrinking wetlands, thus reducing thedistribution and abundance of fish in the Lake basin. For example, the Yaere floodplain in Cameroon, undoubtedly the most significant breeding and nursery wetlandin the LCB, and fed principally by the Logone River has experienced not only asignificant reduction in river flow due to damming but also a remarkable decline in theannual recruitment of juvenile fish from this productive habitat and nursery refugiainto the main bowl of the lake.

In addition, change in species from typical open waterto marshy species is also occurring.Low water has altered the physical environment leading to changes of fish species at boththe individual (physiology) and population levels e.g. spawning, larval dispersal/retention andannual or decadal recruitment (Conwen *et al.*, 2000; Soto, 2002). The commercial *Alestes*fisheries in the Chari-Logone system river have declined drastically in addition to severalhighly valued and abundant commercial pelagic species such as *Lates* and *Hydrocynus*(Neiland *et .al.* 2005). Over 90 percent reduction of fish in the Waza-Logone floodplain was reported (IUCN, 2002b) in addition to massive destruction of nursery grounds especiallyin the Yaeres. Annual juvenile fish recruitment from this dominant floodplain into the LakeChad is currently greatly compromised due to climate change variability and anthropogenicstream flow modification. Reduced flow from the Yaeres has also reduced the amount of nutrients carried asits water travels through the El-beid into the Lake proper, leading to reduced primaryproductivity and with implications for both herbivores and zooplanktivores

4.3.5 Effect on Fisheries, Aquaculture Livelihood

Low river flows have constrained seasonal fish migrations. Fish species that are oftenmigratory and selective in spawning preferences suffered high mortality due to fewer suitable habitats. Constrained migration resulted in natural selection favouringmarshy species such as *Clarias* that are adapted to freshwater shortage conditions(Benech *et al.,* 1983). Fisher has to move, especially from the drier North to the South in search of better fishing sites.

Although aquaculture is not a major enterprise in the LCB at the moment, its practice isslowly emerging in Niger, Nigeria and Cameroon (Authors personal field observation).In aquaculture, where production processes like choice of species, feeding andrestocking are under greater human control, increasing seasonal and annual variabilityin precipitation resulting in drought extremes are likely to be the most significantdrivers of change in inland water aquaculture (Allison *et al.*, 2007). Reduced annualand dry season rainfall and changes in the duration of the growing season are likely tohave implications for aquaculture and create potential conflict with other water usersin an already water scarce environment. Smaller holder fish farmers with ponds thatretain less water and dry up faster are more likely to suffer shortened growing seasons,reduced harvest and a narrower choice of culture species and consequently less incomeand livelihoods from aquaculture (Handisyde *et al.*, 2006).

According to Béné *et al.* (2003a) and Neiland and Béné (2004), fluctuations in fishstocks have had major economic consequences for human societies throughout history.Reduced rainfall, stream flow modification leading to shrinking of fishing groundsand habitat modification, would lead to declining fish catch, fish trade, income, food/nutrition security, labour generation and increased poverty. An impact on food/nutrition security is of particular importance since over 80 percent of the rural poor in theregion are dependent on fish as the commonest and cheapest source of animal protein.In the LCB, reduced water levels have not only led to decreased fish catch but alsoincreased productive capital of fishers especially for hitherto near shore fishers.

The LCB is exploited by both near shore and offshore artisanal fishers, although the former predominate. The near shore fishers, who lack sufficient resources or equipment(eg. bigger boats, engines, larger and more sophisticated gears etc) to fish offshore inresponse to shrinking water and ecosystem changes, are expected to be particularlyvulnerable to changes in fish distributions and productivity. This has not only increasedproductive capital considerably, but also the cost of fish. In the same vein,LCB fishingcommunities have had to move in response to declining fishing ground caused by agradual but steady decline in water area.

A summary of potential impact pathways of climate change on the ecosystem,fisheries and aquaculture in the LCB is shown in Table 4.4.

Table 4.4: Potential Pathways of Climate Change Impacts on Fisheries of the LCB

CLIMATE VARIABLE	PHYSICAL CHANGE	PROCESSES POTENTIAL	IMPACTS FOR FISHERIES/ OTHER SECTORS
Physical environment	Changes in morphologyof lake and size of thefloodplains/wetlands	Reduced lake size and wetlands necessary forbreeding, nursery and annualrecruitment	Potential decline in annualrecruitment of juvenile fish intothe lake leading to reduced fishproduction
	Changes in waterchemistry due toreduced water volume	Heavy precipitation ofnutrients especially Calciumand Magnesium leading toincreased alkalinity salinity andextremely low DO especially atnight and cloudy days.	OverallIncreased primary productivityand dense algal bloom leading tointense respiration and mass fishkill due to extreme anoxia and clogging of fish gills by algal andother particles

	Change in water volumeand lake depth	Numerous exposed bottom sand dunes that became heavily vegetated with aquaticmacrophytes	Reduction in fishing areas, increasedpredation and impediment to navigation and fishing. Massive reduction in papyrus – floatingaquatic vegetation for canoeconstruction
Fish stocks	Low water depth and high water temperatures Frequent up-welling caused by winds	Potential changes in sex ratios. Altered time of spawning. Altered time of migration. Altered time of abundance. Effect on fish recruitmentsuccess. Effect on aquaculture	Potential changes in biodiversity. Difficulty in predicting peakabundance of target species forexploitation. Adverse effect on abundance andproduction of juvenile fish in the system. Swamp species (eg *Clarias*and *Heterobranchus*) replacepelagic species such as *Lates* and*Hydrocynus*. Migration and mobility ofhouseholds due to declining stockexacerbates HIV/AIDS and otherinfectionsReduced aquaculture production
Ecosystems	Reduced water flows and increased droughts	Changes in lake water levels. Changes in dry season waterflows in rivers. Habitat modification anddestruction	Reduced lake and river productivity. Reduced and increased pelagic andswamp fisheries, respectively. Reduced biodiversity. Reduced grazing lands
Inland fishing operations and livelihoods	Changing levels of Rainfall. Less predictable rain/dryseasons. Markets and fish trade	Decreased rainfall leadsto reduced opportunitiesfor fishing, farming andaquaculture as part of rurallivelihoods portfolios Decreased ability toplan livelihood activitiese.g. farming and fishingseasonality Constricting fish markets andtrade	Reduced diversity of rurallivelihoods; greater risks inagriculture; greater reliance onnon-farm income. Reduced safety nets for ruralcommunities Increased vulnerability of riparianfloodplain households and Communities. Reduced income and benefitsof market- based fisheriesstakeholders

(***Source:*** Adapted from Daw *et al*. (2009))

4.3.6 Fisheries Management

A number of institutions participate in the management of the fisheries of the LCB.Neiland *et al.*, (2000) and Béné *et al*., (2005) classified fisheries management systems in LCB into three categories, namely:

(i) Traditional systems (informal);

(ii) Modern or centralized systems (formal);

(iii) Mixed systems.

The traditional systems areclassified as those operated by traditional authorities (District or Village Heads andChief fishermen) which enforce regulations to control fishing activities. The modernsystems are by the administrations of the central governments where fisheries regulations are enforced by officers of the state, usually located in the Departments ofFisheries. In the absence of formal co-management arrangements, the mixed systemsinvolve the participation (intentionally or inadvertently) of both the traditional andmodern government administrations.

As shown in Table 4.5, management systems operated under the traditional administrations (Type I) are very frequent in Cameroon (70 percent of the villages)and relatively frequent in Chad and Nigeria (38 percent and 33 percent, respectively).The mixed system (type II) is most common in Chad and Nigeria (45 percent and 56percent, respectively) and relatively frequent in Cameroon (30 percent). The type III,mixed system occurs sporadically in Chad and Nigeria (17 and 11 percent, respectively)and does not occur in Cameroon. In general, traditional (Type i), overlapping withmodern authorities (mixed type ii) is present in 100 percent of the Cameroonian villages, in 83percent of Nigerian and 89 percent of Chadian villages.

Table 4.5: Classification of Fisheries Management Systems in the Lake Chad Basin

Management System	Description	No. of villages operating under each management system (% of total in each country)		
		Cameroon	Chad	Nigeria
Type i: Traditional	Operated by the traditional authorities (district or village head, chief fisherman)	14 (70%)	11(38%)	3(33%)
Type ii: Mixed	Participation (either intentionally of inadvertently) of both traditional and modern government	6 (30%)	13 (45%)	5 (56%)
Type iii: Modern	Operated by central government's administrations with regulations enforced by officers of the state	–	5 (17%)	1 (11%)
Total		**20 (100%)**	**29 (100%)**	**9 (100%)**

(**Source**: Neiland *et al.*,2000; Bene *et al.*, 2005)

The preponderance or predominance of the mixed management system in the basinis note worthy and could be a veritable platform to anchor adaptive strategies formitigating the impact of climate change in the region if their authorities are not threatenedby government who see fisheries management as their *de facto* responsibility. But howeffective are these traditional authorities in the management of those resources? Aretheir authorities recognized or are they being eroded or threatened?

Béné *et al.* (2005) showed that the authority of the local traditional leaders is still considered accepted and respected by community members. However, the above studies also revealed a gradual and steady erosion of traditionalauthorities especially in Nigeria and Cameroon. The full extent of this gradualdiminution of traditional authorities and the impact on the sustainable managementof the basin's resources cannot be ascertained, but it is reasonable to infer that sucha scenario could lead to negative outcomes for the sustainable exploitation of thefisheries, on the long-run, if the trend continues. A study of the fisheries of theKomadugu Yobe Basin (southern section of the LCB in Nigeria), however, revealedno diminution of the powers of the traditional authorities. In an evaluation of fisheriesgovernance in the area, a State Director of fisheries in the area stated that they need to write the village head of the community where water body are located before embarking on field work to the area (Ovie and Raji, 2009).

The traditional authorities and communities over the years have acquired a sound knowledge of the fisheries and other naturalresources of the basin in terms of their management and sustainable exploitation.While all the water bodies in the basin are *de jure* State properties, the majority ofthem fall into common property regimes with well defined, albeit informal, access right (Berkes, 1989; Béné*et al*., 2005).

The authorized users are the villagers or themembers of the local community. Clear operational rules exist which define, within thecommunities, the way the authorised users can extract the resource. These rules whichare generally not written (informal) are known and respected by the villagers andenforced by the local authorities, usually the village chief and/or the head fisherman.In addition, well-defined institutional mechanisms (collective action rules) have beenestablished within the communities to facilitate conflict resolution and punishment ofresource users that breach extant rules. In general, while the traditional authorities maybe facing increasing pressure and erosion of their authority, traditional managementsystems based on common property regimes is still the predominant system operatingin the Lake Chad Basin especially, in Cameroon, Chad and Nigeria.

4.3.7 Sanction and Conflict Resolution Mechanisms in Management of Lake Chad Basin Fisheries

Given the competitive nature underlying access and uses under a portfolio of commonproperty regimes (CPR) such as in the Lake Chad Basin, conflicts over natural resources(fisheries, land, water, forest etc.) are almost inevitable and likely to increase in aclimate change scenario, making conflict resolution mechanisms (CRM) an importantcomponent of the administration of the basin's resources. Conflict resolution mechanismshave been identified to be crucial to the viability of CPR and their associated management systems (Ostrom, 1990). Such conflict resolution mechanisms can range from being totally informal, that is open discussion between the disputants and eventually a spontaneous mediator, to completely structured and institutionalized procedures (that is, a well developed court with legal authority) as described by Maas and Anderson (1986).

In the case of the LCB, informal mechanisms of resolving conflicts between resourceusers predominate in the region (Béné *et al.*, 2003a). A feature of the existing CRM inthe Basin is its

‘incremental’ nature, which allows higher level traditional institutionsto intervene in the event of failure of lower level authorities or mediators (Béné et al.,2003).

A major pillar of any CRM is the associated sanctions that are brought to bearon violators of standing operational rules governing the use of natural resources.Two types of sanctions have often been associated with common property regimes. Ostrom (1990) and Ostrom et al. (1994), in order to achieve a long-time and enduring resource management, sanctions should be made of a ‘subtle balancebetween two constraints’. Firstly, the arrangement should ensure that the sanctions aregradual and secondly the eventual final sanction should be sufficiently deterring. In thecase of the latter, the social and financial costs of the sanction should be higher than theexpected gain to the violator.In the Lake Chad Basin, the sanction portfolios set up by the local traditionalInstitutions embody above two typologies (Béné et al., 2003a).

First, the sanction(cost) at each level is gradually increased. In the majority of villages in the Chad Basin,the system starts with a verbal warning (no social or financial cost) by the local leaderwhich allows the rule breaker to repent and act responsibly. If the violator continueswith the unacceptable behaviour, the next sanction level usually involves fines that maybe combined with temporary ban from the village or gear confiscation. This continuumof gradual but increasing sanction costs, coupled with the potential involvement ofhigher traditional authority, was judged to be sufficiently dissuasive in the lake ChadBasin (Béné et al., 2003a).

4.3.8 Scope of the Management Plan

The current Management Plan of the Lake Chad Fisheries is limited spatially to the Lake Chad area comprising the southern and the northern basin between Cameroon, Chad, Niger and Nigeria excluding adjacent watercourses. Fishing gears and methods involved are gill nets, beach seines, longlines, metal traps, the "Doumba" and "tarotchawa".

The scope (extent) and the value of the Fisheries at regional level are reflected in the table below: This is the whole of Lake Chad which Cameroon, Chad, Niger and Nigeria are riparian; covering an area between 2 500 and 25 000 km². The main fishing gears and methods involved, as well as high-level objectives common to the four countries are described in Table 9.

Table 4.6: Scope and Value

Category	Description
Fisheries	Lake Chad fisheries between Cameroun, Chad, Niger and Nigeria
Zones	In Cameroun, Chad, Niger and Nigeria jurisdiction
Targeted species	Fisheries being multi-specific, the Management Plan covers the whole of species being captured, with particular attention to vulnerable species such as: *Bagrusbayad*, *Citharinuschana*, *Clarias*spp, *Gymnarchusniloticus*, *Heterotisniloticus*, *Heterobranchusbidorsalis*, *Hydrocynus*sp, *Latesniloticus*, *Oreochromisniloticus*, *Petrocephalusbebe*,*Sarotherodongalileus*, *Synodontis*sp., *Tilapiazili*
Involved fishermen	Chadians, Nigerians, Cameroonians , Nigeriens, Malians and others
Method of fishing	Beach seines , gillnets, longlines, Duma, fishing channels tarotchawa, metal traps
Type of Fisheries	Continental
Values and objectives of high level fishing (LCBC , Maroua-Cameroon, 2007	Preservation of halieutic resources,Contribution to food security, Poverty alleviation, Contribution to the fight against desertification, complementing the specific programme of the rehabilitation of the ecosystems. Valuation of the potential for economic and social development in the Lake Chad Basin, Improved joint management, policies and legislation
Agencies/primary groups (directly involved and taking responsibilities)	Ministries of Fisheries of the four (4) countries and other stakeholders (Ministries of Research, local development, security, etc.), fishermen, decentralized communities, traditional leaders, universities, NGOs, etc.
Other agencies/groups (those who indirectly manage or manage related aspects and do not take direct responsibility)	SODECOTON, SODELAC, PRODEBAT, ONAHA
Regional and international institutions	Lake Chad Basin Commission (LCBC), GIZ, AFD et FAO, UA, CEEAC, CEDEAO
Legal framework	LCBC Water Charter, SAP; RAMSAR Convention, CCPR
Calendar/Duration	Five (5) years

4.4 Measures of Management Currently in Use

The measures of management currently in use in different countries are listed below

In Chad

The joint-management of the water body is implemented in Guitté, Kinasserom, Mittériné and Koulfoua with the setting up of a Management Committee named Local Authority for Orientation and Decisions (LADA) within which a surveillance team called Village Surveillance Committee (VSC) is constituted. The principle is to put in deferred some portions of water. Thus, there are two types of deferement, the final deferement or integral protection zone (IPZ) (all activities are prohibited only experimental fisheries are permitted as well as certain planning) and the temporary deferement or Fisheries Protection Zone (FPZ) (with lift on fishing which vary in duration depending according to fishing areas and in accordance with the decision of the local communities).

These management structures are embodied with local agreements and management rules for fishing areas, in which are listed the obligations and rights of users, the riparian, The Fishing Service and Lake Development Board/Bodies (LDB), offenses and penalties with redress of offenses. The results are promising despite difficulties recorded so far. It was noticed that during fishing permission in Lake Fisheries Authorities (LFAs)that habitat is reconstituted, an increase in size of fish, the reappearance of some extinct species in the area as a result of habitat degradation , decreased conflicts, increased catches , good development of aquatic flora . Some co-management structures were able to generate profits and opened accounts in micro-finance institutions

In Niger

In the Niger side of the Lake Chad, the management measures currently applied are based on regulations including Law No. 98-042 of 7 December 1998 dealing with the system of fisheries in Niger. This law provides the legal basis which determines the current rules of the operating system of fisheries resources.

These regulations measures applied include:

1. Fishing license : there are three types (sport fishing license , scientific fishing license and commercial fishing license (10,000 CFA for nationals and 20,000 CFA for foreigners);

1. The ban on gears and fishing methods such as seine fishing and fishing with scraping nets; fishing with nets whose mesh is less than three (3) fingers that is six (6) inches drawn mesh; the use of explosives and any substance that would likely intoxicate, inebriate, or present a hazard to fish and other aquatic animals; the practice during spawn, of all unauthorized fish fences.

Beyond these regulatory measures, other actions are taken in the Fisheries management framework. These are:

1. Sensitization of fishing communities by administrative authorities and officials in charge of fisheries. The sensitization is centered on the preservation of the lake environment, natural resource management, peaceful coexistence of different users etc;
2. The dissemination of law on fishing and the Code of Conduct for Responsible Fisheries CCRF;
3. The organization and training of fishing communities for a rational use of resources;
4. The protection and restoration of the tributary basin through dune fixation activities, Medialuna californiensis, tree plantation;
5. The setting up equipment and infrastructures for fish valorization.

In Nigeria

Currently, there are no formal management measures in practice. However, some traditional management measures have been put in place by traditional institutions in collaboration with fishermen. During the season of floods in some parts of the lake (Abbadam of the local government area), fishing is not permitted for a period of two months

In Cameroun

Activities or management measures being implemented include:

1. Routine monitoring by agents of the Ministry of Livestock, Fisheries and Animal Industries;
2. Sensitisation and crack down on fishermen;
3. Training workshops on the CCRF;
4. The development of potable water points , building of schools and health care centers;
5. The construction of some infrastructures (sales hall, ice plant unit, smokehouses);

6. Collection of statistics only at fish preservation depots;
7. The collection of taxes for veterinary inspection and local commerce, and export (customs);
8. Issuance of permit to certified fishermen;

Ultimately the management of Lake Chad fishing activities is done outside any management plan capable to lay the foundations for sustainable exploitation.

4.5 Major Issues Related to Governance

The Major issues affecting the sustainability of Fisheries on the governance, as identified during the development of the management plan process are:

1. Weak enforcement of laws governing fishing;
2. Low operational capability of monitoring and control surveillance ;
3. Low capacity of stakeholders, including administrations in charge of fisheries;
4. Low inclusion of fishing in local development plans ;
5. Low development of co-management ;
6. Lack of fisheries management plans;
7. Low compliance of actors;
8. Low cooperation of traditional authorities.

4.6 Rational Behind the Management Plan

After a wet period with a lake consisting of a homogeneous body of water of about 20 000 km2 (decades from 1950 to 1960), Lake Chad has passed in 1973 to a phase of Small Chad, with two main basins separated by the great Barrier. From 1990 to 2013, the average total surface of the Lake was of the order of 8000 km2. The surface water of the northern basin was much more variable, with years without any water supply (1985, 1987, 1988 and 1991). From 1982 to 1994, the Lake Chad has experienced a seasonal drought. However it was relatively wet during the period from 1982 to 1994. The current period corresponds to a small wet Chad (IRD, 2013). These changes in the water level result in changes in the fauna and flora.

The ecosystem services provided by the Lake Chad make it a demographic attraction area. The inflow of people from the near and distant hinterland from the Lake whose resources have been destroyed by droughts, has modified the activities and settlement of the Lake and its banks which

have crucially advanced since the first drought of 1972-73. In 2013, the population was estimated at 2 million people around the Lake against 13 million people for the population of the area of influence; the latter includes people living directly or indirectly from the lake-related activities (agriculture, farm, fisheries, trade in products derived from these activities) within 300 kilometers radius (IRD, 2013).

According to population projections, the population of the area of influence will increase from 13 to 35 million and that of the conventional basin of the Lake Chad from 47 to 129 million in 2050.This rapid population growth will increase human activities around the Lake and could exacerbate conflicts over access to resources.The current situation of the exploitation of Fisheries resources is characterized by a lack of management and information plan on the state of stocks and catches. The current situation is characterized by a high proportion of juveniles in the catches and high post-catch losses, contributing to the decline in fishing communities' income and increases their vulnerability.

The impacts on fisheries resources and habitat due to the use of non-regulatory fishing gears and prohibited fishing techniques, as well as the inadequacy of the texts and weak operational capacity of governments fully justify this current Management Plan of the Lake Chad Fisheries.
Technical, social, environmental and biological interactions in the Lake Chad fisheries have not been fully integrated into the existing management approaches conducted occasionally and on sector based. The Management Plan of the Lake Chad Fisheries will be implemented to integrate environmental dimension, human and governance, with the involvement of all stakeholders in the management process to improve the overall well-being of fishing communities. The integration of these three dimensions in the management plan should help ensure rational and sustainable exploitation of the Lake Chad fisheries and would contribute effectively to food security, poverty alleviation and income enhancement at all levels.

4.6.1 Main Points of the Process

The Management Plan of the Lake Chad Fisheries based on the principles of the Ecosystem Approach to Fisheries is the result of a process that began in December 2013 as part of the partnership between the LCBC andNEPAD FAO Fisheries Programme.

A training workshop for fisheries administrations and other actors on the principles of the Ecosystem Approach to Fisheries was held in N'Djamena (Chad) in December 2013. From January to February 2014 national reference reports of fisheries from Cameroon, Chad, Niger and Nigeria have been made. Four (4) national validation workshops of the reference reports, of identifying issues and of risk assessment were organised from February to March 2014.

The first regional workshop to validate the regional baseline report and assessment of risk was held in April 2014. The regional risk assessment process has continued in the second regional workshop of June 2014. During this second Regional Workshop on performance Report (logical framework) of the management plan was also discussed and helped to define:

1. The global objective;
2. The management objectives;
3. The operational objectives;
4. The measures of management;
5. The indicators.

4.6.2 Objective of the Management Plan

The global objective of the management plan is:

"Ensure the protection and sustainable use of the Lake Chad resources and ecosystems to increase the contribution of fisheries to food security, poverty alleviation and improved income at all levels.This objective will be achieved through the application of the Ecosystem Approach to Fisheries in the Management of the Lake Chad Fisheries. The definition of operational objectives and management measures (actions) will achieve this overall goal.

4.6.3 Alternatives of Management and Operational Objectives of the Management Plan

The Management Plan of the Lake Chad Fisheries aims to improve existing management and monitoring systems by applying the Ecosystem Approach to Fisheries. Three (3) objectives of this plan management have been identified to achieve the overall objective thus, “ensure the protection and sustainable use of resources and the Lake Chad ecosystem so as to increase the contribution of fisheries to food security, poverty alleviation and improved income at all levels”.

These management objectives are as follows:

1. Promote sustainable exploitation of fisheries and protection of ecosystems;

2. To improve the living and working conditions, and income for fishermen and local populations;
3. Improve the concerted management, policy and Fisheries legislation as well as safety.

The management plan includes twelve (12) operational objectives that enable to achieve the identified management objectives and management measures which are actions to be implemented for the achievement of the operational objectives. The improvement of the Management of the Lake Chad Fisheries and livelihoods of riparian communities based on the Ecosystem Approach to Fisheries will be achieved through management options based on the following key strategic axis:

1. Improving the selectivity of fishing gear;
2. Improvement of the legal and regulatory framework;
3. Strengthening the frameworks for concerted action and promoting joint management;
4. Introduction closures periods for fishing and creation of keep out zones (reserves);
5. Improve system of information collection on catches and fishing effort;
6. Improve fishing communities' access to basic social services;
7. Strengthening the socio-economic infrastructure and Fisheries products recycling equipment;
8. Promotion of sustainable funding mechanisms;
9. Reducing the vulnerability of fishing communities through local adaptation plans to climate change and disaster risk etc.

4.6.4 Operational Objectives and Measures of Management (Actions)

Management Objective 1: Promote sustainable exploitation of fisheries and the protection of ecosystems:

Operational Objective1: Fish stocks are re-created and endangered species are protected. Two actions or management measures have been identified in order to achieve this operational objective.

(i) Improve the selectivity of fishing gears. This is to consuct a series of activities that will lead to changes in mesh of fishing gears to reduce the catch rate of juveniles so as to ensure a good fish recruitment.

(ii) Educate fishermen on the prohibited fishing practice. The majority of fishermen ignore regulations on illegal fishing gear (Doumba, fishing channels tarotchawa, etc) that cause

negative impacts on fish stocks including the reproductive cycles. These sensitization campaigns will help to ensure proper compliance with the prohibitions measures.

Operational Objective 2: Housings and biodiversity are restored and preserved

(i) Establish a biological rest period. This is to set a synchronized closure of the Fisheries throughout the Lake Chad whose period should coincide with the flood and recession to protect breeding stocks and juveniles. The period of application of this measure will be decisive.

(ii) Promote protected areas (fishing reserves). Areas suitable for breeding fish in each country will be identified to classify them as a totally protected areas where all fishing activities are prohibited. These areas will be jointly managed by the fishing communities and the administration. However zones of partial protection of Community interest should be encouraged following the initiatives of Chad.

(iii) Protect and restore the banks and land. It is planned to reduce silting of the Lake by strengthening the vegetation cover of the banks through reforestation, but also land restoration.

(iv) Develop and implement a strategy of fight and valuing of invasive aquatic plants (IAP). The strategy aims to remove AIP in order to increase the fishing areas, but also to value the AIP through biogas production units and agricultural fertilizers (manure) to be used by the communities.

(v) Promote Biodiversity Conservation (CITES, RAMSAR, Others). This will be achieved through awareness campaigns on the importance of endangered species and/or protected for biodiversity and ecosystem balance. Local committees of biodiversity conservation will be created and installed in the four (4) countries in order to include a sustainable conservation of biodiversity.

Management Objective 2: Improve living and working conditions, as well income of fishing communities and local population:

Operational objective 1: The fishing communities' income is improved.

(i) Promote alternative income generating activities. The development of alternative activities should help diversify sources of income and support management measures, especially

seasonal closures of fishing. Food speculation, farming and trade will be encouraged by supporting the communities to have input and small businesses funds.

(ii) Provide storage and fish processing facilities to fishing communities. Conservation and processing facilities to be available to the fishing communities are designed to reduce post-catch losses in the value chain of fish which are very high, whether fresh, smoked or dried. Emphasis will be placed on improved shorkor ovens (FAO- Thiaroye of Fish Processing), insulated bodies and drying racks.

(iii) Improve savings and access to loan to the fishing communities. The community savings will be mobilized through the introduction of Micro -Finance Institutions adapted to or near the fishing areas. Revolving funds will be available to professional organizations to fund their activities.

(iv) Develop a marketing strategy to improve the marketing of fish at local and national level. A study will be conducted and validated in each country. This strategy aims to increase the share of fish sold both locally and nationally,

Operational Objective 2: Socio-economic infrastructures are consolidated.

(i) Build and rehabilitate social and economic infrastructures. New rural roads for opening up the fishing areas are opened and existing ones maintained as part of this plan to bring the fishing community centers closer to one another or markets. Fish preservation depot and markets will also be constructed to facilitate the handling and disposal of fish as well as the monitoring of fishing activities. Schools will be built to increase the intake capacity and school attendance. Digging of boreholes will enable fishing communities to have potable water and reduce waterborne diseases.

Operational Objective 3: Technical and organisational capacity of the communities are reinforced.

(i) Develop and implement training programs for fishing communities. Meetings and workshops to identify the needed trainings will be conducted with the participation of fishing communities. These consultations should lead to the holding of training workshops

(ii) Support the structuring and revitalization of fishing communities' organizations. Support the creation of community business organizations will be carried out within the framework of the implementation of the management plan. The existence of professional organizations

is essential to facilitate the implementation of the management actions identified in the plan.

Operational Objective 4: Access of the fishing communities to basic social services is improved.

(i) Strengthen the sensitization campaigns of fishing communities in the fight against STIs (including HIV/AIDS), water-borne diseases and malaria. A study on the behavior, attitudes and practices (BAP) will be conducted and peer educators will be trained and installed in each country to allow better take-over of communities in the fight against STIs (including HIV/AIDS) and reduce the prevalence rate. The drinking water coverage and distribution of mosquito nets will also be included in the fight against malaria and waterborne diseases. Tools for Information Education and Communication (IEC) will be produced and distributed in fishing communities for better awareness-raising

(ii) Improve access to basic education. This action will significantly increase the school enrollment rate so as to reduce illiteracy, fight against child labor and early marriages. This will be achieved through a support to school meals program and distribution of textbooks. The plan also includes improving the primary school completion rates.

Operational objective 5: Social cohesion is reinforced.

(i) Strengthen conflict management mechanisms. Local conflict management committees will be created and installed in the framework of the implementation of the plan. These committees will be responsible for managing conflicts resulting from fishing activities in each country, but also to play a key role in conflict prevention.

Management Objective 3: Improve concerted management, policies and legislation on Fisheries, as well as security:

Operational Objective 1: Statutory and legislative frame is improved.

(i) Review and implement the texts on improving the selectivity of fishing gear. The texts currently governing fisheries in the four countries do not take into account the relevant provisions of certain international agreements (CCPR, CBD, etc.), is about undergoing their reviews and implementation

(ii) Apply the regulations on the prohibition of prohibited fishing methods. Fishing methods such as the "Doumba", "fishing channels", etc. are prohibited in all the regulations.

(iii) Harmonize the framework of laws and regulations on fishing within the LCBC. This is to sensitise all LCBC Member States on the importance of adopting the Water Charter and its annexes on fishing. The development of this appendix must be a priority in order to create a favorable environment for the development of fisheries.

Operational Objective 2: Participative management is promoted.

(i) Improve the inclusion of the fisheries sector in local development plans. The four countries participating in the implementation of the management plan have undertaken a process of decentralization with active local communities. They have local development plans (LDPs) that some do not take into account the fishing sector; fisheries development should be integrated in the LDP for the funding of the sector. In the context of decentralization which is under way in almost all countries, the development of the municipal development plan is essential as required by law on decentralization.

(ii) Promote and implement at national level participatory management plans for fisheries. Specific management plans in the national sections of the Lake Chad must be initiated by each country.

(iii) Promote and implement at local level participatory management plans for fisheries. Local management plans under local management initiatives must be promoted

(iv) Put in place operational frameworks for concerted action at local, national and regional level. The planned frameworks for concertation will increase the harmonization of fishing practices at all levels and are sources of information sharing and experience to strengthen the co-management process.

(v) Establish a sustainable funding mechanism of the co-management structures. To register the sustainable co-management process, it is important to ensure the funding of these entities. The operating model of Beach Management Unit (BMU) of Lake Victoria or Lake George (Uganda) can be adapted to the situation of the Lake Chad.

Operational Objective 3: Operational capacities of Fisheries administrations and other actors are reinforced.

(i) Improve fisheries administration's response capabilities. Particular emphasis will be placed on strengthening the presence of the fisheries administration (personnel in quantity and quality) in the field (creating new managerial positions), building mobility means (vehicles, motorbikes, motorized canoes, etc.) and modernization of working equipment. Training is also provided to the attention of the technical staff on the co-management process of the Lake Chad resources.

(ii) Improve the operational capabilities of other actors. The actors will be trained on leadership, lobbying techniques, associations, savings and credit and the simplified accounting. These trainings are designed to reduce vulnerability and greater ownership of the co-management process as well as the sustainability of actions initiated. Experience exchange trips are also provided to fishermen's organizations on the co-management process in the other lacustrine regions of Africa. Equipment will also be granted to organizations participating in the co-management process of the Lake Chad activities.

Operational Objective 4: Monitoring-control-surveillance and halieutics research are reinforced.

(i) Establish a system of data collection, processing, analysis and dissemination. This is to bridge the information gap on the status and trends of fisheries of the Lake Chad by conducting regular surveys, and collecting , processing, analyzing and publishing regular data on catches and sociometric in directories .

(ii) Develop research programs on fisheries. Research programs in national institutions of the four (4) countries are almost nonexistent. The plan provides for the development and validation of fisheries research programs. Memoranda of understanding with scientific research institutions in the four (4) countries involved will be concluded as part of the management plan for their implementation

(iii) Make control and surveillance operational. New fishing activities surveillance posts on the Lake Chad will be created in each country to strengthen compliance with regulations

Operational Objective 5: Resilience and adaptation of fishing communities to climate change and to disaster hazard are improved.

(i) Introduce and reinforce good adaptation and resilience practices. Local practices of adaptation to climate change will be inventoried, improved and documented. The management plan also includes the development of local action plans for adaptation and resilience to climate change.

(ii) Develop a sustainable funding mechanism for adaptation action plans and resilience to climate change and disaster risk. To reduce the vulnerability of fishing communities to climate change and disaster risk; revolving funds or other appropriate mechanisms like resilience funds will be created in each country to support their activities; especially for the northern basin which is more exposed to risk of drying up.

4.6.5 Indicators and Points of Reference

The attainment of management objectives targeted by the Management Plan of the Lake Chad fisheries will be evaluated through a series of performance indicators to measure changes in the state of fisheries resources and the environment. The value of the performance indicators will be estimated from the data of the monitoring of catches, fishing effort and socio-economic exploitation of the Fisheries from surveys and other collection systems. Environmental data because of their complexity will require collaboration of research institutions and other sectors

During the first year of implementation; socio-economic surveys and socio-economic studies will be conducted on the resource operating system, alternative activities, and current processes to collect more accurate information on the Lake Chad Fisheries baseline cases. These studies / surveys will help to refine the target indicators and reference. Indicators related to management measures are contained in the logical framework of the management plan in Annex 1

4.6.6 Institutional Arrangements for the Implementation of the Management Plan

The institutions in charge of the implementation of the management plan are the LCBC, the administrations in charge of fisheries, fishermen's organizations, wholesalers, processors, NGOs, local governments of Cameroon, Chad, Niger and Nigeria. The implementation of the management plan will be provided by a management or coordination unit, the latter will be supported by national units based in each country. A Regional Steering Committee consisting of four (4) countries, the LCBC and the FAO will be set up. An appeal will also be made to specialized

agencies and/or projects and programs with proven experience. It is important to remind that in the implementation framework of the Strategic Action Programme adopted by the Summit of Heads of State and Government of the LCBC, fishing is considered.The direct beneficiaries of the management plan are fishermen, processors, wholesalers, fisheries administrations, active NGOs and communities along the Lake Chad, Cameroon, Chad, Niger and Nigeria.

The Management Plan of the Lake Chad fisheries will be implemented in a framework of cooperation with research centers (fish) existing in the four countries for monitoring aspects of biological indicators , the Centers for Economic and Social Research for social and economic aspects and the Directorates for the Protection of Nature (DPN) for environmental considerations, especially endangered species. A partnership will also be established with international development organizations such as the IRD, GIZ and FEM, the DFID, etc. It is important to recall that the LCBC has signed agreements for cooperation with universities situated in the basin.The LCBC as a regional entity having regional integration as one of its missions will intervene to:

(i) Facilitate coordination and cooperation between countries;

(ii) Attract long-term funding to support the implementation of the management plan of the Lake Chad fisheries;

(iii) Monitor the implementation of the identified management measures;

(iv) Ensure political commitment and harmonization of legislation and

(v) Encourage the acquisition of knowledge and sharing of information and lessons learned in a sub-regional context to assist countries in decision making on sustainable management of fisheries resources.

The management plan will be implemented for a period of five (5) years from the date of approval by the countries and the availability of funds.The implementation strategy of the management plan will be based on:

1. **The participatory approach:** it is the effective involvement of all stakeholders (fishing communities, governments, development agencies, microfinance institutions, etc.) to allow ownership of the management plan in order to insure the sustainability of the impacts.
2. **Participatory approach**: the Management Unit for the implementation of the plan being made up of a small number of staff, this structure will be more of a role of coordinating and

monitoring. It will rely on external structures (fisheries administrations, NGOs, Firms, Consultants) for the performance of certain activities (studies, training, achievements, etc.).

3. **Partnership**: it is to build on all the achievements in the Lake Chad area by working with other partners, especially Projects or development institutions intervening on the Lake Chad and pursuing similar goals. The partnership could eventually allow a more rational use of resources mobilized by each partner to avoid duplications and to respond to the Paris Declaration on development aid.

4.7 Issues Constraining Fisheries Management in Lake Chad Basin

1. **Threat of Insecurity on Fisheries Activities**

Major Constraint – Insecurity: Frequent Boko Haram incursion, fisheries activities under threat and reduced to the barest minimum due to insecurity.

2. Effects of Climate Change

The effects of climate change, particularly, desertification has become acute to a great extent that the waters have ebbed, thereby leaving little water areas for fish proliferation and growth.

3. Poor accessibility to Fishing and Landing Sites

There are no roads to the fisheries areas: The roads to the fishing and landing sites have become not motorable. Roads not motorable to go to fishing sites. Hence, more fish harvest perishes as post harvest losses leading to significant loss in revenue.

The constraints to change fisheries management strategies generally depend on policy domain. However, Neiland (2003), in a draft proposal for the formation of a "Lake Chad BasinFisheries Development Program (LCB_FDP)" highlighted a number of factors thatconstrain the ability to achieve sustainable livelihoods.Firstly, it is thought that, from a government and policy perspective, the fisheriesand their characteristics are not well understood. More specifically, the **'**value**'** of thefisheries to all basin countries is not fully recognized. For example, the extent to whichfisheries contributes to economic development, food security and poverty alleviation.This lack of both general and specific understanding of the contribution of the fisherieshas constrained the development of appropriate fisheries policies to improve fisherlivelihoods. A better understanding of the operation of the existing fishery system,which is characterized by a high level

of productivity, but also a high level of poverty,is needed by all stakeholders involved to minimize current constraints to change.

Secondly, from the perspective of the fishing communities, the political and socialconstraints which they face in their life are tangible. The Lake Chad Basin is a difficultterrain with communities that are isolated both geographically and socially, and lackaccess to a wide range of information to inform their livelihoods decisions. A greater sharing and dissemination of information by all stakeholders is required in order toidentify key issues and constraints to change and development.

Thirdly, the communities lack an appropriate level of organization and thecapacity to participate in policy or decision making by government or to exchangeinformation with other stakeholders on a regular basis. The deficiency in informationavailability and the difficulties of disseminating same to the rural communities atnational and regional levels in the basin has been highlighted by UNEP GIWA(2004). The creation of opportunities for wider and greater stakeholder participationin decision-making leading to the formulation of appropriate policies and institutions(within fisheries and among sectors) would result in improved resource managementand utilization.

Fourthly, fishing communities in the Lake Chad Basin are vulnerable to externalpressures from stronger individuals or groups, including local political leaders, markettraders and even members of the security forces that operate in the area. Access control,for example, is virtually the prerogative of some powerful individuals or families backedby an equally powerful group of local leaders. Some local leaders and security forcesare known to extort illegal taxes from operators of the fisheries and have constituted aconstraint to adaptive capacity.

Fifthly, despite the huge monetary value of the fisheries, over 70 percent of thefishing communities in the Chad Basin are still categorized as poor (Béné *et al*, 2003a). This prevailing or pervading poverty is a potential constraint to the ability ofcommunities to evolve viable adaptive strategies. Lack of productive capital to procurebetter and improved fishing gears and invest in alternative sources of livelihoods is apotential constraint to adaptive capacity and strategies. Some potential constraints to adaptive capacities have also been highlighted byDaw *et al.* (2009).

It is argued that responses to direct impacts of climate change events on fisheries are more effective if they are anticipatory as part of a long term integrated disaster risk management planning. The lack or weak structure of the DRM agencies inthe LCB is a major constraint to potential adaptive strategies in the region.The lack of diversified fish products and markets, including lack of or poorinformation base on the fisheries is considered another constraint to achieving adaptivestrategies to climate change impact. Diversified fish products would make fisheriesless prone to economic shocks while adequate information would help fishers andfish traders navigate both national and international markets and achieve fair pricesfor their fish (FAO, 2007). Decreasing the marginalization and vulnerability of smallscalefishers is thought to be an anticipatory adaptation to a range of threats, as well asfacilitating sustainable management and viable adaptive strategy to change.

In the Lake Chad Basin, women constitute a good percentage of the population andwork force, but lack traditional hereditary access rights to land or fishing grounds and,therefore, tend to be poorer. The subordinate economic position of women in the regionhas constrained them from engaging in meaningful, viable and sustainable adaptivestrategies as compared to male stakeholders. There is need, therefore, to empowerwomen to enable them construct viable livelihoods for themselves in fulfillment of thethird objective of the Millennium Development Goal.

4.8 Trans-Boundary Issues on Lake Chad Basin

A Delphi exercise undertaken with representatives of the LCB riparian stakeholders (mainlyTTT members from the member states) conducted in Maroua in September 2006 identifieda harmonized list of seven priority trans-boundary problems. This was from a collection ofthe trans-boundary environmental problems presented by each member state. Figure 15 below presents the problems and their individual priority ratings as arrived at by theriparian stakeholders.

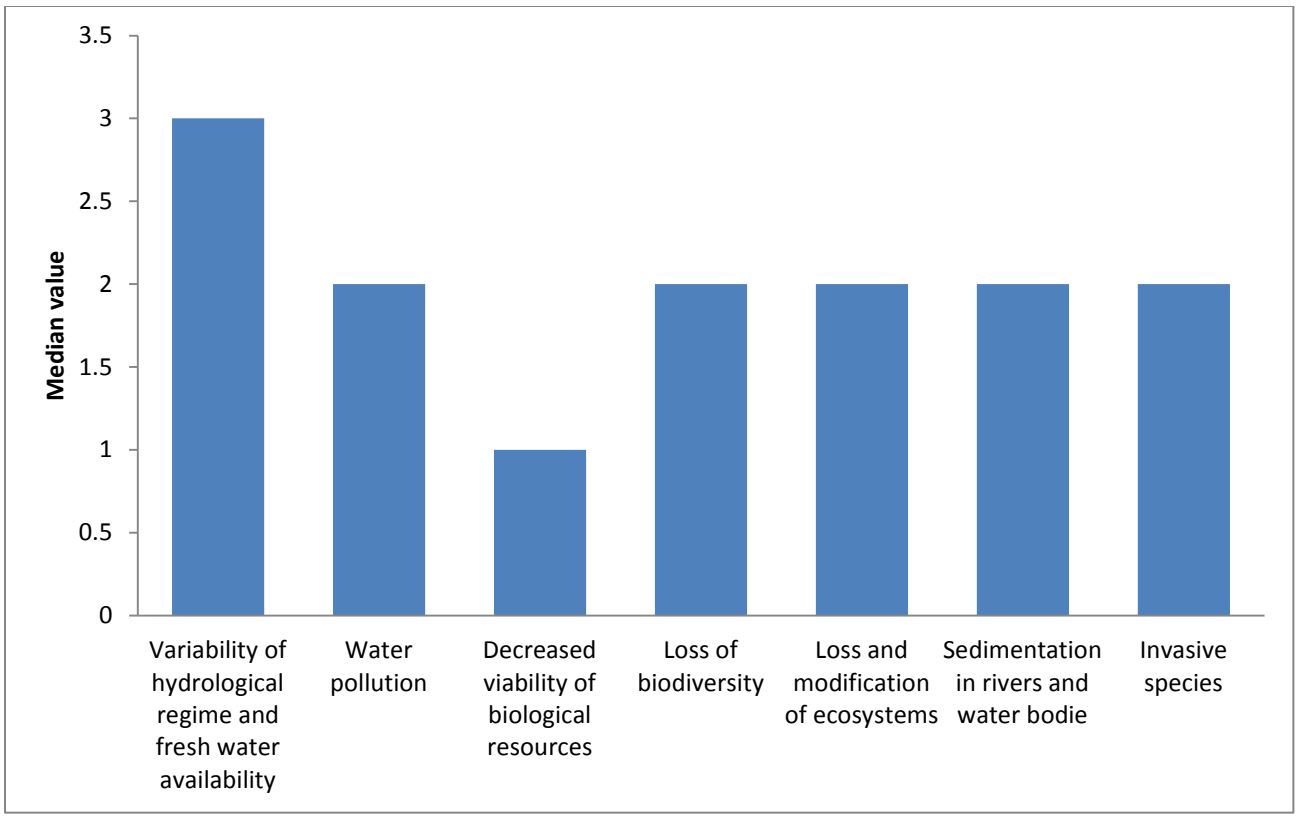

Figure 4.6: Priority Transboundary Environmental Problems of the LCB and their Ratings

The Constraints, Figure 4.6, have been rated by stakeholders from the order of Highest Priority to Least Priority:

(i) Variability of hydrological regime and fresh water availability;

(ii) Water pollution;

(iii) Decreased viability of biological resources;

(iv) Loss of biodiversity;

(v) Loss and modification of ecosystems;

(vi) Sedimentation in rivers and water bodies and;

(vii) Invasive species.

The above trans-boundary problems, which constitute the past, present and future socialrisks to populations of the Lake Chad conventional basin are the products of the combinedimpacts of accelerating global climate change and unsustainable resources use practices bya growing population, driven by institutional failures. The net effect of the transboundaryproblems is deepening poverty in the sub region.

4.9 Variability of Hydrological Regime and Freshwater Availability

Lake Chad and the rivers that feed it, and their associated wetlands, have been traditionalsources of freshwater for domestic consumption and agricultural production throughoutthe centuries. Over the past forty years, the lake has shown a dramatic decrease in size. However, Coe and Foley (2001) in a study prepared for NASA determined that the lake'svolume had declined between 1966 and 1975 by approximately 30%. Since 1963 to datethe lake has shrunk to a twentieth of its former size, apparently due to both climaticchanges and high demands for agricultural water. As the case is with the lake, the rivers that feed it have also experienced desiccation during the same period. Table 16 below, which shows the difference between the long term meaninflow into the lake and the mean for the period 1971 - 1990, illustrates the point.

Table 4.7: Drainage Areas, Inflows and Overall Water Balance of the Lake

S/No	River sub-system	Catchment area (Km^2)	Area of lake & wetlands (Km^2)	Long – term meaninflows in Km^2/yr (pre 1970)	Mean inflow 1971 - 1990
1	Chari - Logon	590,000	8,000	39.8 (93%)	21.8 96%)
2.	Komadugu- Yobe	147,840	6,000	1.0 (2%)	0.45 (2%)
3.	Yedseram-Ngadda-Ebeji	53,720	80 – 120	0.89	0.12
4.	Others			1.2	0.2
5.	Total river inflows			42.89	22.57
6.	Rainfall on open water surface			6.0	2.1
	Total inputs			**48.89**	**24.68**

(**Source**: Oyebande, 1997)

Beside the general decline in the quantity of available fresh water in the lake and its rivers, there is also a marked variability in hydrological regimes of the rivers. For example, theKomadugu Yobe system, which used to flow for nine months a year, now barely flows forfour months and has unpredictable starting and ceasing dates.

The lake's desiccation is a trans-boundary problem because, not only is this developmentimpacting on all the countries of the region, but also a reversal in the trend can be effectedonly if all the concerned act in a concerted manner. Likewise the variability in channelflows, especially in the KYB and Chari Logone systems affect multiple countries and cannotbe addressed by individual countries.

Rainfalls have also not only suffered a decrease in quantity and duration, but there havealso been inconsistencies in onset and ceasing dates.The changes in river-flows and the lake levels have contributed to a continuing decline inlocal access to water, crop failures, livestock deaths, collapsed fisheries, diminishedwetlands services, rising soil salinity, de-vegetation, and loss of biodiversity throughout theregion. For example, some 6,000 ha of irrigated land in the lower Yobe on the Niger side of the border are at risk. Several hundred hectares in small irrigation developments on theNigerian side of the border have been negatively impacted.

The socio-economic consequences of impacts include food insecurity in the region, andcombined with a lack of potable water. This has had implications on the healthstatus of the LCB's population. Furthermore, freshwater shortages have includedupstream/downstream conflict over who has the right to use the diminishing waterresources. Social tensions have been further provoked by the increased pressure onresources from the migration of people from the drought stricken northern regions of theLCCB into areas surrounding the lake and associated river basins, as well as by jobswitching that has intensified the competition for irrigable agricultural land. Continuingsocial disruptions hold the key risk of diverting the majority of resources into seeking tomitigate for these 'symptoms' rather than addressing root causes of system decline.Drought, as an element of hydrological variability, and water diversions have also led to emigration. The entire department of Diffa in Niger has lost about 10,000 inhabitants since the early 1980s.

Overall, the reduction in freshwater is considered as being the most severe problem due toit driving almost all environmental concerns in the Lake Chad Basin. It is a contributoryimmediate cause of five out of the seven transboundary problems identified by stakeholdersin Maroua last September. These are: Decreased viability of biological resources, inparticular fisheries, as many have been lost due to desiccation; Loss ofbiodiversity, especially as a result of the desiccation of the lake and of some wetlands; Loss and modification of ecosystems, especially aquatic ecosystems again as aresult of desiccation; Sedimentation in rivers and water bodies due todecreases in channel flows as well as the loss of the ability of the rivers to flush out theirchannels at the onset on the rainy season and; Invasive species that have beenattracted by the all year round inundation of floodplains and river channels in theKomadugu Yobe system in particular.

Coe and Foley (2004) calculated that irrigation and river water diversions accounted foronly 5% of the decline in the lake's volume between 1966 and 1975, with declining rainfallaccounting for the

remaining 95%. As population expanded irrigation demands increasedby four fold between 1983 and 1994, accounting for 50% of the subsequent decrease in thelake volume. The driving forces associated with this include: persistent droughts anddecrease in rains that made reliance on rain fed agriculture uncertain, lack of integration insectoral development policies and planning that pursued agricultural development at theexpense of the environment, low standards of environmental education and awareness thatclouded appreciation of the negative impacts, and the absence of sustainable developmenton the political agenda. Large and unsustainable irrigation projects built by Niger, Nigeria,Cameroon, and Chad, have been diverting water from both the lake and the majorcontributing rivers, the Chari and Logone system, as well as from the Komadugu Yobe Basin.For example, in Nigeria there are three large dams and 22 small ones in the KYBconstructed during this period. The three large dams are Bagauda (closed in 1972, with asurface are of 145 km2), Tiga (closed in 1972, with a surface area of 180 km2 and Challawa(closed in 1992, with a surface area of 100 km2) constructed primarily to support heavilysubsidized large scale irrigation schemes. In Cameroon the Maga dam, with a surface areaof 400km2, that diverted flows from the Yaeres, was also constructed during this period. Itwas meant to support a large scale rice production scheme, which has now failed.

In addition, heavy overgrazing in the region, resulting in the loss of vegetation and seriousdeforestation, has contributed to the desiccation of the rivers that feed the lake. Refer toSection 4.6 for more detail on this particular issue.The population of the basin also increased by 30% (10 million) between 1994 and 2004,serving as a driving force behind the above developments, as well as behind otherunsustainable resources use activities. Stream diversion, associated with the construction ofwater infrastructure, has also been an immediate cause of anthropogenic stream flowmodification. A case in point is the inefficient raw water intake structures for Kano City inthe KYB which have changed flows in stretches of the rivers from annual to a perennial.The numerous dams have disrupted the timing and extent of the flooding of the LCCBwetlands.Upstream damming, especially their operation in an unintegrated manner, irrigationdevelopment with 11% use efficiency and the drought have negatively affected thedownstream flow regimes and flood pulse on which the populations of the lower Komadugu increasingly depend. This type of development may not be unique to the KYB alone.

4.9.1.1 Water Pollution

Due to the limited industrial activity and relatively limited and localized application ofagricultural fertilizers in the LCB, contamination is currently of limited concern and currentquantities are thought not to exceed the local environmental assimilative capacity. In theKomadugu Yobe Basin in Nigeria, however, there are already traces of pollutants (zinc,mercury and magnesium metals in the system, introduced mainly by tannery and textileindustries in Kano, where there is evidence of the discharge of untreated effluents into therivers.

The relatively high priority rating of this problem by stakeholders is in view of foreseeabletrends and the dangers they portend for the region. Increasing commercial agriculture in,for example, the cotton and rice industries, which are known to use large quantities of agrochemicals(including herbicides, insecticides and fertilizers), will lead to inorganic chemicalpollution and eutrophication.

There is also increasing oil exploitation within the basin, especially in Chad, which will giverise to increased urbanization, population, and resource consumption. Oil spills and relatedhazards will cause severe contamination of the water bodies and further deplete the floraand fauna. In spite of the foregoing there is no evidence of any preparations in the region for addressing the issue (e.g. there is no ongoing review of legislation or contingency planning).
Increased irrigated cultivation tends to concentrate pests. Borers, caterpillars, locusts, crickets, quelea birds, and golden sparrows are already endemic. Increased use of pesticides such as DDT, some of which are considered toxic in the United States and Europe, poses a risk of pesticide loading in water, which could potentially affect the human population.

The KYB chemical pollution from the tannery and textile industry is implicated in incidences of river water pollution (including Zn and Hg), that have in turn led to health hazards (skin diseases and stiff joints epidemics in Kano) and fish kills and resultant loss of livelihoods.Water pollution is a contributory factor to the immediate causes of fisheries depletion in theKYB. Pollution from agricultural chemicals has also contributed to the prevalence ofinvasive species through the eutrophication of the invaded water bodies.The immediate cause of the current traces of pollution of water bodies in the KYB is therelease of untreated zinc and mercury laden effluents by upstream tannery and textileindustries in Kano. This is happening due to a weak enforcement of

environmentalregulations, guidelines and standards, as well as a low standard of environmental educationand awareness that has made the public unaware of the impacts of the industrial effluents.Diffuse chemical pollution is also being driven by unsustainable application of fertilizersand other agricultural chemicals by farmers with low environmental awareness, operatingin the absence of regulations and guidelines for the wise use of agricultural chemicals.

4.9.1.2 Decreased Viability of Biological Resources

Vegetation cover in the basin, which is the primary source of fuel wood, construction wood and other related materials, as well as fodder, foods and medicines, is no longer meeting these needs adequately. In large cities like Kano and N'djamena, fuel wood is sourced from distances of up to 300 km. The rate of regeneration of plant cover in the basin lags behind the rate of exploitation, to the extent that in some parts of the basin, especially the KYB, the seedlings of several tree species have disappeared. Drought has killed off or damaged many tree species. Terminalia avicennoides, Anogneissus, leiocarppus, Scleorcarya birrea, and Lannea and, where the water table has dropped, Acacia nilotica have all sufferred. Tree death has been apparent on both the slightly leached, ferruginous soils of the southeast, and the isohumic soils of the north.

The fish populations in the lake have suffered declines recently from drought, overfishing,diversion or blockage of stream flows, and increased juvenile catch due to use of smallermesh. The most important fish in Lake Chad are the characin (*Alestes baremoze*) and theNile perch (*Lates niloticus).* Characin populations have decreased drastically while Nileperch catch-sizes have decreased substantially so that they seldom exceed 5 to 8 kg inweight, compared to past weights of over 10 kg. The average size of the fish shows that theresource is today being severely exploited.

Viewed as a biological resource, large portions of the soils of the conventional basin aretoday classified as highly degraded.This has resulted from the vulnerability of the soils ofthe basin to degradation, coupled with a tendency to over-exploit the limited carryingcapacity to meet food requirements by using inappropriate or unsustainable farmingmethods. This is illustrated by the widespread encrustation of halomorphic alkali soils thathave been denuded. Around N'djamena, soil degradation has spread among the brown soils,the hydromorphic soils, the ferruginous soils and the alkaline soils. The degradation of vegetation cover has had a multiplier effect on

ecosystem degradation,as the people's response to the concomitant shortages has been more unsustainableharvesting and more damages. The shortages have led to more competition and evenresources use conflicts, especially among pastoralists and between pastoralists and cultivators. It has also caused soil degradation, mainly by exposing the soils to erosion anddepriving them of organic matter content. These in turn have caused declines in incomes.

Declines in the viability of fisheries have led to less catches in both the quantities caughtand the sizes of the catches. This again has translated into impoverishment.The encrusted soils reduce infiltration and increases runoff, sheet wash and scouring. It also encourages the formation of sand sheets and nebkhas. The net result is less soil productivityand increased poverty.Devegetation and soil degradation lead directly to loss of biodiversity, and evento reduction in available fresh water, as it encourages rapid run offs andchannel siltation. They also lead to ecosystem modification, and can encouragethe prevalence of invasive species.

Chaotic deforestation is a chronic problem. Domestic and industrial energy use from thefish-drying and bread-making industries of Maiduguri, Kano, N'djamena and other majortowns contributes significantly to deforestation. Wood cutting has become a lucrativeeconomic activity that is conducted without adequate management plans for naturallyforested areas. For example, in the Nigerian sector of the LCB, demand for wood exceedssupply by a large margin. This is because the annual domestic wood demand by theestimated population of 22 million is 7.5 million metric tones, while what can be harvestedsustainably from the sector averages 5 million metric tonnes per annum (Neiland andVerinumbe 1990).
Seasonal burning for land clearance is also a serious problem that contributes todeforestation and air pollution.

The degraded soils have little to do with drought. They are predominantly the result ofdevegetation by humans. Up to 120 km east of N'djamena, the cutting of trees (*A. seyal*) inthe sandy clays and the cutting of *A. nilotica* from the hydromorphic soils is severe. *A. nilotica* has almost entirely disappeared. The most severe degradation is east of N'djamena.Significant habitat modification is one of the driving forces behind the decreased viability offisheries. This has been largely a consequence of the freshwater shortage. The unsustainable exploitation of the fish and other living

resources is thus not considered asthe primary reason for the fluctuations in fisheries production experienced over the pastyears, as habitat modification is the main culprit.

Among the root and underlying causes of diminishing fisheries are the facts that: there is nointernationally recognized institution controlling fishing effort, areas and seasons; there isalso a huge black market in fish sales making it difficult to monitor species, amount and ageof fish; there are no enforceable rules on mesh size, species catch, fish "reserves", age of fishcaught, etc. The lack of enforceable codes allows over-exploitation of certain species andage-classes. For example, in 1977, commonly used net mesh size was already too small. Itshould not have been smaller than 60-70 mm. By 1971, Alestes baremoze had been overexploitedindependent of water levels and drought conditions.

4.9.1.3 Loss of Biodiversity

While conditions differ for different ecosystems and parts of the LCB, in general thebiodiversity and ecosystem health have declined dramatically and continue to do so.Fish diversity has reduced dramatically throughout the basin. In the HNWs in the KYB, forexample, a biodiversity survey conducted by IUCN in 1997 revealed that 43 species from 14families had disappeared from an inventory done two decades earlier that listed 24 familieswith 106 species (Okali and Bdliya, 1997).

Regarding wildlife, the sitatunga is now considered extinct in Niger while only a fewdeclining populations remain in the Lake Chad region of Nigeria and no recent informationis available for Chad and Cameroon. A reduced hippopotamus population is still present andotters remain common. Nile crocodiles are now uncommon in the lake. A few populations ofelephant, kob, and red-fronted gazelle still survive. Although humans have generally huntedout other large mammals and crocodiles, viable populations of smaller mammals (such asthe endemic Lake Chad gerbil), smaller reptiles, and amphibians remain.Of global significance is the threat of loss of a floating rice variety (Glaberima) in the KYBand the Kuri cattle breed around the lake. The rice variety, grown mainly along the middlereaches of the Yobe, has a unique flavor and is quick and high yielding. The Kuri cattle areresistant to the common bovine diseases in the region. Their disappearances will reduceopportunities for effecting improvements in crop and livestock production.Changes in biodiversity affect ecosystem functions and productivity. While some of

theseimpacts can be predicted, others cannot. As biodiversity decreases, ecosystem productivity and services deteriorate.For example, the decrease in crocodile and hippopotamus populations may have adverselyaffected fish populations. Crocodile prey heavily upon catfish (Clarias gariepensis) whichconsume the eggs and fry of tilapia and other cichlids. Without crocodiles to control catfishpopulations, the catfish reduce tilapia stocks. Hippos also maintain fish stocks by stirring uprich water sediments, keeping deepwater channels open and increasing water fertility withtheir dung.

Furthermore, as a result of climate variability and water development projects beingpursued without integration to other sectors, at least five species of fish (*Bagrus docmac, Alestes baremose, Labeo parvus, Citharinus latus, Gymnarcus niloticus*) have disappearedfrom different parts of the Lake Chad Basin in Nigeria. Examples of such projects include thelarge dams in the KYB and the manner in which they are operated without due recourse toenvironmental considerations. The experience in the Logone valley south of the Company of Growth and Modernization of Yagoua rice cultivation (SEMRY).Irrigation Project is also similar: fish yields collapsed by 90% for lack of inundations.The net consequence of biodiversity loss is increased impoverishment of the humanpopulation as a result of the loss of natural products and ecosystem functions.

Biodiversity loss causes decreased viability of biological resources and the lossand modification of ecosystems. It is caused to a large extent by variability ofhydrological regimes and fresh water availability, as well as water pollution and invasivespecies.Habitat loss from the uncontrolledexpansion of farmlands and settlements, and the drainage of wetlands, which along with theother immediate causes are driven by the lack of administrative frameworks for protectinghabitats outside protected areas. This is further worsened by the prevalence of weakenvironmental policies and regulations or their weak enforcement, as well as the absence ofresources use planning. Climate change is predicted to have further severe further impactson biodiversity.

The fish habitat in the lake has altered from being an open water environment to being apredominantly marshy environment. The fish species composition has changed to reflectthis and significant biodiversity loss has been recorded during the past decade or so.According to the LCBC fisheries unit, *Clarias gygas* has disappeared due to the habitatchanges, while *Heterotis*

niloticus, Alestes (Sardine) and *Gymnarcus niloticus*, all of whichused to be dominant, are now scarce. On the other hand, Tilapia (Oreochromis) has nowbecome predominant.Bird life is threatened by decreasing water levels that have resulted in loss of wetlandhabitats in general and seasonal inundations in particular, which are needed by the birds.Recent concerns include the availability of nesting sites for the endangered West Africansubspecies of black-crowned crane (Balearica avonina pavonina) and adequate winteringgrounds for numerous intercontinental migrants such as the ruff (Philomachus pugnax).The decreased inundated area of the Waza-Logone floodplain has been a major cause forthe reduction in the number of kob, and the complete disappearance of buffalo, waterbuck,bushbuck and common duiker in the Waza National Park.Devegetation and declining rains have led to a marked shortage of seedlings of large treespecies in the wild.

4.9.1.4 Loss and Modification of Ecosystems

Extensive habitat and community modification of the aquatic ecosystems has beenexperienced in both the lake and river environments. The lake habitat has changed frompredominantly open-water to a marshy environment.An estimated 50% of wetlands in the LCB have already been destroyed and 36% of fishspecies are threatened.Regarding the broad terrestrial ecosystems of the basin, general floristic degradation hasconstituted various forms of habitat modification. The major kinds of floristic degradationinclude:

(1) Reduction of canopy coverage that provides the best plant microclimates andprevents erosion;
(2) Change of grasses from perennial species to annuals and dicots;
(3) Reduced biomass of forest products;
(4) Loss of root volume and soil-holding capacity;
(5) Reduced cycling of soil minerals by deep rooted trees;
(6) Loss of legumes that restorenitrogen to the soil; and
(7) Loss of species diversity.

Upstream dams have altered the flow regime of the lower Yobe and the major inflow to thenorthern pool of Lake Chad. Although no detailed study has separated the impacts of thedrought from those of the dams, it is apparent that the groundwater table has lowered,causing streams, ponds, ox-bows and village wells to have less water for a shorter periodduring the year.

The five to six month flow of the Yobe now lasts three to four months.There are areas that are never flooded even in good rainfall/runoff years. The Maga dam inCameroon had a similar impact on the Logone, and a worse one on the Yaeres.

The modification of ecosystems has ended the Yobe fishery and much of the recessional riceproduction. In addition, flood depression fisheries have collapsed. A lot of plant and animalbiodiversity have been lost. The resultant or accompanying degradation has translated intothe loss of products that support livelihoods, besides the loss of fisheries. A case in point isthe loss of a genetically unique rice cultivar in the KYB. The loss and modification of ecosystems has been a major cause of biodiversity loss, variability of hydrological regimes and fresh water availability anddecreased viability of biological resources. It has been facilitated bysedimentation in rivers and water bodies and invasive species.

Stream flow modification, resulting mainly from reduced rains and damming, which hasforced the lake to contract, has significantly affected the lake environment, by contractingthe open water lake into a marshy ecosystem.Intensive cultivation and large numbers of domestic animals, as well as the over harvestingof vegetal and faunal resources contributed to the degradation of the wetland ecosystems.The primary reason for the reduction in the extent of the wetlands has, however, beenattributed to the changes in the seasonal timing and extent of flooding. Consequently, sincethe 1960s wetland resources in the LCCB have been reduced by almost 50%.

Human influences that have led to terrestrial ecosystem degradation include:

(1) Overcuttingtrees for fuel wood, especially near cites;
(2) Over-cutting for construction wood,especially borassus and doum palm;
(3) Over browsing, overgrazing and trampling bylivestock;
(4) Clearing for irrigation agriculture and waterworks; and
(5) Clearing for humansettlements.

Their root causes can be traced to population pressure, absence of sustainabledevelopment or the wise use of natural resources on the political agenda, low standards ofliving, low standards of environmental education and awareness, and a lack of integration insectoral development planning and management, among others.

4.9.1.5 Sedimentation in Rivers and Water Bodies

This pertains to the sedimentation of the rivers that feed the lake, as well as of small lakesand wetlands in the basin. In the KYB's inland delta in the Hadejia Nguru wetlands this hasdried out some channels, as their intakes got filled up by sediments. The Chari Logonesystem, especially in its upper reaches, also has large sediment deposits in the channel.This problem has led to changes in channel flow patterns aswell as a decrease in theinflows into the lake, making it a transboundary issue.The major impact of sedimentation in channels is the local diversion of flows. In the HNWsthis has led to the desiccation of a channel that about 300,000 people have been dependingupon for irrigated agriculture, as well as the flooding of communities by the diverted flow,which has caused immense damages to infrastructure, fisheries and farmlands.

Some of the silted lakes and other water bodies became suitable for colonization by invasivespecies, especially typha that thrives best in fresh shallow water.The net consequences of channel desiccation and typha invasion has been deepeningpoverty and increased resource use conflicts.Sedimentation of water bodies is a contributory factor of variability in hydrological regimesand fresh water availability, decreased viability of biological resources, loss of biodiversity,loss and modification of ecosystems, as well as the facilitation of invasive species.
Human impacts on stream, river and ouadi channel changes can be traced tourbanization, roads, upstream dams and/or diversions and increased runoff and sheet washfrom damaged hill slopes, especially as a result of uncontrolled farming and devegetation.

The landscape changes interlace with natural causes such as tectonic events, long-termmeteorological drought, and extreme runoff and channel flow events. The human impactsare themselves driven by poor enforcement of environmental protection regulations, lowstandard of environmental education and awareness, population pressure, and lack onintegration in sectoral development planning and management, among others.

4.9.1.6 Invasive Species

This pertains to the domination of a habitat by a single plant or animal species to theexclusion of other species that ordinarily thrive in the same habitat. In the KYB there aretwo prominent invasives, typha grass and quelea birds. In the Chari-Logone system it iswater Hyacinth while the lake itself has been invaded by Typha and water Hyacinth.The typha and other invasive weeds

issue, although prevalent at specific locations, istransboundary in nature because it impacts on shared river systems. In the Komadugu Yoberiver system in Nigeria, for example, it has colonized over 1000 Km^2 of fadama land in theHNWs, and has contributed immensely to the diversion of flows away from Lake Chad.

The Red billed quelea bird (Quelea quelea lathamii) has a grazing range of up to 500 km,which more than often crosses borders, and thus cannot be controlled withoutinternational cooperation. It is a small seed–eating bird which is a serious pest of sorghumand millet in much of central and West Africa. The two cereals form part of the staple diet for the human population and due to their drought tolerance' can be grown throughout theregion. The birds occur in colonies of up to millions of birds. Normally the birds feed ongrass seeds but in the absence of these they attack the crops mainly at dough stage, suckingout the soft grain. Damage caused inindividual field can be as high as 100 percent if no control measures are undertaken.

The major environmental impact of weed infestation is the blockage, and in some instanceseven diversion of channels. This has led to parallel incidences of channel desiccation andinundation in the HNWs, the net consequences of which have been loss of livelihoods,poverty and resources use conflicts.Quelea birds destroy crops and thus resulting in losses in incomes and food stuff.Furthermore, Spraying with the organophosphates has been the predominant means tocontrol it for more than forty years. Birds of prey, owls and passerines have been commonlyreported casualties of spraying over land. Moreover, organophosphates are known to havenegative effects on aquatic invertebrates, in particular on populations of crustacea, whichpredicates against its use near water bodies. Non-target species may be affected directly byspraying, but predatory birds, scavenging birds and even mammals can be contaminated bysecondary poisoning when they eat Quelea carcasses found up to 20 km or more from theprimary control site.

Invasive species are facilitated by variability of hydrological regimes and fresh wateravailability, water pollution, loss and modification of ecosystems, as well as sedimentationin rivers and other water bodies. It leads to the decreased viability of biological resources.The major cause of typha invasion in the KYB is a change in the hydrological regime, whichturned a seasonal river into a perennial river. This in turn is the result of poor damoperation procedures and inefficient raw water intake structures, which put a lot of waterin the river system during the dry season. The Kano City raw water intake structure on theKYB, for example, takes maximally only 5% of dam releases in

the dry season effected on itsaccount. The remaining 95% of the releases, at a maximum of 25 million cubic meters persecond, and a minimum of 10 million cubic meters per second, provides unwanted dryseason flows downstream. This is happening due to the absence of an integrated system ofwater resources management in the basin, which is illustrated by a poor enforcement ofenvironmental protection regulations and the absence of sustainable development/wise useof natural resources on the political agenda. There is in addition the issue of eutrophicationas another immediate cause, which is driven by the lack of best practices in the use ofagricultural chemicals, which itself is the result of the absence of an administrativeframework for managing diffuse sources of pollution in agriculture. Quelea birds, on theother hand, have become more prevalent as crop pests due to the degradation anddestruction of their grazing sites through uncontrolled expansion of farmlands andsettlements, which are in turn the products of population pressure and low standards ofenvironmental education and awareness

4.9.2 Senegal River

Inland fishing catches has been weakened mainly due tosuccessive rainfall deficits (drought) in recent decades and changing hydrological regimes of major rivers (dams and irrigation schemes). At the same time, the development of agriculture industrial (tomato, sugar) and rice cultivation in the northern region of the country have forced good number of fishermen retrain, temporarily or permanently, in the sector Agricultural.

Aquaculture, usually introduced in the framework of projects (mainly fish, shrimp, and oysters), has not yet yielded positive results (absence of monitoring and coordination, lack of control popularized techniques) despite individual initiatives and many projects implemented. Despite the existing potential, aquaculture and inland fisheries have changed little during the last two decades and remained sluggish due to a context of unfavorable ecological and socioeconomic conditions.

Diallo and Ndiaye (2014), Senegal Rver has lost its biodiversity, with a resultant decrease in fish landing due to the construction of dams (Diama in Senegal and Manatali in Mali – for agricultural and electricity purposes). Despite the sector economic and social importance, the sector has also face serious disequilibria both in resource exploitation and market supply. Unsustainable fishing practices and changing hydrology are negatively impacting livelihoods in many communities.

There is the absence of collusion between the administration and professionals in the RBO organization structure. This has a negative impact on the behavior of actors, in terms of enforcement and difficulties in mobilizing to manage sustainable fishing.

4.9.2.1 Recent Changes in the River Regime and Basin Environment

Over the last three decades, a considerable decrease in rainfall has landed the region's countries in a series of deficit years. This chronic decrease in rainfall in the basin is accompanied by a comparable but amplified decrease in the river's hydraulicity. The river's average annual flow fits in with a continuous downward cycle since the beginning of the last century. The average flow module in Bakel decreased by more than half between the two halves of the last century and then by half again between the two last quarter centuries. In other words, the annual average flow in Bakel went from 1374 m3/s for the period 1903–1950 to 597 m3/s for the period 1951–2002; and an average of 840 m3/s for the period 1950–1972 to only 419 m3/s for the 1973–2002 period (OMVS, 2003). Deteriorating hydro-climatic conditions before the construction of the dams is also illustrated by the fact that for the reference period 1904–1972, 8 of the 10 years recording the lowest hydraulicity are concentrated in the 1970s and 1980s. When the dams were built, the river regime was undergoing profound changes. Similarly, the physical setting was experiencing rapid encroachment of desertification.

4.9.2.2 Proliferation of Invasive Species

The volume of land occupied by invasive aquatic plant species and their growth rate is one of the most troubling environmental problems in the Senegal River Basin. Over the last decade, invasive plant species have spread at an extraordinary rate in the river basin, particularly in the lower valley and delta. These species were mainly reeds (*Typha* and *Phragmites*), kariba weed (*Salvinia molesta*) and water cabbage (*Pistia stratiotes*). The total surface area invaded by plants was estimated at just over 100,000 ha in 2001 (SOE, 2005). In less than 10 years, harmful aquatic plants have invaded most of the active waterways. Invasive plant proliferation has clearly been fostered by the presence of nutrients (sufficient quantities of nitrogen and phosphorous), calm waters, low currents and stopping the up-flow of saltwater (AGRER et al, 2003). These factors are due to large infrastructure projects: the two large reservoirs upstream (Manantali) and downstream

(Diama) and their connecting structures (levees, irrigation systems) that together have changed the river's hydraulic regime and water quality (AGRER, 2003).

Invasive species disturb the overall functioning of the fluvial ecosystem and disrupt socio-economic activities such as irrigated agriculture, fishing and livestock farming. The immediate and root causes of proliferation of invasive species are as follows:

Immediate causes:

1. Change in the river's water regime (lack of/low tidal fluctuation);
2. Water softening (blockage of saltwater up-flow);
3. Development of irrigated crops and nutrient disposal in the river's water (nitrogen, phosphorous); and
4. Importation of non-native species (case of *Salvinia molesta,* which was accidentally introduced in the outskirts of Saint Louis before proliferating in the rest of the delta and lower valley).

Root causes:

1. Dams/regulation of the fluvial flow;
2. Non-enforcement of laws related to the introduction of non-native species;
3. Lack of a clear policy on the importation of non-native plant or animal species; and
4. Lack of an early-warning and ecological surveillance system.

4.9.2.3 Threats to Biodiversity

Even though no inventory or systematic monitoring has been set up for the basin's animal and plant species, the threats to biological diversity have been illustrated through the degradation of natural habitats and, particularly, plant formations (included under the topic ―land degradation and desertification‖) and wetlands, frequently known for their high biodiversity value. Over the last few decades, these wetlands have shrunk considerably. This phenomenon combined with alteration of the river regime and the occasional deterioration of water quality has greatly affected the ecological benefits and functions of these areas. Degradation of natural habitats puts the basin's biological diversity in danger.

The basin's ichthyological fauna illustrates this well. The Senegal River's ichthyologic fauna includes freshwater species but also brackish-water species. In 1998–1999, 63 fish species belonging to 18 families were inventoried in the river (Roche International, 2000). However, the study also noted a decrease in fish quantity and therefore the river's halieutic productivity. Downstream from Diama, this decreased productivity resulted in fewer fish catches on the order of 50–70% (AGRER et al, 2003). Among the main causes of an assumed decrease in fishing productivity in the valley are decreased flooding regulated by the dams and lowered water quality due to aquatic plant species invasion (AGRER et al, 2003). On the other hand, the Diama and Manantali reservoirs host rich and varied fish stocks. The Roche International survey (2000, op. cit.) estimates that fishing contributes to feeding a population between 350,000 and 600,000 persons living along the river. Hence, the decrease in ichthyologic fauna in some areas of the river can have significant social and economic impacts on the basin population.

Immediate causes:

1. Fauna and flora habitat loss following deforestation, bush fires and mining operations;
2. Decrease or suppression of annual flooding resulting in a loss of spawning grounds for fish fauna;
3. Non-adapted fishing techniques (capture of juveniles);
4. Poaching in protected areas; and
5. Proliferation of monospecific species such as *Typha* and other invasive species.

Root causes:

6. Poverty resulting in few or no alternative income sources to poaching and the destruction of natural habitats (particularly in the relocation areas for displaced Manantali residents);
7. High dependence on primary natural resources and agricultural income;
8. Climate variability and change (decreased river hydraulicity);
9. Weak enforcement of policies and laws to protect species and ecosystems hosting a rich biological diversity (wetlands, for example);
10. Lack of regulations on fishing practices;
11. Misunderstandings about biodiversity issues and the advantages of conservation; and
12. Rising demographic pressure on natural resources

Fisheries in Senegal River face a number of challenges which may be summarized as follows:

1. The small size of the fishing areas about the importance of activities and the increasing scarcity of the resource, which accentuates the pressure and exacerbates conflicts;
2. The lack of basic infrastructure in fishing centers (areas landing, conservation of resources and transportation of products, etc.);
3. Inadequate training and organizational weakness of the players in the various sectors;
4. Supply difficulties of shore units;
5. Low value added and productivity;
6. The inadequacy of fishing activities financing systems.

The constraint of fisheries development in the Senegal basin includes:

1. Notorious Declining fish production linked to deficits successive rainfall (drought) in recent decades and changing hydrological regimes of major rivers (Dam construction and irrigation schemes);
2. Obsolescence of national regulations;
3. Absence of complete and recent statistics on all levels water;
4. Inadequate training and organizational weakness of the actors;
5. Lack of interest of credit institutions to the subsector and
6. credit access difficulties for fishermen;

4.9.3 Niger River Basin

1. Objectives of Niger Basin Authority

There is need to review Niger Basin Authority working objectives. There is no special consideration for fishing and fishery as natural resources of the Basin. Fishery is considered as a form of agriculture, which is not part of the Basin. But Niger River is the natural habitat of fish like any other aquatic environment. Therefore, fish need to be given a priority in the management of the Basin.

1. Limnology of Dam and Reservoirs

Limnological examinations of dams are the baseline for sustainable fish production in dams and reservoirs. Proper pre and post impoundment limnological data, good design and efficient

operational management of dams and reservoirs are required for effective management of dams and reservoirs for increased fish production. This will provide prognostication on dams aging, eutrophication, ecological interactions and the impacts of watershed uses. This could then be used in dams' management, operations and conservation of the water resources. Therefore, in planning, construction, execution and subsequent management of dams, limnologists and fisheries biologists should be consulted, (Mustapha, 2011).

Some of the limnological assessments to be carried out before proceeding on the contruction of dams are:

1. Initial environmental examination (IEE);
2. Environmental impact assessments (EIA);
3. Environmental risk assessment (ERA) (Bernascek, 2001).

Effective fish passage structures for easy migration of up and down stream across the dam should be provided, to solve the problems of negative impacts of dam construction on fish. Proper construction practices should be ensured to control and reduce the problem of soil erosion and silt run – off into the river during construction, this will minimize the problems of turbidity and thereby reduce the situation of the breeding habitats of fish, (Mustapha, 2011).

1. **Introduction of Fish Species**

Introduction of fish species can be used to improve fish production of lakes and dams whose fisheries have collapsed or to create a fishery in a lake where no such fishery existed as in the Lake Kariba, although, introductions of fish species was recorded to have both positive and negative consequences, (Ogutu-Ohwayo, and Balirwa, 2004). The negative impacts of fish species introduction is the predatory behaviour of some fish. The introduction of the clupeids in Lake Kariba resulted in an increase in the quantity of fish landed from 1000 tons in 1974 to 24,000 tons by 1985 (Marshall 1988). Unfortunately, the establishment of Nile perch in Lake Victoria was accompanied by a decline and in some cases total disappearance of most of the native fish species. Stocks of haplochromines which were the most abundant fish in Lake Victoria and formed 80% of the fish stocks (Kudhongania and Cordone 1974, Okaronon *et al* 1985) comprising of over 500 species (Seahausen, 1996) declined and 60% of the species are feared to have become extinct due to predation by Nile perch (Witte *et al* 1992a, b). Introduction of the clupeid in Lake Malawi was opposed and abandoned on the ground that its impacts on the complex fish fauna of the lake could

not be predicted, (Ogutu-Ohwayo, and Balirwa, 2004). Therefore to introduce any fish species to a water body, assessment of biological characteristics of the native and fish to introduce should be carried out to know the type of relationship that will be established between them in the River.

1. **Control of Population around the Basin**

The degradation of freshwater fisheries in Africa can be traced to rapid population growth and changes in livelihood systems in the drainage basins. A doubling in population since the1960s has led to pressure on the diverse natural resources of which fisheries are part. As most of the African countries are among the poorest in the world, it is to be expected that poverty is a key driver of the exponentially increasing population that seeks to maximize on socio-economic development objectives. This leads to increasing deforestation, intensification of agriculture and urbanization. Most African governments receive support from UN agencies such as UNICEF and UNFPA aimed at educating communities in family planning, encouraging widespread of immunization and handling of preventable diseases.

While there have been some positive impacts, the population in many countries is still high. With severe droughts and floods that characterize many parts of the drainage basins and low agricultural prices, declining soil productivity, and unemployment, entry into the usually open access fisheries provided options for poverty alleviation and sustaining of peoples livelihood. Therefore, measures to control population growth should be accompanied by improved livelihood patterns in the communities and practical education programmes in resource use.

2. **Control of Sedimentation**

Another factor that has contributed to loss in fish habitat, fisheries and biodiversity is sedimentation. In the 1970s, the mean depth of Lake Baringo was 5.6m but currently, the total depth of the lake has been reduced from 8.9m in the 1970s to less than 1.9m by 2003 due to growing human and livestock population accompanied by deforestation. Of the seven rivers that were flowing into the lake in 1970s only one river currently flows into the lake. Sedimentation has resulted into a loss of many fish species such as *Labeo* that contributed to the livelihood of local people. On Lake Tanganyika sedimentation reduced the diversity of invertebrate and fish fauna (Cohen *et al*, 1993). Sedimentation is primarily caused by inappropriate land use practices especially on sloping land

3. **Capacity Building**

The fishermen around Niger River need to be orientated to diversify their livelihood strategies, they need to be encouraged to engage in alternative occupations such as aquaculture or farming (Enin, 2012). These will help the fishermen to have complementary and alternative income – generating opportunities in addition to earnings from fisheries related activities as required through raising of awareness; skills development; credits and savings; diversification programmes, etc. FAO-UN (2012) advised that small-scale fisheries actors should consider diversifying their livelihoods, if the state of the fishery resources and the environment is such that continued use patterns threaten their sustainability. There is need to increased attention to social development to include health, education, organisational development and empowerment, etc. This is needed to ensure that small-scale fishing communities are empowered and that their members can enjoy their rights as human beings and members of society and to depend less on fisheries resources.

Effective capacity building will include improving understanding of ecosystem structures and functions; training managers and regulators to deal with a broader range of options and trade-offs, conflicts, rights and regulations; and enhancing stakeholder capacity to participate. This may be achieved, at least in part, by mobilizing and linking with existing institutions, (FAO, 2013).

4. **Rights and Responsibilities of the Fishing Communities**

The need for small-scale fishing communities to have secure access to aquatic resources include their responsibilities to restore, protect and manage local aquatic and coastal ecosystems on which they depend for their well-being and that they have used traditionally for their livelihoods. There is need to acknowledge the importance of a sustainable use of aquatic and other natural resources and of the need to fulfil the right to development by meeting both developmental and environment needs of present and future generations.

The right to secure access to aquatic resources is divided into two. They are:

1. Use rights: This involves the rights held by individual fishermen, fishing groups or fishing communities to have access to a fishery and use the fishery resources.
2. Management rights: This includes the right to be involved in the management of a fishery

This is to ensure fisheries co-management, to empower small-scale fisheries actors to take part in decision-making affecting their livelihoods. Small – scale fisheries actors should recognise that rights and responsibilities are inseparable. They have to be fully represented in relevant local and national professional to be actively taking part in all decision and policy making processes open to them. They have to contribute to a sustainable utilisation of the resources to which they have use rights. Destructive and illegal fishing methods or other practices that are harmful to the environment or unsustainable should be replaced by responsible practices, (FAO-UN, 2012).

3. **Fishery and other Sector of the Economy**

Governments should recognise the increasing competition over the River resources by different sector of the economy. Small – scale fisheries in inland waters tend to be particularly vulnerable to the impact of other sectors like agriculture, dams, and hydropower. Governments should use cross-sectoral approaches, including spatial planning, in order to reconcile interests of different users, recognizing that small-scale fishers and fish workers are often the weaker party in conflicts and may require special attention. Mechanisms for resolving conflicts are needed and should be part of the national legal frameworks, (FAO-UN, 2012).

4. **Control of Post – Harvest Loses**

Postharvest losses should be avoided and ways for creating value addition sought, building on existing traditional and local cost-efficient technologies as well as making use of technology transfers. Environmentally sustainable practices should be promoted, deterring, for example, the waste of inputs needed for fish handling and processing (e.g., water, and firewood or other types of energy sources), (FAO-UN, 2012).

5. **Gender Equity**

Development programs that fully incorporate women and marginalized groups into program design and implementation are more effective than those that don't, (USAID, 2013). Men and women should be treated equitably and fairly with regard to rights. It should be recognised that women and men play important and complementary roles in the governance and development of the small-scale fisheries sector, and that they should enjoy equal respect and rights, in all aspects of life and in decision-making. While the concept of gender, by definition, deals with both men and women – and boys and girls – and the socially, culturally and economically established roles and

relationships between them, women are often more disadvantaged than men. Gender equality efforts hence often mean supporting and empowering women whilst working with both men and women. (FAO – UN, 2012).

6. Fishing Gear and Methods

The impact of some fishing gear and methods on the bottom habitat (biotic and abiotic) can often have a negative effect on the ecosystem. There is limited knowledge about this impact, however, and more research is required to examine the extent of the impact of various gears. For gear known to produce serious impacts, the introduction of restrictions may be necessary and, where possible, new technologies that mitigate any negative impact will need to be developed.Fishing operations may also cause other negative impacts to the environment, such as continued fishing by lost gear 'ghost fishing', as in the case of gillnet and pot trap. Minimizing such impacts will require development and successful introduction of alternative cost effective technologies and fishing practices. Many ecosystems, especially those in coastal waters, are impacted not only by fisheries, but also by other users, including upstream land-based activities. In these cases, many of the broader measures will be the responsibility of other agencies. Fisheries managers will need to take a proactive approach so that the appropriate authorities recognize fisheries as an important stakeholder in these ecosystems, (FAO – UN, 2012).

Mesh size restrictions can be a useful measure to avoid capturing individuals of target species in the immature stages, but they have limitations in multi-species fisheries. When organisms of different shapes and sizes occur on the same fishing ground, immature individuals of a co-occurring larger species might still be captured. Selectivity can be improved through a variety of methods other than mesh size, including the use of square mesh, sorting grids and other devices which enable the unwanted portion of the catch to escape.

7. Spatial and Temporal Controls on Fishing

Fishing mortality can be modified by restricting fishing activity to certain times or seasons, or by restricting fishing in particular areas. The number of fishermen to operate at a particular time needs to be regulated. Such measures can be used to reduce the mortality rate of individuals of either target or non-target species in vulnerable life stages. Where stocks are shared by more than one country, the closures – like other management measures – must be coordinated. The selective

reduction of fishing mortality rate on both target and non-target species generally reduces both the direct and indirect effects of fishing on the ecosystem. Closures may be used to protect critical habitats where fishing activity would otherwise cause damage to the physical structures supporting the ecosystem. They may also help to reduce mechanical disturbance to the benthos and facilitate the establishment of more stable and structured communities. The principle of Total allowable catch (TAC) which is the total amount of resource allowed to be taken in a specified period (usually aone-year period), as defined in the management plan, should be enforced. Total Allowable Catch (TAC) may be allocated tothe stakeholders in the form of quotas as specific quantities or proportions.

CHAPTER FIVE

GAPS IN EXISTING FISHERIES LEGISLATIONS FOR INLAND FISHERIES AND PROPOSAL FOR REALISTIC OPTIONS FOR POLICY FORMULATION AND REGULATORY FRAMEWORKS

5.1 Fisheries Policy and Legislation in Lake Chad

The countries with territory most associated with the LCB (Cameroon, Chad, Niger, Nigeria and, to a lesser degree, the Central African Republic) all demonstrate poor performance in relation to world indicators of economic and social development. With the exception of Nigeria and to a lesser extent Cameroon, the economies are strongly dependent on the agriculture sector and at least 50% of the population is classed as rural. Chad and Niger represent 73% of the total LCB by area and exhibit the greatest shortfalls in global indicators of social and economic development. Niger has an adult literacy rate of only 17.6% and in both countries the total population below the poverty line is about 64%, for instance.

About 20% of the total area of the LCB (the "Conventional Basin") is under the mandate of the Lake Chad Basin Commission (LCBC). The LCBC was created in 1964 by Cameroon, Chad, Niger and Nigeria with the overall policy objective to exploit and improve the management of the LCBC water resources for the welfare of the people (Magomna and N'Gaba Tchéré, 1999).
This includes:

1. the regulation and control of water and other natural resources in the Basin;
2. the promotion and coordination of research and development projects in the Basin, and
3. the promotion of regional cooperation and conflict resolution (Neiland *et al*, 2002).

The role of the LCBC with respect to regional and national fisheries policy is limited and the past focus has largely been the coordination of water projects.The management plan for the Lake Chad Basin is predicated on three key objective areas which include the economy and environment, human well-being and governance.

5.1.1 Policy Case Study

The fisheries sector is organized around four activities: industrial fisheries, maritime artisanal fisheries, inland fisheries and aquaculture. In 2003, inland and maritime fisheries landed around

168,000 tonnes of fish, 93,000 of which came from maritime artisanal fisheries and 75,000 tonnes from inland fisheries. A few years ago, industrial fisheries produced around 10,000 tonnes. In 2003, it landed between 7,000 and 8,000 tonnes whilst aquaculture produced about 5,000 tonnes that same year. The annual national production was therefore estimated at 180,000 tonnes in 2003 of which at least 93% came from artisanal fisheries (NGOKE. *et al*, 2005).

In 2003, the annual requirements for the population were around 298,000 tonnes for an average annual consumption per capita of 17.9 kg (NGOKE *et al*, 2005). In order to meet its deficit, the country imports around 126,000 tonnes of fish every year. For the most part, these imports come from Senegal and Mauritania and 90% are horse mackerel, mackerel and sardine, cheap species particularly valued by those who are destitute.Official exports which concern essentially crustaceans caught by industrial fisheries are insignificant (NGOKE. *et al*, 2005). Yet Cameroon, a net importer of fisheries products, has important assets for fisheries and aquaculture development:

(i) A 360 km maritime coast with a 40 km Economic Exclusive Zone (EEZ) and a 20 km continental shelf;

(ii) A rich and dense water network, with a wide range of fish species, over 40,000 km², that is 8.4% of the national territory, including floodplains (86%), natural lakes (4%), dam reservoirs (7%) and rivers (3%) (NGOKE *et al*, 2005). Inland fisheries concern three zones: a forest area with three important river basins (Nyong, Ntem and Sangha), the central area with a river basin (Sanaga) and three man-made dams [Bamendjin (33,000 ha) on the Noun river, Mapé (50,000 ha) on the Mapé river and Mbakaou (55,000 ha) on the Djerem river] and the Northern area with the Lagdo and Maga dams and the Lake Chad Basin fisheries (Chari- Logone system and Logone floodplains or Yaérés);

(iii) A climate, soil and a topography conducive to aquaculture, especially in the small valleys in the Western and North-West provinces, the forest areas of the Centre, South and East and the Amadoua plateau;

(iv) A continuously growing national and sub-regional demand for fish products;

(v) legal and statutory texts which are currently being improved in order to, among other things, integrate the relevant principles from the Code of Conduct for Responsible Fisheries (CCRF) and precise provisions concerning aquaculture (NGOKE *et al*, 2005) ;

(vi) National and international bodies which support the sector.

5.1.2.0 Analysis of the Fisheries Co-Management Policies in Cameroon

Having withdrawn from Niger in 1976 following the droughts, Lake Chad returned in 1998 and occupies around 70% of its previous surface area estimated at 310,000 ha. This return has meant a fisheries revival and this is now the primary economic activity in terms the generation of income, employment, hard currency and tax receipts in the Diffa region.The Lake Chad fish production, comprising mainly three fish species currently populating the waters (*Heterotis niloticus, Clarias s p and Oreochromis niloticus)*, increased steadily and very significantly between 1999 and 2003 and hence represents 62 to 78% of the national production. It increased from 4,200 tonnes in 1999 to 43,700 tonnes in 2003 (fresh fish). The reasons for this are, amongst others, the improvement in collecting catch statistics thanks to the institutional support of the Sustainable Fisheries Livelihoods Programme (SFLP - GCP/INT/735/UK) which has permitted the implementation of an information monitoring system on Lake Chad fisheries and the very limited lake withdrawal since it reappeared.

The Lake Basin fishery is one of the principal economic activities in the region. The export of smoked fish towards Nigeria has generated a hard currency inflow of 7,409,225,000 CFA francs (Na-Andi, 2003) and customs revenues of 102,241,297 CFA francs in 2003 (DGD, 2003). Fishing is carried out by national and foreign commercial fishers (Nigeria, Chad, Cameroon, Mali, Central African Republic, Sudan).

Other actors who operate in the fish value chain are the brokers, the women fish processors, the intermediaries, the retailers, the transporters and the handling agents. Despite the socio-economic importance of fisheries in terms of employment, incomes, tax receipts and hard currency generation in the Lake basin, the development of the sector faces huge constraints which are presented in Table 5.5.

Table 5.1: Strengths, Weaknesses, Opportunities, and Threats at Lake Chad level

Strengths	Threats
High productivity Existing markets of some importance Social and economic benefits for the actors	4. Lake withdrawal 5. Environmental degradation 6. Poor management 7. Insecurity
Weaknesses	**Opportunities**
Lack of appropriate sectoral fisheries policy Poor organization of the actors Insufficient involvement of micro-finance institutions Insufficient institutional links Insufficient collaboration between the actors Poor actor capacities	7. Local willingness to take part in the decentralization project 8. Regional partnership programme (LCBC) 9. Ongoing mechanisms to improve the microfinance sector 10. Existing networks for collecting and disseminating information in order to influence policy development.

5.1.3.1 National Co-Management Policy (or Fisheries Decentralization)

Cameroon does not yet have a national fisheries co-management policy or a fisheries decentralization policy. But within the fish resource management framework and thanks to support from the Sustainable Fisheries Livelihoods Programme (SFLP), a co-management process has been pursued since 2002 on two water bodies and one fish market.

From 1990, a participatory approach has been used in most development sectors in Cameroon. Thus, in 1992, in the fisheries sector a Master Plan was drawn up with the participation of several actors (fishers administration, partner administrations, research institutes, chambers of commerce and industry, financial institutions, representatives of international organizations providing technical support, primary actors, secondary actors, NGOs, etc.)

But it is especially from 2000 that the fisheries administration really began to promote the participatory management of fish resources with the support of SFLP which bases its approach on Sustainable Livelihoods (SLA) (Bondja M. and al., 2005). Co-management was introduced at Mapé in 2002 then at Maga in 2003 and at the fish markets of Garoua in 2003 following participatory appraisal exercises organized on these sites (BIGOMBE P. and al., 2002; BELAL *et al*., 2003).

In 2005, the fisheries legal framework governed by the law 94/01 of 20 January 1994 dealing with forest, fauna and fisheries was revised in order to take into account some relevant aspects of the FAO Code of Conduct for Responsible Fisheries (CCRF) and the decentralized management, or co-management, of the fish resources. This revision also aimed to devote an entire law to the fisheries and aquaculture sector and to avoid its dilution among other sectors as is the case with the law 94/01, which encompasses forest, fauna and fisheries. The draft text is still awaiting adoption.The general objective of the co-management approach is to manage fish resources through a rational exploitation with a sharing of the duties, of the responsibilities, of the profits, and of the rights between the different stakeholders and to reduce the number of conflicts (Bondja *et al.,* 2005).

Fish resource co-management or participatory management involves several actors who are stakeholders in the management of these resources. This is the case in the various sites concerned by this process (Mapé, Maga and the Garoua fish market). At Mapé, the co-management process started in March 2002 and involved the following stakeholders: the fisheries administration, the administrative authorities (Bankim and Magba subprefects), the police forces, the representatives of decentralised services from other ministries (agriculture, forest, fauna, environment), Bankim and Magba local government institutions (CTD), traditional institutions, the National Electric Company (AES-SONEL), the projects (PAPT), the primary and secondary actors (fishers, female and male processors, transporters, traders, etc) and other water and resource users. (Bigombe P. and al., 2002; Belal E. and al., 2003).

At Maga, the process started in December 2003 and involved as well as the fisheries administration, the administrative authorities (Maga and Kaï-Kaï subprefects), the police forces, representatives of decentralised services from other ministries (agriculture, forest, fauna, environment), Maga and Kaï- Kaï local government institutions (CTD), traditional institutions, the Company of Growth and Modernization of Yagoua rice cultivation (SEMRY), the primary and secondary actors (fishers, female and male processors, transporters, traders, etc) and other water and resource users (Bigombe *et al*., 2002 ; Belal *et al*., 2003).

As regards the Garoua fish market, the process was launched in 2003 and involved as well as the fisheries administration, fish retailers, wholesalers, fish scalers, the police forces, butchers, cattle

traders, female and male processors, local government institutions (CTD), representatives of decentralized services from the Ministries for Female Advancement, Health and Social Affairs (Bondja *et al.,* 2005).

The three case-studies presented below illustrate the impact of fisheries co-management in Cameroon and concern:

1. Fish resource co-management at Mapé: "the project supporting the organization of fisheries communities for participatory management of the Mapé dam reservoir";
2. Fish resource co-management at Maga dam reservoir: "the project supporting the sustainable management of the Maga dam reservoir"; and
3. Participatory management of the Pont and Yelwa fish markets in Garoua: "the project supporting the Northern female fish sellers association".

5.1.2 Gap in Existing Policies

5.1.2.1 Fish Resources Co-Management at Mapé Reservoir

The Mapé reservoir resulted from the building of a dam on the river Mapé destined to supply the hydro-electric dam of Edéa. It was filled in 1988 and covers some 550 km² for a capacity of 3.3 million m3. This dam reservoir spreads over three provinces (the Amadoua, the West and the North- West) two of which are really active (with both an administration and a management system set up for Thewater body, each province tending to appropriate the management of the part corresponding to its district.)

The development of this reservoir has attracted people of diverse origin either in agriculture or husbandry but especially in fisheries. Some 20 ethnic groups live around this reservoir. More than 4,000 fishers in 128 fishing camps, each under a practically independent camp chief (or Djaouro), operate on this water body the whole year long and use a multitude of fishing gears and sometimes illicit practices. There are also around 20 traditional leaderships which all claim ownership of the water body. This mosaic of ethnic groups, the plurality and diversity of interests, the differences of opinion concerning the management of the space and the multiple misunderstandings have weakened the social cohesion and created tensions and conflicts between the local ethnic groups (Bamoun and Tikar and the others, between stockbreeders and farmers and between fishers using

different fishing gears and techniques (as in the case of Nigerian fishers who use the beach seine contested by all the other fishers, etc.) Several of these conflicting situations have led to accidents and intertribal clashes, sometimes with deadly consequences because of the non-respect of traditional and governmental regulations concerning the access to and the sharing of resources, the control of fishing areas, of farmable land and rangeland (Bigombe *et al.,* 2002). This worrying situation led the administrative authorities to refer the case to the fisheries department so that conflicts could be managed and solved. The fisheries department took the case to the Regional Support Unit (RSU) of the SFLP, through the National Coordination Unit (NCU), to get its support. Thus a joint RSU/NCU mission came to Mapé from 14 to 24 June 2000 to decide, with the communities, upon the necessary actions. This mission showed that all interventions should focus on developing a plan to manage the reservoir in order to help the stakeholders to organize themselves and set up a co-management system. The studies undertaken later on the dam reservoir, in November 2000 (Framework-Survey and Socio-Economic Study), in March 2001 (Participatory Appraisal and Training Workshop in MARP/AMED) and the mission of the RSU project management officer in October 2001 provided much information on the dam reservoir characteristics and confirmed the need for the participatory management of its resources.

Therefore, the first phase of the co-management process, funded by SFLP, started in March 2002. This phase focused on five main activities, that is:

(i) Training stakeholders on co-management and setting up a starting committee;
(ii) Facilitating social communication campaigns;
(iii) Organizing communities;
(iv) Undertaking complementary studies; and
(v) Organizing stakeholder meetings to negotiate and sign agreements.

The Mapé dam reservoir co-management process achievements concern mainly the analysis of the site situation and its complexity, the identification of the stakeholders, the planning of the process, the creation of the management committee in 2003, the wording of a so-called Mapé declaration and the reservoir management agreements negotiated and signed by the stakeholders and in existence since 2003 (Bigombe *et al.,* 2002).

The main and already visible impacts of the process are a stronger social cohesion, a greater respect of fisheries regulations, stronger capacities of the stakeholders concerning good

governance and development plans, fewer and fewer juveniles in catches, a situation of dialogue between the different stakeholders, communities more involved in the management and the local development and more inclined to collaborate with the fisheries administration and a partnership between CTD, AES-SONEL and the management committee.

The main constraints of the Mapé co-management process are linked, inter alia, to insufficient scientific knowledge on the state of the dam reservoir resources, to insufficient information concerning co-management and to illiteracy which is quite widespread among fishing communities. The main opportunities for this co-management process are the support of the stakeholders and their determination to improve the livelihoods of fishing communities.

5.1.2.2 Fish Resource Co-Management at Maga Reservoir

The Maga reservoir resulted from the building of dykes in 1979 around a flat marsh of the *Guerléo* river and of the mayos (temporary rivers) *Boula* and *Tsanaga* flowing into the floodplain of Logone. It covers, on average, 240 km² and was completed in order to irrigate the rice-growing areas of the SEMRY unit II. An important fishing activity has developed there with many fishers of diverse origin (Cameroonians and foreigners) estimated at, at least, 1,200 with an annual production of around 2,000 tonnes. Fishing is allowed nine months out of twelve (there is a 3-month closed period from July to September) (Belal et al., 2003).

The fall in catches and their smaller size as well as the numerous conflicts between fishers led the fisheries administration, with the support of SFLP, to organize a participatory appraisal for this water body in 2001. The results confirmed that co-management was the appropriate approach for the beneficial and sustainable management of the fish resources in this reservoir. This began in December 2003, funded by the SFLP.

The process that followed was almost identical to what happened at Mapé with the following main activities: training stakeholders on co-management and setting up a starting committee, facilitating social communication campaigns, organizing communities and negotiating and signing management agreements involving the various stakeholders (Belal et al., 2003).

The Maga reservoir co-management process achievements concern mainly better knowledge on the reservoir situation, the identification of the stakeholders, the planning of the process, the creation of the management committee in 2004, the reservoir management agreements negotiated and signed by the stakeholders and in existence since 2004, the creation of policing committees in 2005 and of Village Development Committees (Belal *et al*., 2003; Bondja *et al.,* 2005).

The already visible impacts of the process are also: a stronger social cohesion, a greater respect of fisheries regulations, stronger capacities of the stakeholders concerning co-management, fewer and fewer juveniles in catches, a situation of dialogue between the different Stakeholders, Communities more involved in the management and the local development and more inclined to collaborate with the fisheries administration and an established partnership between CTD, SEMRY and the management committee.

The main constraints of the Maga co-management process are also linked, inter alia, to insufficient scientific knowledge on the state of the dam reservoir resources, to insufficient resources for the running of the committee and to illiteracy which is quite widespread among fishing communities. The main opportunities for this co-management process are the support of the stakeholders and their determination to improve the livelihoods of fishing communities.

5.1.2.3 Garoua Fish Market Co-Management

The Pont and Yelwa fish markets of Garoua have existed since 1965. With the passing of time, they became bigger and acute sanitary problems had to be addressed. An informal association of female fish sellers called the Association of Northern Female Fishsellers (AFVPN) has existed on these markets since 1998. In 2000, they appealed for help to the fisheries administration for solutions to the sanitary problems faced by their markets and their difficult working conditions. The fishing administration, with the support of SFLP, organized a participatory appraisal with the female fish sellers of these markets in April 2001. The results led to the creation of a project called "Project for the Support of the Association of Northern Female Fish sellers" which was submitted to SFLP for funding.

The main objective of this project is the participatory management of the two markets with, as well as co-management, the following main activities: building eight improved fish-smoking ovens and

training in fish-smoking techniques, sanitizing the markets with the purchase of refuse bins, the acquisition of cold boxes, freezers and training in cold storage techniques, diversifying income generating activities through market gardening and the supervision, support and monitoring of association activities. But the fisheries administration asked this association to approach the Provincial Delegation of the Ministry for Female Advancement (MINCOF) to help them formalize their organization (writing statutes, internal rules and legalization of the association).The co-management process was launched in 2003 and consisted of training stakeholders on co-management and setting up a starting committee, informing and raising awareness of the partners on the project and the process, and the negotiation and signature of management agreements.

The Pont and Yelwa fish markets co-management process achievements consist of, inter alia, identifying the stakeholders, planning the process, creating the management committee, negotiating and signing the market management agreements by the stakeholders in 2005, sanitizing the markets through the purchase of thirty refuse bins and the construction of two latrines, building eight improved smoke ovens and training in fish-smoking techniques, improving fish preservation through the purchase of three freezers, twelve ice boxes and fifty fish baskets (Bondja *et al*., 2005).

The already visible impacts of the process are, inter alia, the quality of the smoked fish, the freshness of the fish sold on these markets, the improved hygiene conditions and the dialogue which has been established between the various market users, particularly the female fish sellers and the butchers. The main constraints concern the slow understanding of the process by the stakeholders and the illiteracy level which is quite high among the female fish sellers. The biggest opportunity resides in the market management agreements.

5.1.2.4 Fisheries Co-Management Policies in Cameroon

Analysis of the fisheries co-management policies in Cameroon is a case study which is part of the fisheries policy framework and together with governance analysis makes up the first stage of the project entitled: "food security and poverty reduction through improved governance and fisheries evaluation in African rivers". This three-year project (2006-2008) focuses on two African basins (those of Lake Chad and the Zambesi). It is funded by the German Federal Ministry for Technical Cooperation and Development (BMZ) and is co-ordinated by the WorldFish Center. In Cameroon,

this study was carried out by the Ministry for Stock Breeding, Fisheries and Animal Industries (MINEPIA) during the third trimester of 2006.

Fisheries are an important and vital sector of the Cameroon economy concerning food and socioeconomic aspects. Concerning food, fish is the most accessible protein source for the Cameroon people, especially the poorest. Fish products contribute around 25.5% of protein food intake in Cameroon. The average fish consumption per head and per year is 17.9 kg against 13.07 kg/inhabitant for meat (NGOK E. *et al*, 2005).

Concerning the social aspect, artisanal fishery (maritime and continental) which is exclusively a rural activity provides direct employment in harvesting and indirect employment in all post-harvesting and related activities (around 250,000 jobs in 2003: 65,000 in fisheries and 185,000 in related activities, of which 62.5% come from artisanal fisheries (NGOKE. and al, 2005).

Concerning the economic aspect, fisheries contribute to creating wealth through marketing fishing gear and tools as well as the catch. In 2003, fishing activities (including processing and related services) generated value-added of 119.4 billion CFA Francs that is 1.7 % of the global value-added: 52.4 billion from maritime and inland artisanal fisheries; 58.4 billion from processing and related services and 8.6 billion from industrial fisheries (NGOKE. *et al*, 2005).

5.1.3.5 Fisheries Management Systems and Performance

In many African fisheries, traditional management was present (fishing gear restrictions, a system of closed seasons, habitat modification) and some remnants can still be found. In traditional systems, the elders, the fishers and other user groups collectively choose the person best able to represent authority or best able to establish and enforce the rules and guidelines concerning the exploitation of adjacent or local fish resources for the general welfare. These rules and guidelines are supposed to be respected by all. The main management approaches and measures used focus on the direct regulation of exploitation, the indirect control of fishing effort, the regulation of catches through quotas and the seasonal closure of the fishery, etc. But in spite of all the efforts made to prepare and adopt these approaches and measures, most of them are not implemented or, in the best case scenario, are poorly implemented. This is due to the fact, among other things, that

the main feature of fisheries is the free access to fish resources. This is still the case in artisanal fisheries, despite the fast-growing fishing effort.

In order to improve the management of Cameroon fish resources, several legal texts have been drawn up: law N° 81/013 of 27 November 1981 and its Decree N° 83/171 of 12 April 1983 then law N° 94/01 of 20 January 1994 dealing with forests, fauna and fisheries and its decrees N° 95/413/PM of 20 June 1995 and N° 2001/546/PM of 30 July 2001. But they have brought mixed results and performances probably because of, among other things, a top-down approach with very low participation (involvement) of local actors (the resource user) and of civil society.
In 2005, a wide consultation involving all stakeholders (partner administrations, economic operators and artisanal fishers) led to these texts being revised so that relevant aspects of FAO CCRF and participatory management of fish resources could be taken into account.

5.1.2.6 Gap in Policy Case Studies

The policy studies revealed much about the history, objective and performance of fisheries policy in the countries. Policy formation is difficult to understand because it is rarely transparent or linear and the "politics of policy" (Borrini-Feyeraband et al, 2004) mean that there are rarely obvious strategies to influence the policy making process. It is possible to identify policy "spaces", however, and places where "win-win" outcomes may be achieved.

In Nigeria and Cameroon, fisheries co-management has only operated within donor-funded projects. Nigeria is alone here in lacking formal policy for decentralization. In Cameroon and Niger however, it is intended that positive changes in fisheries management will occur as new roles and responsibilities are established for regional and local government. The majority of these decentralization policies are associated with national PRSPs and the international narrative that links inclusive forms of local government with proper change. From the case studies there are no special arrangements made for fisheries. It is assumed that a process of decentralization will naturally extend to local and inclusive fisheries management institutions. Political and legal support to the decentralization process in these countries covers broader rural development objectives such as education and health, as much as NRM. However, there is a danger that decentralization without capacity building can introduce NRM conflict and erode existing institutions for management.

The Cameroon and Niger reports show that these two countries have detailed rural development and decentralization policies. The reports indicate that these polices should incorporate fisheries management but, especially in the case of Niger, sufficient financial support for local government institutions is lacking and the decentralization process is slow.

Trans-boundary issues relating to fisheries and natural resource management are obviously significant in the LCB. Where the country reports have highlighted this issue they have stressed the role of existing institutions and regional agreements for improved management. The LCBC may be the best positioned agency to oversee coordinated management across the four countries but this would require greater capacity and sharing of information. Neiland et al, (2002) propose support to a new platform - the LCB Fisheries Forum - that would allow feedback between all fisheries stakeholders in the region.

The narratives that underpin formal policy pronouncements and strategies are largely internationally driven and this is in part a reflection of the PRSP process. The fisheries content of the study country PRSPs were broadly consistent with existing policy. The fundamental difference between the governance-based agenda for Nigeria and the decentralization narrative of Niger, and Cameroon is clear (Table 9). In this latter case, the agriculture sector is seen by international actors to represent the greatest potential for growth, especially in Niger.

Table 5.2: Dominant Developments Narratives Shape Fisheries-Related Policies

	Nigeria	**Niger**	**Cameroon**
Dominant Narrative	**Good governance** (accountability, due process) will enable development via national wealth & resources	Increasing progress in decentralized NRM → **Decentralization** &**participation** will provide fully representative & democratic processes useful in NRM	
PRSP Fisheries Strategy	Non-specific but commits to water management for the full range of users	Technical, human & financial investment in production eg. Stocking	Technical, human & financial investment in production eg. Stocking

Table 5.3: The Policy Setting for Decentralisation of Fisheries Management in the Three Countries

Policy setting (for decentralisation of fisheries)	*Political constraints to implementation**	*Opportunities & potential "win-wins"*
Cameroon • National Constitution (1996) • National Governance Programme (1995) • PRSP (2000)	There is still a requirement for more cross-sectoral approaches at regional and local level	Implementation of new law (2004) supporting district & regional government & use of the new "Decentralised Local Authority"
	New fisheries management institutions must be more inclusive of poorer interests	Regional planning with new CSOs such as GIC and developing consensus building role of government agencies
No policies for fisheries decentralisation or co-management specifically	Greater regional collaboration needed	Strengthen role of LCBC
Niger • PRSP (2002) • Rural Development Strategy (2003) • National Policy for Local & Community Development • Three programmes for local governance	Policy pronouncements have not been supported with sufficient capacity building at local government level – both human and financial resources are lacking.	Local statutory frameworks and fisheries best practice is emerging as a result of slow capacity building through the three governance programmes.
	Unclear role for traditional authorities leads to local conflict	CSOs have negotiated new partnerships & management arrangements & could be supported further in local planning & consensus building
No policies for fisheries decentralisation or co-management specifically		
Nigeria • Inland Water Fisheries Decree (1992) • PRSP	Lacking policy coherence and collaboration between fisheries, water and agriculture sectors	Encouraging input of CSOs such as FISON could meet governance (donor) concerns and help sustainability of local arrangements (for Fisheries Department)
	Lacking policy accountability to public and other government administrations	Key government stakeholders such as FDF acknowledge a serious problem exists
No policies for fisheries decentralisation or co-management specifically		

5.1.2.7 Key Points Concerning Sustainable Developmentof the Fisheries Sector

Faced with a growing deterioration of natural resources, several management systems have been set up. The Rio summit in June 1992 was the starting point in raising awareness on Nations' collective responsibility for global equilibrium and introduced the concept of *sustainable development*. Cameroon has progressively inserted the main recommendations of this summit into its legal system. For example, a ministerial department responsible for environmental issues and an advisory national commission for environment and sustainable development were created; and the new forest, fauna and fisheries code was adopted together with a parent act on the environment (Anonymous, 2003f). The sustainable management of resources has forced change in the country's existing approaches, particularly the *top-down approach.*

Concepts such as *participation* or *participatory approach* emerged in development in many sectors, in particular the fisheries sector in Cameroon in the 1990s. Donor agencies and

development partners, wishing to match their investments and the real needs of the population, even made it a prerequisite to most project funding. (Anonymous, 1995d).

5.2 Gap in Existing Fisheries Policies in Niger Basin

Niger has an important aquaculture potential estimated at 400,000 ha of fresh-water bodies: the Niger river and its tributaries, the Komadougou Yobé, Lake Chad, 970 natural ponds and 69 artificial reservoirs (Programme for the Development and Management of Water Resources, 1999), (the Directorates for Agriculture Equipments and Management and Water Resources, 2003).

5.2.1 Characteristics of the Fisheries Sector

River Fisheries

They comprise (i) the Niger River, 550 km long across Niger and (ii) its seven tributaries, (iii) the Komadougou Yobé and (iv) fossilised-water streams (Dallols Bosso, Maouri) and occasional rivers (streams) (Goulbis N'Kaba, Korama and Maradi). Their essential characteristics (length and annual water volume) are presented in Table 5.3.

Table 5.4: The Main Rivers of Niger

River	Length (km)	Volume (millions m^3)
1. River Niger	550	32.400
Dargol (Tributary)	142	160
Sirba (Tributary)	100	697
Goroubi (Tributary)	210	160
Dyamangou (Tributary)	50	100
Tapoa (Tributary)	42	40
Mékrou (Tributary)	100	923
Gorouol (Tributary)	105	322
2. Komadougou (River)	160	501
3. Goulbi of Maradi (River)	-	218
4. Maggia	-	173
5. Goulbi n'kaba	-	20
6. Korama	-	200
7. Dallol Maouri	-	250
8. Dallol Bosso	-	200
Total		**36,364**

***Source**: Programme for the development and management of water resources (MH/E/LCD 1999)*

River fisheries contain a very diverse ichtyofauna with some 100 fish species in the Niger River and have become the main fishing zones following the drought years of 1974/1976 until 1999. Fish harvesting in the river basins represents more than 80% of the national fish production and the fishing income represents 82% of the total income of a fisher household (Price, 1986). This period coincides with the time when Lake Chad had withdrawn from Niger and this explains why the river production represents the major source of national production.Four nationalities of fishers exploit the river (Nigeriens, Nigerians, Malians and Beninese). Their number was estimated at

7,900 people in 1985 (Coenen, 1985). Unfortunately, fishing in the river basin and in the Komadougou Yobé is confronted with various constraints which are presented in Table 5.5.

Table 5.5: Strength, Weaknesses, Opportunities, and Threats in the Niger River and the Komadougou Yode

Strengths	**Threats**
9. Biological diversity 10. Fishing communities' know-how in fishing and aquaculture 11. Existence of potential markets 12. High fish production	13. Sand progression 14. Water hyacinth proliferation in the Niger river 15. Demographic pressures 16. Overfishing 17. Environmental degradation
Weaknesses	**Opportunities**
18. Low organisational level of the actors at base level 19. Lack of fisheries management plans 20. Sparse basic social services (credit, health, drinking water) 21. Insufficient legislation and regulations 22. Post-harvest losses because of non-existent conservation methods 23. Lack of collaboration between resource management institutions at regional level 24. No partnership between development services and research institutions 25. Poor socio-economic and biological data to help with fisheries planning and management 26. Poor use of the biological diversity value (fish species with economic value and of local initiatives on natural resources management in rural areas through socio-economic, biological and socio anthropological research.	27. The decentralization process 28. "Shared vision" concerning cross-border resource management (Authority of the Niger Basin) 29. Present development and basin resource management projects (WWF, ADB, ADB/ECOWAS), 30. Mastering water and potential zones for the development of intensified fisheries (cut-off meanders) and aquaculture 31. Existing research infrastructures (Molli and Sona) and research institutions [IRD (Research Institute for the Development), INRAN (National Agronomic Research Institute of Niger), University] 32. Emergence of the civil society (APN, AMN, other NGOs despite their institutional weaknesses: operations, representativeness).

The combined effects of these different constraints mean that there is a general trend towards a reduction in fish production which has dropped from 7,000 tonnes in 1978 to less than 4,000 tonnes even during a rainy year.

1. **Ponds and Artificial Reservoirs**

Ponds are water bodies formed in the hollows of valleys and of temporary streams running intermittently, namely the fossil valleys (Dallols Maouris and Bosso), the Korama, the Maggia, the Goulbis etc. There are 970 of them, with their water mainly coming from rainfall. Their permanent or semi-permanent flow depends mainly on rainfall and the amount of water withdrawn for various uses (agriculture, livestock and other) Water reservoirs are water bodies resulting from relatively small dams built for agricultural irrigation. There are 69 of them, 46 of which were built within the framework of the Highly Indebted Poor Countries initiative (HIPC) from 2001 to 2002.

Table 5.6: Programme for the Development and Management of Water Resources

Sites	Ponds	Water reservoirs	Total
Agadez	9	1	10
Diffa	14	7	21
Dosso	113	14	127
Urban community of Niamey	13	3	16
Maradi	96	4	100
Tahoua	280	16	296
Tillabery	145	20	165
Zinder	300	4	304
Total	**970**	**69**	**1039**

Sources: Programme for the Development and Management of Water Resources (1999)

The Directorates for Agricultural Equipment and Management and for Water ResourcesManagement initiatives (fish-stocking, technical training and organization of fishers, etc.) towards the sustainable management of the ponds and water reservoirs have demonstrated the very high fish productivity of these water bodies and the economic profitability of such initiatives is shown in the results from the Tahoua department (see Table 5.6).

Table 5.7: Strengths, Weaknesses, Opportunities and Threats (SWOT) at Pond and Artificial Water Reservoir Levels

Strengths	Threats
2. Biological diversity 3. High fish productivity, 4. Community-based management initiatives (traditional knowledge and know-how)	5. Environmental degradation 6. Sand progression through water and wind erosion 7. Aquatic plant proliferation (*Typha-sp*, *Pistia stratiotes).*

Weaknesses	Opportunities
8. Insufficient access to basic social services 9. (credit, health, drinking water) 10. Insufficient socio-economic, environmental and biological data that could help plan and manage fisheries 11. Poor organization of fishing communities 12. Insufficient exploitation of biological diversity (fish species of commercial interest) and of community fisheries' management initiatives in bio-ecological, socio-economic and socio anthropologic research. 13. Poor partnership and collaboration between actors, extension and research institutions 14. Legislation and regulation (insufficient) poorly implemented	15. Fishing communities' willingness to take an active part in the local development process 16. Economic and financial profitability of management actions 17. HIPC funds that can be used to increase the number of artificial water reservoirs and to improve access to basic social services (schools, health, drinking water, roads, credit) 18. Existing research institutions (IRD, INRAN, University) and infrastructure allowing the development of the research sector 19. An emerging civil society (APN, AMN, NGOs despite their institutional weaknesses: operations and representativeness) in the fisheries and aquaculture areas 20. Convincing results of the improvement and the diversification of fisheries community livelihoods through community projects and institutional financial support from SFLP.

5.2.2 Gaps in Existing Policies and Management Related Systems/Measures

There are identifiedsignificant gaps existing in the LCB management that require urgent intervention. It will therefore be necessary for AU-IBAR to intervene and assist in these identified areas.

1. Low ICT Capacity and Facility: The information technology facilities and capacities are low and weak and it will be desire-able for input and intervention by AU-IBAR.
2. Lack of Harmonization of Legislations: even though the LCB management countries have policies, the existing ones are not harmonized thus leading to poor management of the LCB and poor fisheries. There is need for effective harmonization of the member countries legislation for an enhanced resources management and increased productivity;
3. Absence of Regional Action Plan: Essential guidelines for operation and regional action plans for sustainable management will be required for the LCB fishing areas;

4. Delayed International Interventions: attempts have been made to develop management plans with the assistance of the FAO. However, LCB is still expecting the final version of the document.
5. Threat to Security: the incessant terrorist attacks is having negative impact on the fisheries and fishing activities
6. Ties at the Lake Chad. Fishing activities are therefore at the lowest level as the fisher-folks now have fears for their lives.
7. Poor Access to Fishing Sites: all access to the fishing sites and environment has been taken over by the military in a harmonized attempt to tackle the insurgence. This has impaired fishing activities in the areas and consequent low fishing harvest and productivity.
8. Post-Harvest Fish Losses: heavy post-harvest fish losses are being incurred and this has become a serious economic problem in LCB areas. This is caused by lack of access to the fishing areas for traders to collect harvested fish products.

5.2.3 Senegal River

Mauritania and Senegal have adopted the Code of Conduct for Responsible Fisheries and ratified International Conventions on the Law of the Sea (Montego Bay Convention, 1982 imposing including the principle of the Exclusive Economic Zone of 200 miles for the benefit of the coastal State) and on Biological Diversity (Rio Convention 1992).

Each State has a policy of fisheries pursuing development goals sustainable and in whose service are mobilized several types of instruments including regulatory measures, tax measures and a number of provisions and structures allowing, in varying degrees, consultation between the State and users and decentralization management.To support development of inland fisheries and aquaculture in selected areas of the river basin, there is need to provide fund for strengthening fisheries-related institutions, development of sustainable fisheries' management programs, support for enhancing the value of fish catches through better storage infrastructure, and finance of aquaculture development programs.

5.2.4 Governance of Fisheries

Legal Framework

In Senegal, inland fisheries are under the law N° Loi n° 63-40 du 10 juin 1963 et le Décret N° 65-506 du 19 juillet 1965 portant application de la loi précitée, modifié partiellement par le Décret N° 67-0128 du 1er février 1967 et celui N° 70-1423 du 28 décembre 1970.Next to this law, there are others textes such as arrêtés, code de conduite, conventions internationales. However, the laws are being reviewed. Next to modern laws, there are customs laws, which are still used in some rural areas. In Senegal, fisheries policy is currently governed by the strategy Sustainable Development of Fisheries and Aquaculture 2001, the letter (the protocol?) to Sector Policy of 2007, the 2007 Plan of Action and the Law on Fisheries Code maritime, completed by 2007 decree reorganizing the Ministry of Maritime Economy. This law fully concentrates power to introduce management measures and development, including the granting of fishing rights (licenses and artisanal fishing license) in the hands of the Ministry of Fisheries.

This strategy refocuses sectoral development on the management of fishery resources and the sector, including effective measures to reduce capacity and effort on fishing. The Senegal Government has instituted the planification Tools such as: the National Action Plan of inland fisheries (2006). This is the major planification tool for inland fisheries and it has been produced from an exhaustive diagnostic of the fisheries sub-sector., The National Environmental Plan have also been established In order to handle the link between environment issues and the sustainability of fisheries. This is necessary to take into account environmental aspects, in terms of conservation and protection of aquatic ecosystems.

5.2.5 Institutions

At institutional level, the fisheries administration has undergone several changes since 1959. Today, the Ministry responsible for fisheries includes inland fisheries and aquaculture. This scheme, which covers all aspects of fisheries (marine and Mainland) and aquaculture, is intended to ensure greater coherence in the actions development sector. Before March 2000, inland fisheries under the Ministry of the environment, including “Managing wildlife and inland waters” division that was responsible for setting implement the national policy in this area. This division was responsible for some Regional Inspectorates of Water and Forests (Ziguinchor, Kolda, and St. Louis).

Today, inland fisheries are under the Ministry of Fisheries. The decree on the organization of the Ministry of Fisheries created the DPCA includes: the division aquaculture, division management and inland fisheries division. The Senegal manages an extensive program of cooperation in fisheries at all levels (bilateral, subregional, regional and international). At the bilateral level, Senegal has signed cooperation agreements (fishing) with Guinea Bissau, Gambia, Mauritania, Cape Verde and Japan. At the multilateral level, cooperation frameworks consist Economic Union Monetary West African (UEMOA), the African Economic Community of states West (ECOWAS), the Commission sub-regional fisheries CSRP), the European Union(EU), the World Trade Organization (WTO) Ministerial Conference fisheries cooperation between the riparian states of the Atlantic Ocean (COMAHFAT) Organization of the United Nations Food and Agriculture Organization (FAO), the Committee Central Atlantic Fisheries (CECAF), the International Committee for the Conservation of Atlantic Tuna (ICCAT), the Committee for Inland Fisheries and Aquaculture (CIFA), the Interstate Committee for the Fight against Drought in the Sahel (CILSS), the Organization for Development of the Senegal River (OMVS).

5.2.6 OMVS Institutional Framework

The Organization pour la mise en valeur du fleuve Sénégal (OMVS) is collaboration between Mali, Mauritania, and Senegal in an effort to harness and develop the Senegal River basin and to share its resources among the three member States. The OMVS is a comprehensive organization with the goal of fostering economic development in the Senegal River basin through better international cooperation. In the 1972 Convention establishing the OMVS, the Senegal River and its tributaries were declared an “international river.” Dams built under the convention were termed “common works” jointly owned by the three member states. The OMVS has established three consultative bodies: The Permanent Water Commission, the Advisory Committee, and the Regional Planning Committee. The Permanent Water Commission is the consultative body of the Council of Ministers and consists of representatives of the member states. Its main task is the definition of the water allocation among the member states and sectors, namely: industry, agriculture, and transport. The Advisory Committee is the consultative body of the OMVS and is composed of representatives from governments, financial institutions and the OMVS. The Regional Planning Committee advises the OMVS whether the available water resources can meet the regional development plans of the member states. The member states have established National

Offices that are represented in the Advisory Committee of the OMVS. They assist the organization in implementing its projects and coordinating its activities in the member states.

The OMVS was founded to provide a secure and steadily improving livelihood for the inhabitants of the river basin and neighboring states. The mandate of the OMVS is very broad and ranges from policy-making, regulation to project implementation. Specifically, the OMVS is commissioned to determine the water allocation between the states and sectors, to define the general development policy for the Senegal River and its resources, and to plan and implement projects and monitoring.

5.2.7 Objectives of the Organization

To address the problems associated with the significant inter-annual variability in rainfall and water flow of the Senegal River, three of the four main bordering countries—Mali, Mauritania, and Senegal—entered into a treaty to form the Senegal River Authority, the *Organisation pour la Mise en Valeur du Fleuve Sénégal* (OMVS), and related organizational structures in 1972. The Organization's main objectives are:

1. To attain the goal of food self-sufficiency for the SRB inhabitants;
2. reduce the economic vulnerability of the organization's member states to climatic fluctuations as well as to external factors;
3. To contribute to the three countries development through sub-regional co-operation;
4. To secure and improve the incomes of the basin's populations thereby contributing to halt or curb rural exodus;
5. To develop quantitatively farm production; and
6. To ensure ecological equilibrium in the basin.

This is the context wherein the OMVS was mandated:

1. On the one hand, to implement a program of infrastructure designed to ensure river regularization and salt intrusion protection as well as transport and power generation and;
2. On the other hand, to contribute to integrated sectoral development in the fields of agriculture, mining, industry, transport and health in the basin.

5.2.8 Legal Instrument

Signed by the Heads of State and of Government of the three member states and ratified by their respective parliaments, four conventions constitute the basis on which the OMVS was established. These are namely:

1. **The Convention on the Legal Status of the Senegal River**

Signed on 11 March 1972, under this convention, the Senegal River (including its tributaries) is declared an "international waterway" in the territories of the Republics of Mali, Mauritania and Senegal. The convention also provides for freedom of navigation and equal treatment in relation to the various forms of utilization of the river water resources. As regards the exploitation of the river for agricultural or industrial purposes, the convention provides for the principle of the contracting states' prior approval of all projects likely to modify in a noticeable way the characteristics of the river, its hydrologic regime, the sanitary state of its water resources and the biological characteristics of its fauna and flora. Any of the contracting states many terminate the convention at the end of 99 years, effective from the date of formal notification to the other parties.

2. **The Convention on the Establishment of the OMVS**

Signed on 11 March at Nouakchott by the Heads of State and of Government of the republics of Mali, Mauritania and Senegal, this convention provides for the mandate and competence of the Organization whose executive organ is the High Commission.

3. **The Convention on the Legal Status of the Jointly Owned Structures**

Signed on 21 December 1978 by the Heads of State and of Government of Mali, Mauritania and Senegal, this convention provides for the legal status of the so-called Jointly Owned Structures. It also defines the rights and obligations of the co-owner states and provides for modalities in relation to the establishment of Agencies to be entrusted with the management of said Jointly Owned Structures. The convention enjoys a core position in the organization’s legal frame in that it provides for indivisible joint ownership of the OMVS common interest structures.

4. **The Convention on the Financing Modalities of the Jointly Owned Structures**

This convention completes the legal frame. Signed on 12 May 1982 in Bamako, It provides for the financing modalities of the OMVS program (contributions, loans, grants), the guarantee

arrangements vis-à-vis financiers and donors (joint and several guarantee) and a cost and charges allocation key between member countries; a key that can be adjusted whenever need be on the basis of the actual advantages drawn by each member state.

The current cost allocation key stands as follows:

1. Mali 35.30 %
2. Mauritania 22.60 %
3. Senegal 42.10 %

The above-mentioned basic legal framework was supplemented in 1997 with two other conventions on the establishment of Management Structures for the Diama and Manantali dams, namely:

4. The convention on the establishment of the Diama Dam Management and Operation Agency (SoGED)
5. The convention on the establishment of the Manantali Management and Operation Agency (SOGEM)

THE INSTITUTION AND ITS ORGANS

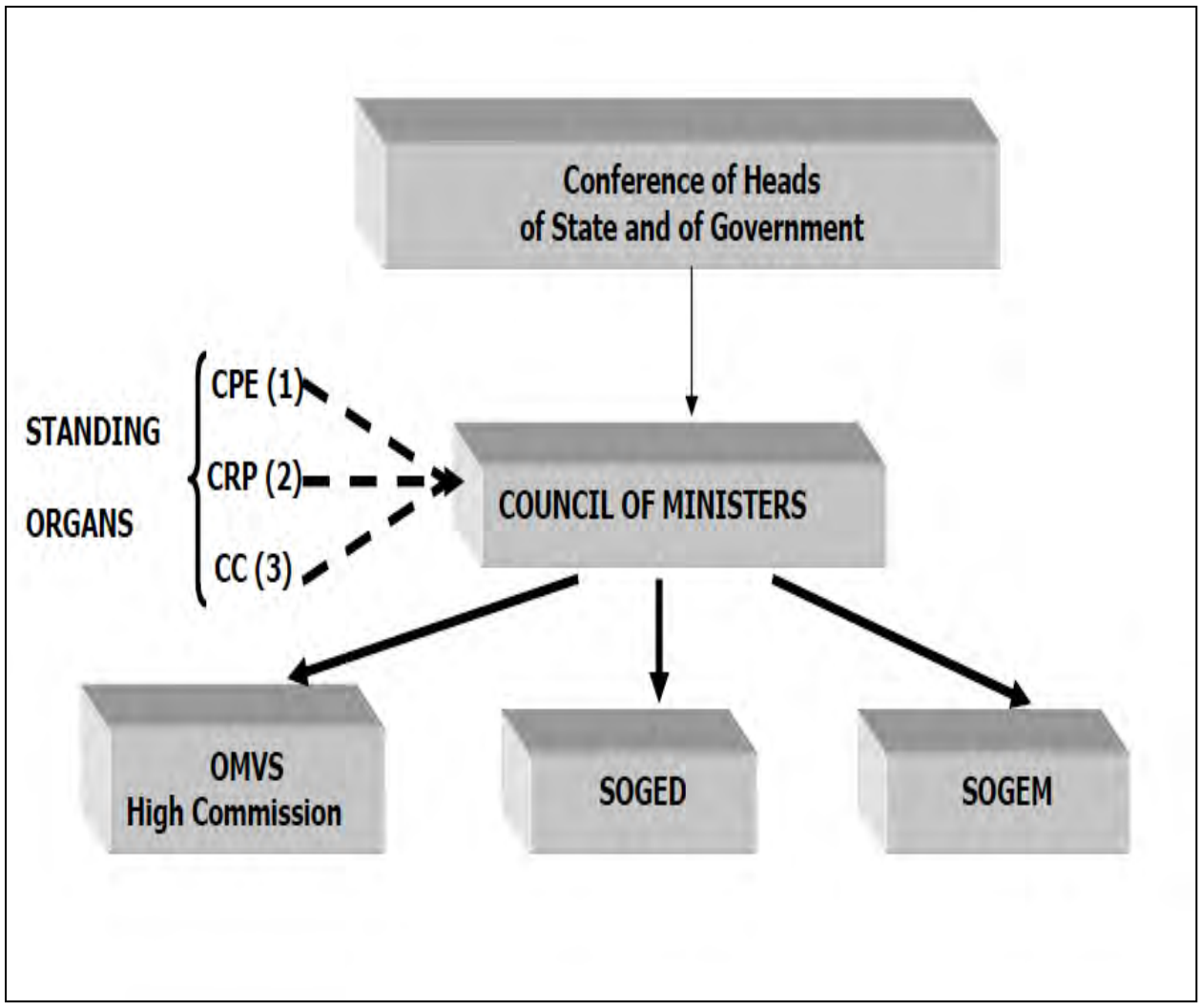

Figure 5.1: The Institution and its Organs

5.2.9 Constituent Organs

Under the amended Convention of 11 March 1972, the OMVS is placed under the supreme authority of the *Conference of Heads of State and of Government* that defines the Organization's co-operation and development Policy. Chairmanship of the conference is ensured for a two-year term by each of the Member States. In addition to the Conference, the Organization includes the following five standing organs, namely:

1. **The Council of Ministers**: Concept and supervision body of the Organization, it is entrusted with the elaboration of the overall co-operation and development policy for the

Senegal River basin in relation to the exploitation of its resources. Its chairmanship is ensured in turn for a two-year term by each of the Member States.

2. **The High Commission**: Executive organ of the Organization, the High Commission is entrusted with the implementation of the Council of Ministers' decisions and reports, on a regular basis, on the progress thereof as well as on any initiative made in relation to the instructions received from said Council and within the limits of the powers it is vested with. It is headed by a High Commissioner appointed for a four-year term and assisted by a Secretary General also appointed for a similar term.

3. **The Manantali Energy Management Agency (SOGEM):** Established on 7 January 1997, SOGEM is an inter-states public company entrusted with:

1. The management, operation, maintenance and refurbishing of the Jointly Owned Structures (namely the Manantali dam, the hydroelectrique plant and the power transmission lines); and
2. All industrial, commercial or financial operations, directly or indirectly, associated with the purpose and missions of the Agency.

In its capacity as the General Assembly of Shareholders, the OMVS Council of Ministers constitutes SOGEM's supreme organ. The Agency is administered by a nine - member Governing Council appointed by the member states (3 members for each) and is headed by a Director General. The Governing organs are renewed every four years.

3. **The Diama Dam Management and Operation Agency (SOGED):** Just as SOGEM, SOGED is an inter-states public company also established on 7 January 1997 and entrusted with:

1. The management, operation, maintenance and refurbishing of the Jointly Owned Structures (namely, the Diama dam and its dykings);
2. The designing, engineering works and financing of any new Jointly Owned Structures;
3. All industrial, commercial or financial operations, directly or indirectly, associated with the purpose and missions of the Agency; and
4. Cost recovery of water fees for farm, industrial or domestic purposes.

Here too, in its capacity as the General Assembly of shareholders, the OMVS Council of Ministers constitutes SOGED's Supreme Organ. The Agency is administered by a nine - member Governing Council appointed by the member states (three (3) by each) and renewed every fourth year.

5.2.10 Advisory Organs

5. **The Water Standing Committee (CPE)**

An advisory Organ of the council of Ministers, it groups representatives of the organization's member states and is entrusted with defining the principles and modalities for the allocation of the Senegal river water resources among the states and among the various utilization sectors. CPE reviews the Member states projects that are likely to have any impact on the river and advises the council of Ministers as to their acceptability or invalidity. Its role is paramount in relation to water use and pollution control.CPE also elaborates the water resources Management plan on the basis of utilization requirements and of the Manantali-diama management simulation. This plan is submitted to the council of Ministers that is also the supreme organ of all management structures.

6. **The regional planning committee (CRP).**

Just as the CPE, the CRP also groups the representatives of the Member states and is entrusted with advising the council of ministers on the investment program relating to an optimal development of the basin's resources. Its proposals are aimed at ensuring coherence and harmonization of development policies in the Senegal River Basin countries.

5.2.11 Institutional Linkages

The OMVS functions with the following management bodies:

Permanent bodies:

1. Conference of Heads of State and Government (CCEG, Conférence des Chefs d'Etat et du Gouvernement);
2. Council of Ministers (CM, Conseil des Ministres);
3. High Commission (HC, Haut Commissariat), executive body;
4. Permanent Water Commission (CPE, Commission Permanente des Eaux) made up of representatives of the organization's member states, and which defines the principles of and procedures for the allotment of Senegal River water between member states and use sectors. The CPE advises the Council of Ministers;

Non-permanent bodies:

5. An OMVS National Coordination Committee in each Member State;
6. Local Coordination Committees;
7. Regional Planning Committees (CRP, Comités Régionaux de Planification);
8. Consultative Committee (CC, Comité Consultatif).

This organizational framework, statutorily strong but flexible on the operational level, enables all of the actors and stakeholders to participate effectively in the efficient management of both the basin's natural resources and its other economic potentials. For more than thirty years now, they have been able to find suitable solutions to all of the technical, social, political and other problems linked to the development of the Senegal River basin's water resources.

5.2.12 Achievements of the OMVS Program

5.2.12.1 The Diama Dam

Constructed in the delta section of the river where the natural slope is extremely slight, the mainfunctions of the dam are:

1. To stop the intrusion of the salt wedge during low water periods;
2. To create a fresh water reserve which, whilst allowing for the development of irrigation, also helps reduce pumping heads (at the level of pumping stations);
3. To improve the filling conditions of the lakes of Guiers in Senegal, R'kiz in Mauritania as well as of the myriad of effluents and marigots in the Delta.

The structure is designed to ensure the passage or discharge of floods (up to 6,500 m3/s) through seven 11.5m high and 20m wide radial gates.It is also equipped to ensure navigation through a 13m wide and 175m long lock. The Diama dam preliminary and detailed engineering studies were entrusted by the OMVS to a Consortium of consulting engineers in 1976 and were completed in 1978.Construction works lasted five (5) years (1981-1986) as specified in the work schedule and the dam was commissioned in 1986.The Diama structure is supplemented by lateral dykings, which allow for the operation of the dam at level 2.5m I G N.

5.2.12.2 The Manantali Dam

The Manantali structure is located about 95 km south-east of bahfulabeh in Mali. The purpose of this project is to achieve the following objectives:

1. To provide a regularized 300m3/s flow for the requirements of irrigation, navigation and potable water supply in the Senegal River Valley;
2. To allow for power generation which, in the final stage, will help achieve a generation capacity of about 800GWH/year;
3. To create an artificial flood through support releases to the inflows of the uncontrolled tributaries;
4. Thanks to the wiredrawing possibilities offered by the impoundment, to reduce the amplitude of exceptional floods likely to occur.

The structure consists mainly of a concrete and rockfill dam whose maximum height is 68m above foundations and which includes the electromechanical equipment.

This 1,432m crest-long concrete and rockfill dam includes a 471 m long central concrete part and two lateral Rock fill dykes, respectively 613m and 348m long that link the concrete structure to the hill sides on both banks.

The Manantali reservoir whose maximum operating level corresponds to 208.00 m IGN (i.e. above sea level) is 80km long and covers 477 km^2. The reservoir allows for the impoundment of about 11 billion m3. When under operation, the level of the reservoir fluctuates between elevation 187 and 208 m IGN; the operational or useful volume standing at about 8 billion m3.

The hydro-mechanical equipment include:

1. Seven 3.80 m wide and 4.80 m high bottom outlets located at level 155 IGN and equipped with radial and security gates. Each of these gates allows the discharge of maximum flows of 505m^3/s;
2. Eight surface spillways whose gates are located at elevation 202 m IGN whilst the dam Crest rises to 208 m IGN. These gates are designed to control flows at the dam crest and each allows for the discharge of a maximum 235 m3/s.

The dam is also equipped with five water intake structures designed each to supply water to aturbine for the purpose of electric power generation. Access to the dam crown is ensured by a

road running from level 164.00 m and progressing along the dyke on the right bank.Initiated in September 1976, the Manantali dam engineering studies were completed in early 1979. Construction works for this structure started in June 1982 and were competed on schedule in late March 1988.Filling of the reservoir started during the 1987 rainy season and the normal 208m IGN operatinglevel was reached four years later, namely in September 1992.

Additional benefits are:

(i) The creation of a significant fisheries resource in the Manantali reservoir, which has led to the seasonal settlement of fishing communities;

(ii) The maintenance of the Diawling, Djoudj and Trois Marigots/Ndinel national parks and protected areas and;

(iii) Year-round navigation of parts of the rivers' system.

The Manantali reservoir is Mali's third largest 15 fishing area after the Niger Interior Delta and the reservoir at the Sélingué dam. Despite these contrasts in evolution, fishing is still an important activity today throughout the basin where it is the main source of income for more than 6300 fishermen. Close to 2000 fishermen depend on fishing as a supplementary source of income. These fishermen are divided as follows: 79% in Senegal, 16% in Mauritania and 5% in Mali (Roche International, 2000).

5.2.13 Finances

Two types of funding are used to finance the development of the Senegal River basin. The first one covers the operating costs of the various OMVS bodies, and comes from the three member states; each of them pays one third of the total in January of every year. To finance the jointly owned structures and other development activities, funds are sought in the form of loans extended either to the states or directly to the OMVS. In this case, the member states must guarantee the loans. Each member state ensures the reimbursement of its share of the loans.

The apportionment of costs and debts is done according to an accepted formula, subject to revision, as stipulated in the conventions. The underlying principle of cost recovery is that the users pay, but economic conditions are also taken into consideration. Taxes paid to the organization are used to cover operating expenses. Managing multiple uses: an original approach Due to potential conflicts between power generation and the other uses of the Senegal River, the

three governments have embarked through OMVS on the implementation of an environmental impact alleviation and follow-up programme (PASIE, Plan d'Atténuation et de Suivi des Impacts sur l'Environnement). It is an environmental programme specifically designed to address, monitor and mitigatethe environmental issues raised by (or related to) the development and distribution of power from the Manantali power plant.

The OMVS's fundamental conventions of 1972 and the Senegal River Water Charter signed in May 2002, which establish its legal and regulatory framework, clearly state that river water must be allocated to the various use sectors. The resource is not allocated to riparian states in terms of volumes of water to be withdrawn, but rather to uses as a function of possibilities. The various uses can be for agriculture, inland fishing, livestock rising, fish farming, tree farming, fauna and flora, hydroelectric energy production, urban and rural drinking water supply, health, industry, navigation and the environment.The principles and procedures for the allocation of water were drawn up and a Permanent Water Commission (PWC) was set up to serve as an advisory body to the OMVS's Council of Ministers that makes decisions and asks the High Commission to oversee their application. The OMVS's process for managing needs has four steps.

1. First, an inventory of needs is taken by the OMVS National Committees under the Ministries in charge of water in each country. The 'state of needs' is then sent to the OMVS High Commission.
2. The High Commission centralizes all of the needs, writes a synthesis report and convenes a meeting of the Permanent Water Commission to vote on recommendations. It then draws up a record of the proceedings with precise recommendations for the Council of Ministers.
3. The Council of Ministers makes decisions based on the information provided by the Permanent Water Commission, either in a formal meeting or by informal telephone consultation. The High Commission receives instructions from the Council of Ministers and transmits to member states and other actors the procedures for carrying out the measures adopted by consensus by the member states in the Council of Ministers.
4. The work of the Permanent Water Commission and the criteria used by the ministers for decision-making are based on the following general principles:

1. Reasonable and fair use of the river water;
2. Obligation to preserve the basin's environment;

3. Obligation to negotiate in cases of water use disagreement/conflict; and
4. Obligation of each riparian state to inform the others before undertaking any action or project that could affect water availability.

The objective of the OMVS method of water allocation is to ensure that local populations benefit fully from the resource, while ensuring the safety of people and structures, respecting the fundamental human right to clean water and working towards the sustainable development of the Senegal River basin.

5.3 Niger River Basins

5.3.1 Fishery Policy Formulation

Niger River although endowed with the highest fishery resources in the West Africa regional water basin (Neiland and Béné,2003),is also a resource source for other economy sectors among the riparian countries. It means that Niger River resources do not only support fishery sector of the economy, but other sectors of the economy like:

1. Agriculture: This include water for irrigation farming and drinking water for livestock and support good pasture for cattle, sheep and goat;
2. Power: This involves generation of hydroelectric power;
3. Transportation;
4. Domestic water use: This includes provision of portable water for drinking, laundry etc.;
5. Industries: This encourages location of manufacturing companies around the Basin areas for easy supply of water and as a source of effluent discharge.

Moreover, there is conflict among these sectors to which of the sector should have the pre – eminence. It is a clear truth that water supports life, life depends on water, and water resources of Niger River is highly demanded by these rivalry sectors of the economy (Neiland and Béné, 2003). It is also clear that giving priority to a sector of the economy, other sectors may be at disadvantage, producing less than their potential capacity. Nevertheless, it is known that Niger River like any other water bodies throughout the world is the natural habitat of fish. Therefore, giving fishery sector a priority is justifiable, but having in mind that other sectors of the economy are equally important for sustainability.

Therefore, policy has to be made to decide the proportion of the Niger River resources to be allocated to each sector to maintain sustainability. Noting that, the present utilisation of Niger River resources to other sectors of the economy contribute to the decline of fish production in the recent years. For example, current agricultural practices such as bush clearing, overgrazing, fertility loss, poor drainage systems and utilization of zones close to the river have led to extensive land and water degradation. Though agricultural pollution is limited presently, it is gradually increasing with improper use of pesticides and fertilisers (Niger Final Brief, 2003). This drains into the River, couple with effects of dams construction for hydro electric power generation that bring a great degree of unaccounted, unrecorded severe mortality or damage to fishes passing through the discharge structures through abrasion against dam walls, (Bernasckek 2001).

Nevertheless, fishery sector of Niger River Basin also has its internal challenges that militating against its productivity. The Basin's fish stock has decreased with the almost disappearance of certain fish species, because of disturbances in the river's floodplain and over – fishing. Contribution of inappropriate fishing methods such as illegal, unreported and unregulated (IUU) fishing nets, poison and explosives all have led to overfishing and have negative environmental impacts. Meanwhile, the potential of fishery sector in the Basin to contribute to poverty reduction and improved the livelihood of the populations living around the Basin have not been optimally exploited. It is estimated that Africa loses between US$2 – US$5 billion annually due to mismanagement in the fishery sector (AUC – NEPAD, 2014).

Policy is needed urgently to reverse the current trend of decline and waste that characterises African fisheries, and to enable these to contribute sustainably to economic growth, food security, nutrition, and healthy ecosystems. These are problems created by various sectors of the economy demanding for Niger River water resources. These problems need effective solution to be solved by fisheries management. Meanwhile, the UN – FAO Technical Guidelines for Responsible Fisheries (Inland Fisheries) (1997; p.3) provides some guidance for the development of an appropriate response, stating that:'Management should be conducted in a climate of compromise with other users and depends as much on regulations governing their activities as those governing the fishery itself. In other words, inland fishery managers are rarely in control of the resource they manage. Because of this the code (Code of Conduct for Responsible Fisheries) must be interpreted to inform and involve sectors other than fisheries'.

The development of policies for the world's river basins requires decisions to be taken concerning the alternative usage of water resources, to include other sectors. Under ideal circumstances, these types of decisions should be based on a sound methodological approach that incorporates the views and desires of all stakeholders involved, and should also be underpinned by a wide range of information (hydrological, biological, ecological, economic, social and institutional dimensions).

Unfortunately, in most developing countries, the circumstances for decision – making are far from the ideal condition described above. The basis for sound decision – making is limited by a range of factors, particularly the nature of weak state and weak governance (that limits stakeholder participation and cooperation) and limited institutional capacity (that limits information flows), (Neiland and Béné, 2003).

5.3.2 Gap in Existing Policies

It is inadequate to address the fisheries problems or challenges by concentrating only on fishing activities as only cause of fish stock depletion. But other major factors that pose threats to the recovery of fishery ecosystem related to human activities and natural factors are to be focal points, (SPC, 2010). Fisheries (either large or small fisheries) activities usually affect other components of the ecosystem broadly in two ways:

1. Direct impact: Fishing activities cause by-catch of non-targeted species, physical damage to habitats, food-chain effects, or changes to biodiversity, overfishing;
2. Indirect impacts: This involves changing biological interactions among the fish stock. This involves increasing or reducing the abundance of a predator, prey or competitor. The reduction in numbers of a predatory species may allow its prey to increase in numbers and the reduction of a prey species may induce predators to feed on other species.

Likewise, ecosystem components also affect fisheries through the effects of climate, agricultural practices, forestry and pollution. Fisheries and other sectors of the economy form an ecosystem (co – habited in the same ecosystem) in which the activities of one affect other. However, interrelationship that exist between fisheries and other ecosystem components called for sustainable development in which responsible fisheries management must consider the broader

impact of fisheries on the ecosystem and the impact of ecosystem on fisheries as a whole, taking biodiversity into account, (FAO, 2013).

But, our ability to predict ecosystem behaviour is inadequate, but it is known that all ecosystems have limits that, when exceeded, can result in major ecosystem change which may become impossible to reverse. The sustainability of capture fisheries depends upon healthy and productive ecosystems and sound management (USAID, 2013). Maintaining biological diversity is regarded as being of major importance to ecosystem functioning and productive fisheries, as well as providing flexibility for future uses. Therefore, there is need to understand 'Ecosystem Approach to Fisheries (EAF)' with the aim of planning, developing and managing fisheries in a way that addresses the multipleneeds and desires of societies, to maximally exploit the resource potentials of aquatic resources (ecosystem) without jeopardizing the options for futuregenerations to benefit from the full range of goods and services provided byaquatic ecosystems. The identification of the various direct and indirect uses and users of these resources and ecosystems is a necessary first step to attain a good understanding of the full range of potential benefits, (FAO, 2013).

3. Institutional concepts and functions

An effective ecosystem approach will depend on better institutional coordination between ministries of different economy sectors. This will require clear definition of roles and responsibilities, improved coordination and integration across government and other users and more accountability across all stakeholder groups. A greater emphasis on planning at a range of geographical levels that involves all relevant stakeholders will be required and will involve a much more collaborative approach and sharing of information. The magnitude of this task should not be underestimated, (FAO, 2013).

All parties need to acknowledge the importance of small-scale fishery as a provider of food, income and livelihoods as well as contributor to economic and social development. Holistic and integrated approaches will be employed to ensure cross-sectoral coordination recognising that the small-scale fisheries sector is closely linked to many other sectors. To this end, natural resources, ecosystem management, social and economic development have to be combined and given appropriate consideration. Preferential use rights should be granted to fishery resources to fishers that employ responsible fishing practices and that are environmentally, socially and economically

viable. To maintain sustainability, precautionary approach and risk management need to be applied to prevent undesirable outcomes, including not only overexploitation of fishery resources and negative environmental impact, but also unacceptable social and economic consequences. Therefore, policy make should encourage research and academic institutions, (FAO – UN, 2012). There should be sufficient human capacity in many key areas in fisheries and aquaculture administration, management and research, so that there will be effective means of information – collection and analysis systems, to the effect that decision – making processes will not be hindered, (AUC – NEPAD, 2014).

4. **Cooperation Among Member Countries**

Ita (1993) reported that foreign observers frequently comment that fishing in African lakes, rivers and their associated wetlands is usually haphazard, this is because there are usually no laws and regulations controlling the exploitation of the fisheries of most African inland waters. He stress further that waters usually traverse more than one State and fish do not respect State boundaries, migratory fish often enter channels which pass through more than one State. Therefore, action or lack of action by one State has a profound effect on the fishery resources and fishing in another State. In addition, migrant fishermen often cross State boundaries using unlawful methods to capture fish, and the dumping of poisonous products or industrial wastes in one State, which does not give priority to fisheries, can lead to mass destruction of valuable fishery resources downstream in another State where fishing may be of high priority. This statement also holds for Niger Basin resource management. There is need for cooperation and collaboration between members. AUC – NEPAD (2014)'s report on Africa fisheries confirmed that inadequate cooperation and collaboration contributes to high incidence of illegal, unreported and unregulated (IUU) fishing on the continent, representing, for example, over US$1.5 billion of lost resource rents in 2011 for African countries. The high degree of interconnectedness requires strengthened regional cooperation, collaboration and coordination in the management of shared ecosystems and the strengthening of the African voice in the international arena.

5.4 Fishery Regulation in Nigeria

Inland fisheries contribute about 40% of the total fish supply in Nigeria (Ita, 1993), therefore, there is need to safeguard it. Ita (1993) produced a model draft of Inland Fisheries Laws and Regulations

which was modified for adoption by delegates from different States in Nigeria at a meeting convened by the National Institute for Freshwater Fisheries Research (formerly Kainji Lake Research Institute) in April 1985. The major aspects considered in the draft laws and regulations included:

(i) Composition and definition of the inland water bodies of Nigeria;

(ii) Definition of ownership of these inland water bodies;

(iii) Licensing of fishermen, crafts, gears and cold rooms;

(iv) Fisheries laws and regulations;

(v) Offences and penalties;

(vi) Definition of the law enforcement agencies and implementing agencies.

However, there is presently no uniform Federal Inland Fisheries Management Policy in Nigeria, although some States in Nigeria have extracted some aspects from this draft to promulgate their Edicts. Ten states out of thirty – six State of the Federal Republic of Nigeria have promulgated their Fisheries Edicts, but yet to be effectively implemented.

1. Registration and licensing of fishermen
2. Mesh size regulation
3. Gear size regulation
4. Prohibition of the use of poison and explosives
5. Fishing with electricity
6. Closed season and area

According to Ita (1993), a typical State Fisheries Edict in Nigeria reads:

(i) No fisherman shall:

  (a) Catch any of the freshwater fish species below the size specified in Schedule I of this Edict;

  (b) Fix stationary fishing structures across the river for the purpose of cultivating, culturing or propagating fish.

(ii) No person shall take from or destroy any fish within the water bodies by any of the following methods:

1. The use of any explosive substance or electricity;
2. The use of any poisonous or noxious matter;
3. The use of gillnet or drawnet of less than 3 inches or 7.62 cm mesh size;

4. The use of clapnet, castnet or any webbing traps of less than 2 inches or 5.1 cm mesh size;
5. Lift net of not less than 1.5 inches or 3.8 cm mesh size.

(iii) No person shall:

1. Preserve fish by use of insecticide or other toxic chemical;
2. Transport, display or sell fish under unhygienic conditions.

(iv) No person shall fish within the territorial waters of the State unless he obtains a licence so to do.

The Edict goes on to elaborate on the licensing procedures and fees and on penalties for committing any of the offenses stipulated. With the exception of a few omissions, of some factors likely to cause fish depletion such as barriers for capturing migratory species and draining of pools to crop all the fish, the edict could be said to be fairly comprehensive and easy to understand by local fishermen if translated into the local languages.Ita (1993), saw some lapses and contradictions in the Edict which could cause problems during enforcement. These are discussed below:

i) Fish size stipulation and mesh size limitation. The schedule for sizes of fish to be caught has been drafted. The schedule I of the Edict outlines of ten species with stipulated sizes for capture is shown below

Table 5.8: Schedule I of the Edict Outlines of Ten Species with Stipulated Sizes for Capture

Fish	Length (cm)
Lates niloticus	20+
Gymnarchus niloticus	35
Heterobranchus sp.	30
Hydrocynus sp	30
Hyperopisus sp.	30
Citharinus sp.	23
Distichodus sp.	22
Tilapia sp.	12
Heterotis sp.	30
Bagrus sp.	30

Source: Ita (1993)

In view of the fact that the Edict permits the use of assorted fishing gears with varied mesh sizes ranging from 1.5 inches (3.8 cm) to 3 inches (7.62 cm) the listing of the unit sizes of the different species for capture could cause problems during implementation. A fisherman caught with

undersized fish captured with either clapnet of 2 inch mesh or lift-net of 1.5 inch mesh could be rightly fined by the law enforcement agents who possibly do not know much about the selectivity of these gears. The clapnet, gillnet and dragnet of similar mesh sizes are likely to catch fairly uniform sizes of fish. However, as earlier discussed above, clapnets have limitations in use and should either be exempted from the minimum mesh size stipulation or fixed along with gillnets and dragnets at 3 inch mesh size (minimum) to avoid complications with the fish size stipulation.

Similarly, fishermen using lift-nets along the Niger and Benue Rivers use a minimum of 3 mm mesh size to catch freshwater sardines (clupeids). The stipulation of 1.5 inch (3.8 cm) eliminates this group of fishermen as was observed in one of the northern States. Another controversial net was the "Malian" open water seine-net introduced by fishermen from Mali for catching clupeids in Kainji Lake and along the Upper Niger. This net, popularly called "Dala" net, is made of mosquito netting material with 3 mm mesh. It has a head rope of 100 – 150 metres with a depth of about 5 metres. The head rope is fitted with floats made of haffia bamboo poles at about 15 cm intervals. The foot rope consists of rolled nylon netting without sinkers. The net is operated by two canoes in open water as open water seine-net or hauled to the shore with about five or more fishermen in each canoe. Catches from this net consist of about 90% clupeids when operated in open water and less than 80% clupeids when operated along the shore. Other species identified in the catch included juveniles of *Alestes*, *Schilbe*, *Eutropius*, *Synodontis*, *Tilapia*, *Labeo* etc.

The "Dala" net, although controversial among riverine communities, and even among Lake Kainji fishing communities, was identified as a new technology for catching clupeids in the open water of Lake Kainji where the "Atalla" lift-net fishermen cannot operate on account of wave action. Its operation was recommended for Lake Kainji where the catch was over 90% clupeids. It is important therefore for all the gears used in any particular State to be identified and indicated in the edict to avoid subsequent controversy after the promulgation of the edict.

5.5 Actions in Progress in Member Countries

The actionsin place for the development of the fisheries of the Niger River Basins have been financially supported by the World Bank. The following have been carried out:

(i) Water resources development and sustainable ecosystem management in Niger Basin;

(ii) Support for increased annual fish production in Niger and Mali;

(iii) Equipment are provided for fishermen and conservation of fisheries resources with the next phase on resilience to climate change and food security in Niger Basin.

CHAPTER SIX

ESSENTIAL GUIDELINES AND REGIONAL ACTION PLANS FOR SUSTAINABLE MANAGEMENT

The Guidelines and Regional Plans exist to a large extent in the three ecosytems of LCB, Senegal and Niger River Basins. However, these strategies are fragmented and their coordinations appear to be weak, with little impact on Fisheries development. It will therefore be most desirable for interventions to be implemented on regional bases for synergy and achievement of better impact on sustainable fisheries management in the region.

Therehave been 5 years development programmes including Fisheries Master Plan, Poverty Reduction Strategy, Institutional Arrangement, and Structural Adjustment Programme.Interventions on regional bases should take care of the following lapses:

6.1 Actions by AU-IBAR on the Three Water Bodies

AU-IBAR is requested to urgently assist LCB, Niger River Basin and Senegal River Basin management by:

1. Information technology facilities and human capacities of the management of the LCB, Niger River Basin and Senegal River Basin should be improved.
2. Policies of LCB, Niger River Basin and Senegal River Basin management countries should be harmonized for an enhanced resources management and increased productivity.
3. Guidelines for operation and regional action plans for sustainable management of the LCB, Niger River Basin and Senegal River Basin fishing areas should be developed.
4. Development and effective implementation of fisheries management plans will enhance sustainable fisheries development of the LCB, Niger River Basin and Senegal River Basin.
5. The Fisheries Management Guidelines for the information that need to feed into a fishery management plan should include:

1. The area of operation of the fishery and its jurisdiction; the various stakeholders of fishery sector and other sectors of the economy that share the same aquatic resources with fisheries;
2. The gear and vessel types to be employed in the fishery;
3. The history, management and socio-economic importance of the fishery;

4. If possible, the distribution area of the most important commercial species in the catch (preferably as a map);
5. Relevant information about the life histories of these species;
6. The effects of the fishery on the recruitment, abundance, spatial distribution and age or size structure of the target species, as far as possible;
7. Any available monitoring data;
8. Any management procedures already in place, with descriptions and a performance evaluation, (FAO, 2013);
9. Awareness creation on the importance of Inland Fisheries for food security and major source of income in rural areas;
10. Improved attention to inland fisheries in all the issues related to artisanal fisheries sector;
11. A rethink about boundaries between marine and inland fisheries (Abroger le décret 75-1091);
12. Harmonization of inland fisheries legislations;
13. Strengthen inland fisheries offices and centers in human ressources, equipment and logistics ;
14. Development of sub regional, regional and international coopération in terms of inland fisheries**.**

6.2 Five Year Development Plans

Immediately after independence in 1960, Cameroon adopted a planning and development approachbased on five-year plans. Five five-year plans for economic and social development were developedby the Government.The objective of the first two plans (1960/1965; 1966/1971) was to promote raw material exports inorder to obtain the hard currency necessary to fund the activities of other sectors. Because of thisapproach, fisheries were undervalued, particularly artisanal fisheries. In those first two five-year plans,the budget allocated to the fisheries sector accounted respectively for 0.44% and 0.28% of the nationalbudget. However, the government's objectives were to increase national production through theincrease and modernization of the industrial fishing fleet and the creation of an artisanal fleet (Bondja *et al*., 2005).

The 3rd, 4th and 5th five-year plans (1971/76; 1976/81; 1981/86) focused on the following actions:organizing fishing zones, organizing the administration, developing and intensifying high-

sea fishing,promoting aquaculture and marketing of fish products. For example, the general objective of the 5th planwas to produce 163,000 tonnes of fish at the end of 1986.

The 6th five-year plan (1986/1991) which allocated 0.38% of the national budget to the fisheries sectorand aimed to increase fisheries production by 10% per annum was not implemented. The economiccrisis disrupted its implementation. Acting upon advice received from the International MonetaryFund (IMF) and the World Bank (WB), the government undertook a Structural AdjustmentProgramme (SAP) in order to adjust the needs to the available means (Anonymous, 1986).

6.3 The Structural Adjustment Programme (SAP)

Between 1977 and 1985, the GDP increase was spectacular (on average 10% a year), following thediscovery and the exploitation of oil (TIOTSOP and al., 2000). The economic recession started in1985 with the fall in the price of oil and other staple products and continued until 1989. In June 1991,Cameroon's foreign debt was estimated at 1,300 billion (67% of GDP). The economic crisis that Cameroon went through led to a disequilibrium in the macro-economic accounts and in particular inthe public finances. The measures adopted in order to boost the economy were essentially carried outthrough Structural Adjustment Plans (SAP) agreed with the Bretton Woods Institutions. In order not tolimit structural adjustment to the financial sector with a re-balancing of the macroeconomic accounts,the Government redefined its development strategy and particularly the economic role of the State.Among other things, a liberal environment was set up, characterized by a progressive reduction innon-tariff barriers, the privatization of most companies in the production and marketing sectors andprice deregulation (Anonymous, 2005f).

6.4 Fisheries Master Plan

The Fisheries Master Plan was developed in 1992, in a context of structural adjustment. Its objectivesaim principally to promote national production in order to minimize imports and in the long run toachieve food self-sufficiency. This policy hinges on four strategic axes:

(i) Improving the situation ofeconomic operators and strengthening institutional support;

(ii) Setting up a statistical system;

(iii) Developing fisheries which are not yet exploited or insufficiently so;

(iv) Improving the harvesting,processing and marketing methods and techniques of fisheries products and

(v) Promoting anddeveloping private commercial aquaculture (Tiotsop and al., 2000). But the implementation of thisplan was prevented by the economic crisis.

6.5 Poverty Reduction Strategy Paper (PRSP)

From 1995 onwards, the economic recovery was confirmed by growth rates of around 5% a year. Butthe Government was aware of the fact that the population's standard of living could only improve in asustainable way if the pace of economic growth was much higher than the pace of demographicgrowth (2.8%) and this for a long period of time. Hence the Government's main developmentobjective is to improve the population's livelihoods significantly in order to alleviate poverty in asustainable way. This led to the country joining the Heavily Indebted Poor Countries (HIPC) initiativein 1999. It, therefore, became necessary to develop a coherent series of policies within the PovertyReduction Strategy (PRS) programme framework with several components, one of which was theRural Sector Development Strategy (RSDS), a productive component but also a social componentcovering sectors such as education, health, town planning etc. (Anonymous, 2005f).The fisheries sector development strategy fits into the global rural development plan, with an aim ofsignificant poverty reduction. This strategy hinges on the following four axes:

(i) Modernizing the production tools (production systems) through: reducing post-harvest losses,training and integrating young Cameroonians in fisheries and fisheries-related jobs, re-stocking damsand other such barrier lakes with fish, promoting inland water bodies and creeks and perfecting specificand adapted food for the species that are being grown;

(ii) Improving the institutional framework through formalizing intersectoral institutional co-operation,capacity building in designing, monitoring and assessing fisheries policies, supporting socioprofessionalstructuring and establishing resource management committees in the big dams;

(iii) Improving incentives by adapting national legislation to relevant international fisheriesconventions, finalizing the implementation of appropriate legislation, developing an appropriate fiscalsystem for fisheries and aquaculture, improving access to the funds necessary for fisheries activitiesand aquaculture and improving collective infrastructures that support production;

(iv) The sustainable management of natural resources through: developing and implementing specificnational fisheries action plans (sharks, illegal, unregulated and unreported fishing etc.); setting up anefficient statistical data collection and processing system; rationalizing and controlling fishing effortwith an operational system of closed seasons; monitoring and scientific observation of fisheriesactivities (Anonymous, 2001d).

6.6 Institutional Arrangements

The Lake Chad Basin Commission (LCBC), an Inter Governmental Agency was established by the Fort Lamy (now N'Djamena) Convention and Statutes on May 22 1964 by the heads of four countries that share the Lake. This Old Conventional Basin did not include the Central African Republic and excluded the large desert expanses of Algeria, northern Niger, northern Chad and Sudan and, in particular, excluded the upstream part of the active basins of the Chari-Logone and Komadugu- Yobe. In March 1994, Central African Republic was admitted as the fifth member State during the 8th Summit of Heads of State (held in Abuja, Nigeria) leading to the New Conventional Basin thus increasing the conventional area to approximately 987 000 km2. This has enlarged the conventional basin to include the upper basins of the Chari-Logone and Komadugu-Yobe systems. The New Conventional Basin includes five countries; Chad, Nigeria, Cameroon, Central African Republic and Niger. Sudan was admitted into LCBC in June 2000, but is yet to ratify the Convention establishing the Commission, a necessary precondition for partaking in the activities of LCBC. The admission of Sudan has now increased the conventional area from 427 000 km^2 in 1964 to 1 035 000 km^2 in 2000. This new definition of the conventional Lake Chad Basin thus takes into account almost all the water resources that supply the Lake, the floodplains and the aquifers in the lake area (World Bank 2002b).

The functional system boundary for water, land, forest and wildlife comprise much smaller sub-sets of the Lake Chad Basin Commission's geographic limit. This is because the hydrologically active area of the Basin is much smaller (966 955 km2) than the topographic limits of the Basin (2,434,000km2) which cover a large part of desert areas in Niger and Chad and are hydrologically de-coupled from the Lake (World Bank 2002b).

The primary responsibilities of the LCBC are: to regulate and control the utilization of water and other natural resources in the Basin; to initiate, promote and coordinate natural resources

development projects and research within the basin area; to examine complaints; and to promote the settlement of disputes, thereby promoting regional cooperation and integration. The Fort Lamy Convention recognizes the sovereign rights of the member States over the water resources in the Basin, but forbids any unilateral exploitation of the lake water, especially when such use has a negative effect on the interests of the other states. It also recognizes the right of the member States to plan projects, provided that they consult the LCBC beforehand. The member States were also supposed to refrain from adopting any measures likely to alter the Lake's water balance, its exploitation by other riparian states, the quality of its water and the biological characteristics of the fauna and flora in the Basin. Lastly, the member States must inform the LCBC of all projects planned within the Conventional Basin. National, sectoral and environmental plans exist in each country. National institutions are officially in charge of coordinating the implementation of Action Programme 21 in Chad, Cameroon, Niger and Nigeria.

At national level, the relevant environmental institutions are:

1. Cameroon: National Consultative Committee on the Environment and Sustainable Development (CCNEDD), which includes the Prime Minister, various ministers, professional associations and NGOs.
2. Central African Republic: Ministry of Meterorology and Ministry of Mines and Energy.
3. Chad: National High Committee on the Environment (HCNE) which includes the Prime Minister and various ministers.
4. Niger: National Council for the Environment and Sustainable Development (CNEDD) which includes the Cabinet leader, ministers, civil society, university and NGOs.
5. Nigeria: Federal Environmental Protection Agency (coordination of ministries) backed by the National Advisory Council (governmental organisations, private sector, NGOs, community organisations, university) and by the National Council on the Environment (States). Almost all the States in the Federation have prepared a long-term Environmental Action Plan.

6.7 The Lake Chad Basin Commission (LCBC)

The Lake Chad Basin Commission (LCBC) was established on 22nd of May 1964 by the four countries that bordered Lake Chad: Cameroon, Niger, Nigeria and Chad. The Republic of Central Africa joined the organization in 1996, Libya was admitted in 2008. Observer status is held by

Sudan, Egypt, the Republic of Congo and the Democratic Republic of Congo. N'Djaména, Capital of Chad hosts the Headquarters of the Commission. The mandate of the Commission is to sustainably and equitably manage the Lake Chad and other shared water resources of the Lake Chad Basin, to preserve the ecosystems of the Lake Chad Conventional Basin, to promote regional integration, peace and security across the Basin. The LCBC is a basin organization, member of both the African Network of Basin Organizations (ANBO) and the International Network of Basin Organizations (INBO). The Commission if funded by contributions of Member State, but there is reflection for an autonomous financing of the Organization

6.8 Historical Summary

The commission was initiated on the 22nd of May 1964 by Fort-Lamy Convention (now N'Djamena). The founding fathers are: Ahmadou Ahidjo (Cameroon), N'Garta Tombalbaye (Chad), Hamani DIORI (Niger), Tafawa Balewa (Nigeria). The basic documents are: Convention, Statutes and Internal Regulations and the member countries are: Cameroon, Niger, Nigeria, Chad, CAR and Libya. The surface area of Conventional Basin was 967 000 km² (excluding Libya) while the population of the Conventional Basin was about 30 million inhabitants. The common heritage of the commission is Lake Chad, the third largest freshwater lake in the world and fourth largest in Africa. Surface area at inception of LCBC was 25 000 km² and the surface area in 2010 was about 2 000 km². The tributaries around the lake are the Logone and Chari, El-Beid, Komadougou-Yobe, Yedsaram, Ngadda, Serbewel and taf-taf. Small-scale fishing, irrigated agriculture and research for oil resources are the economic activities offered by Lake Chad.

6.9 Jurisdiction and People

The jurisdiction of the LCBC extends to the Conventional Basin (967 000 sqkm, without Libya) made of three (3) regions in Cameroon, three (3) in Central African Republic, two (2) in Niger and six (6) States in Nigeria, and the entire Chad Republic. Ppopulation in the Conventional Basin of Lake Chad is around 30 million inhabitants coming mainly from Cameroon, Niger, Nigeria, Chad and Central African Republic. People living in the Lake Chad Basin are drawn from several ethnic groups and tribes, such as the Kanuri, Mobber, Buduma, Haussa, Kanembu, Kotoko, Shewa Arabs, Haddad, Kuri, Fulani and Manga. They are fishermen, herders, farmers, traders, even some have become farmer-herders or famer-fishermen.

6.9.1 Mandate

(i) Sustainable and equitable management of the Lake Chad waters and other transboundary water resources of the Lake Chad Basin.

(ii) Preservation and protection of ecosystems of the catchment area.

(iii) Promotion of integration, and preservation of peace and security peace in the Conventional Basin.

6.9.2 Missions

1. To collect, evaluate, and disseminate information on projects prepared by member States and recommend plans for common projects and joint research programmes in the Basin.
2. To keep close contact between the High Contracting Parties with a view to ensuring the most efficient use of the waters of the Basin.
3. To monitor the execution of studies and works in the basin and to keep member States informed.
4. To draw up common rules regarding navigation and transport.
5. To draw up staff regulations and to ensure their application.
6. To examine complaints and to promote the settlement of disputes.

6.9.3 Vision

The Lake Chad Region would like to see by the year 2025

1. The Lake Chad – common heritage – and other wetlands maintained at sustainable levels to ensure the economic security of the freshwater ecosystem resources, sustained biodiversity and aquatic resources of the basin, the use of which should be equitable to serve the needs of the population of the basin thereby reducing the poverty level.
2. A Lake Chad Region where the regional and national authorities accept responsibilities for freshwater, ecosystem and biodiversity conservation and judicious integrated river basin management to achieve sustainable development.
3. A Lake Chad Region where every Member States has equitable access to safe and adequate water resources to meet its needs and rights and maintain its freshwater, ecosystem and biodiversity resources.

6.10 Organization and Fundamental Principles

The commission consists of **t**hree organs and each of the organs are discussed:

1. The Summit of Heads of State

Highest decision-making and advisory organ of the Commission. It meets once every year in an ordinary conference. Summits held since the inception of LCBC:

1. Fort-Lamy (Chad) 5-6 July 1972;
2. Yaounde (Cameroon) 3-4 December 1973;
3. Enugu (Nigeria) 1-3 December 1977;
4. Lagos (Nigeria) 21-22 April 1983;
5. Lagos (Nigeria) 29 April 1985.
6. N'Djamena (Chad) 28-29 October 1987;
7. Yaounde (Cameroon) 13-14 February 1990;
8. Abuja (Nigeria) 21-23 March 1994;
9. N'Djamena (Chad) 30-31 October 1996;
10. N'Djamena (Chad) 28 July 2000;
11. Abuja (Nigeria) 30 June 2005;
12. Abuja (Nigeria) 27 March 2008.
13. N'Djamena (Chad) 1st November 2010;
14. N'Djamena (Chad) 30 April 2012;

2. The Council of Ministers

It is an organ responsible for the supervision and control of the Commission. It meets once a year in an ordinary session to adopt the budget and annual action programme of the Commission. The Council of Ministers is made up of two Commissioners per Member State.

3. The Executive Secretariat

It is the organ which executes the decisions and resolutions of the Summit of Heads of State and the Council of Ministers. The last reform adopted in two stages (June 2008 and May 2009) has resulted in a new organization whose work sits on the following guiding principles:

Inclusiveness:

1. Acknowledge the interests of member States and those of other stakeholders to the international, national and community level and find a good balance between them;
2. Respect the principles of good governance.

Competence:

1. Offering high quality products produced with the greatest scientific and academic rigour;
2. Having appropriate skills and means for an international organisation;
3. Applying international, financial, administrative rules and procedures.

Efficiency:

1. Carrying out its mandate and rendering pertinent and useful services.

Performance:

1. Managing talents and resources in an ambitious, economic and ecological manner;
2. Planning and controlling all actions at the level of policy, project and operational processes.

Flexibility:

1. Anticipating the evolution of the Basin and knowing how to respond to emergency situations.

Co-operating in order to render the capacities of the organisation more flexible.The organization chart of the Lake Chad basin commission is presented below.

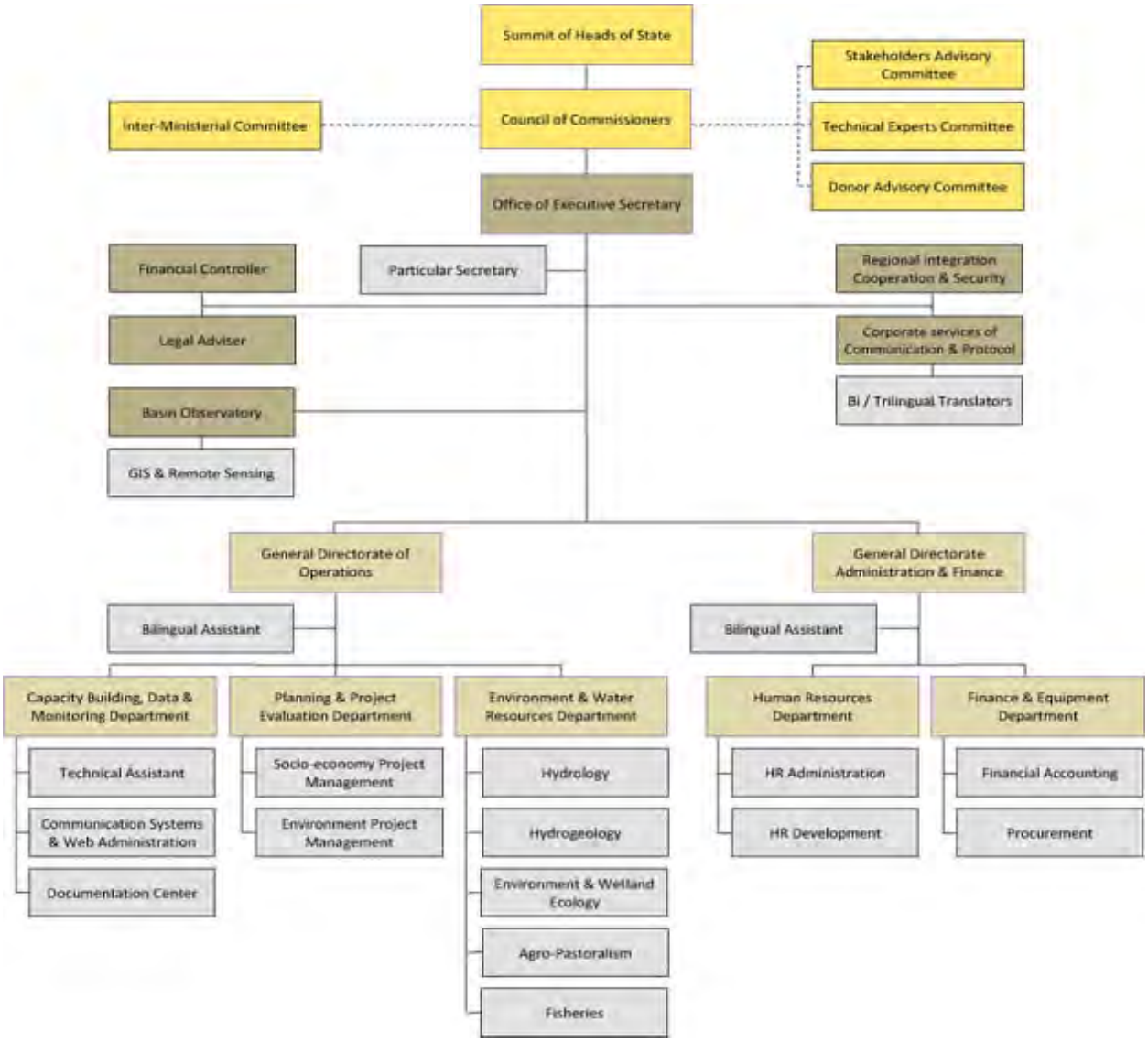

Figure 6.1: Organization Chart of the Lake Chad Basin Commission

6.11 Past Projects on Lake Chad Basin

6.11.1 Diagnostic Study of Environmental Degradation in the LakeChad Conventional Basin 1989

The study was undertaken by specialist consultants in cooperationwith LCBC member States with funding and support from UNEP.The study gave a synopsis of environmental degradation in thediagnostic basins of the Lake Chad Basin. The goals of the reportwere to identify the symptoms, causes, and also to set priorities forstrategic action. In November 1989, a report was submitted to theEnvironmental Ministers of the LCBC member States with a numberof

recommendations (Kindler et al. 1990). The diagnostic studyidentified causes of environmental degradation and recognized defining "type years" according to rainfall, channel flow, lake levelsand flooding as a necessity for a flexible development policy whichcan adjust rapidly to water supply changes.

The study recommended:

(i) Integration of irrigated cropping with food storage and famine prevention programmes;

(ii) Improving water and soil conservation through incorporation of tree regeneration, forage production and other agro-forestry techniques in irrigated agriculture;

(iii) Imposing a moratorium on large-scale water projects;

(iv) Undertaking a review of existing water projects;

(v) Correcting the environmental impact of specific projects to downstream and floodplain users; and

(vi) According priorities to downstream users (fishery, recession agriculture, pasture, groundwater recharge) and to multiple use of wetlands (wildlife, tourism and economic production).

6.11.2 Master Plan for the Development and Environmentally Sound Management of the Natural Resources of the Lake Chad Conventional Basin 1992

The Master Plan, compiled in cooperation with UNEP, UNSO, NationalExperts, the LCBC Secretariat and Consultants, was drawn up on thebasis of the recommendations of the Diagnostic Study. The MasterPlan supplemented by a programme of action for sustainableagricultural development was prepared with the assistance of the FAO**.** A prioritized Master Plan was produced from these two documents, for the environmentally sound management and development of the conventional basin. The document consists of 36 projects relating to water resources, agriculture, forestry, biodiversity management, and livestock and fishery development within the Lake Chad Basin.

6.11.3 Decision Support System Project

The Decision Support System Project (DSS) funded by UNEP withcontributions from the LCBC in 1995 was intended to support theimplementation of the Master Plan. Expected outputs were a

DSS anda donors' conference. The donor conference was not undertaken asthe Planning Committee decided on first preparing a Strategic Action Plan.

6.11.4 Planning and Management of Water Resources of the Lake Chad RAF/88/029, 1990-1993

A project financed by UNDP. Objectives included the evaluation of waterresources, strengthening of data collection and management, modelsimulations, formulation and evaluation of development strategies. Theoutcomes from this project were incorporated in the Master Plan andeventually the Strategic Action Plan.Monitoring and Management of Groundwater Resources in theLake Chad Basin 1992-1993Financed by the French Cooperation under convention No98/C88/ITEand executed by the consultancy firm BRGM. The objective of the projectwas to provide the LCBC with a groundwater resource managementmodel. Insufficient funds resulted in the development of only a premodel.The project provided remarks and recommendations for thegroundwater resources in the Lake Chad Basin, and also identified gapsin knowledge.

6.11.5 Lake Chad Basin PDF-B Strategic Action Plan 1998

Integrated and sustainable management of the international waters ofthe Lake Chad Basin: A Strategic Action Plan (SAP) was initiated in 1996following a request from the LCBC made to the GEF (LCBC 1998). Thepreparation of the SAP facilitated by the United Nations Departmentresponsible for Economic and Social Affairs (UNO-DESA) was supervised,corrected and validated by member States and by LCBC specialists. Theobjective of the SAP was to prepare a regional framework for protectingthe environment and for the sustainable use of the various resourcesthroughout the Lake Chad Basin.

6.11.6 UNESCO-BMZ Management of Ground-Water Resources for Sustainable Development of the Lake Chad Basin

Within the framework of UNESCO International HydrologicalProgramme (IHP) particularly its project on "Humid Tropical Zones"and the implementation of LCBC's Master Plan for the Developmentand Environmentally Sound Management of the Conventional LakeChad Basin, implementation of the above project commenced in1997. UNESCO implements the project which is funded by the GermanMinistry for Economic Co-operation and Development (BMZ). It has thefollowing objectives (UNESCO 1997):

(i) Knowledge and quantificationof the recharge and reserve of the underlying aquifers underthree different climatic scenarios of humid, medium and dry years;

(ii) Evaluation of aquifer recharge from floodplains and surface water;

(iii) Proposal of regulatory issues for aquifer protection;

(iv) Proposalof management systems for the quaternary and continental terminalaquifers through the development of a flow simulation model for thethree different climatic scenarios;

(v) Improvement of the efficiency ofnational agencies for coordinating the development actions throughpurchased equipment, trained staff, data base and computer simulation;and

(vi) Contribution to the implementation of the LCBC Master Plan.The project prepared a hydro-geological synthesis report at the end of1997 that highlighted data gaps and information that would need to beupdated during the project execution. The final hydro-geologic reportincorporating all data and analysis done by the project, including thegroundwater model developed, is being awaited.

6.11.7 GEF/UNDP and World Bank Project: Reversal of Land and WaterDegradation Trends in the Lake Chad Basin Ecosystem

GEF initiated a project brief, as well as the SAP. On the basis of the brief 10 million USD was designated for this project. “The developmentobjective is to build capacity within the Lake Chad Basin Commission (LCBC) and its national committees so that it can better achieveits mandate of managing land and water resources in the greaterconventional basin of Lake Chad”. A Transboundary Diagnostic Analysisand Strategic Action Programmeare currently being initiated (World Bank Project Appraisal Document, 2002a).

6.11.8 Sustainable Development of Continental Fisheries - A Regional Study of Policy Options and Policy Formulation Mechanisms for the Lake Chad Basin EU-INCO Project 1999-2003

Funded by the European Union, the EU-INCO project is a collaborationof both African and European research teams. The project was operatedover three years and included a full range of research, knowledgedissemination and capacity-building activities(Neiland & Béne 2003).

6.11.9 Promotion of the Use of Renewable Energy Resources and Conservation of Flora Species in the Dry Lands of Mega Chad of the West African sub-Region, 2001-2004

The community-based project covers four countries namely Chad, Cameroon, Niger and Nigeria. The project focuses on measures toaddress loss of biodiversity due to habitat loss as a result of uncontrolledexploitation of vegetal resources, with its negative implications onclimate change; and, increasing rate of land degradation, whichexacerbates the poverty condition of the inhabitants. Pilot projectsinclude: training and implementation of renewable energy and waterconservation technologies, establishment of woodlots of threatenedspecies of community value, and youth and environmental clubs.

6.12 Senegal River

The OMVS is a robust regional organization whose financial stability allows it to focus on pursuing technically feasible and politically supported projects agreed upon by its member countries. The OMVS has the full support of its member countries as its regional mission goals of increasing food security, producing energy, reducing poverty, and promoting the free movement of goods and services are in perfect alignment with the policies of its member countries.

Despite geopolitical turmoil in the sub-region, the OMVS has always managed to assert its role as a cooperative management organization that facilitates benefits sharing of this important resource to all it members.In the 1980s, a dynamic partnership was established between the OMVS and the World Bank. The latter contributed in particular to strengthening subregional integration by supporting Guinea's inclusion. The Bank also supported the modernization and adaptation of OMVS entities and promoted the sustainable management of water resources with the goal of reducing endemic poverty in the basin. Through programs such as the Senegal River Basin Multi-Purpose Water Resources Development Project (PGIRE), the World Bank has helped the OMVS enhance the development of transboundary waters, cross-border malaria prevention, and the development of hydroelectric generation. Activities during the first phase of the project helped improve communities' livelihoods through irrigation, fishing development, and agro-forestry, helping to create over 18,000 new jobs and boosting considerably the revenue for stakeholders in the fishing and agriculture subsectors.

In Senegal region, the programmes are concentrated on Matan (700km from Dakar) and Kanel (720km from Dakar). The activitiesundertaken in management of the Senegal Basin fisheries include; formation of fishermen and women cooperatives, Procurement of fishing equipments / inputs for fisherfolks, Construction of fish market in Sadel and Odobere, Recruitment of consultants to carry out fish stock assessment in Matan and Kanel. In Senegal, fisheries sector is guided by laws and different reforms.

1. The major planification tool for inland fisheries is the National Action Plan of inland fisheries (2006) produced from an exhaustive diagnostic of the sub sector.
2. The National Environmental Plan was instituted to take care of the link between environment issues and the sustainability of fisheries due to the necessity to take into account environnemental aspects, in terms of conservation and protection of aquatic ecosystems.
3. The fisheries and aquaculture department policy letter (2007) : Governmental document in which the major strategies to develop fisheries have been setted up for the next coming years.
4. The Sénégal Emergent Plan (2013) : The reference of all the economical and social governmental policies for the emergence of Sénégal through the coming 20 years

6.12.1 The Legal Framework Regulating Senegalese Fisheries

The legal backing for the Senegal fisheries is the 1998 *Code de la Pêche* (Fisheries Act). In the same vein to its 1976 and 1978 predecessors, this Act states that *"the right to fish in waters under Senegalese jurisdiction belongs to the State which may grant this right to physical or moral persons of Senegalese or foreign nationality. The management of fish resources is the prerogative of the State. For this purpose, the State defines a policy to protect and conserve these resources, and to ensure their sustainable use in order to preserve the marine ecosystem."* Furthermore it stipulates that fish resources under Senegalese jurisdiction constitute a *"national heritage"*. In other words, fish resources present in the Senegalese EEZ belong to the Senegalese People as a whole but the State is the custodian of these resources and has the duty to manage them sustainably, namely for food security, and income generation for current and future generations. Thus, the State is responsible for organizing the sustainable conservation of these resources, the

development of rights for the users, as well as their monitoring. From these perspectives, it can be understood that less emphasy is placed on inland Basins fisheries.

To perform its regulatory roles and manage the country's fisheries, the State through *the Ministère de l'Economie Maritime, Transports maritimes, de la Pêche et de la Pisciculture (MEM)* relies on seven technical departments:

1. The Directorate of Marine Fisheries (*Direction des Pêches Maritimes, DPM*),
2. The Directorate of fish processing industries (*Direction des industries de transformation de la pêche, DITP*),
3. The Directorate for protection and surveillance of fisheries (*Direction de la Protection et de la Surveillance des Pêches, DPSP*),
4. The Department of inland fisheries (*Direction de la pêche continentale, DPC*),
5. The Department of Community Areas (*Direction des Aires Communautaires, DAC*),
6. The Department of Merchant Marine (*Direction de la marine marchande, DMM*),
7. The Office of management and exploitation of seabed (*Direction de la gestion et de l'exploitation de fonds marins, DGEFM*).

The institutions of interest in this study are:

1. The Directorate of Marine Fisheries (*Direction des Pêches Maritimes, DPM*): The main missions of the Directorate of Marine Fisheries are:

(i) To design and implement the state policies in respect of marine fisheries; and

(ii) To manage the fisheries in accordance with these policies. The *Code de la Pêche* together with the *Lettre de Politique Sectorielle (LPS)* and the *Stratégie de Croissance Accélérée* (SCA, Accelerated Growth Strategy) provide the key strategic orientations by setting the legal, sectoral and macroeconomic framework for the policies undertaken by the DPM.

2. The Centre for Planning (*Cellule d'Etudes et de Planification, CEP*): created in 2000, the CEP's major role is to contribute to the elaboration of prospective and strategic programs consistent with the country's strategies while the DPM is in charge of the actual implementation of the programs. It is also responsible:

(i) For undertaking impact assessment of macroeconomic policies in the fisheries sector;

(ii) For preparing the sector's public investment budgets, and

(iii) For publishing economic information and statistics.

3. The Directorate for Protection and Surveillance of Fisheries (*Direction de la Protection et de la Surveillance des Pêches, DPSP*): its mission is to ensure the protection and surveillance of the EEZ and compliance of fishing regulations.

The sector also benefits from the scientific support of the Centre for Oceanographic Research of Dakar-Thiaroye (*Centre de Recherches Océanographiques de Dakar-Thiaroye, CRODT*). This national institute for fisheries research is responsible for monitoring fisheries and fish stocks. It is supposed to play an important role in the preparation of fishery management plans and in supporting the Ministry of Marine Economy in the formulation of policies and decisions on fisheries through the elaboration of strong research programmes. However, a number of observers note that the CRODT is currently unable to fulfill its missions namely due to its lack of funding caused by the suspension of the protocol of the fisheries agreement with the European Union as it was largely financed through the financial contribution provided by that agreement.

The provisions of the Code *de facto* deny local authorities the prerogatives of managing fish resources. Like many former French colonies, the Senegalese State inherited a highly centralized administration that concentrates all powers regarding the management of natural resources. It is only with the slow process of decentralization, which reached its climax in 1996, that a system of local management of natural resources has been recognized. Although a number of prerogatives regarding natural resource management have been devolved to Local Governments, competence in fisheries management has not been transferred by the State administration. Fifteen (15) Fisheries policies are elaborated and implemented based on a top down approach where the directives emanate from the central administration in Dakar and are brought down to the stakeholders with little or no consultation. Thus, fishers' communities tend to be alienated from the state because of the lack of consultation regarding decisions affecting directly their livelihood.

6.12.2 Senegal Management Policy

New orientations for development have been setted up through the National Inland Fisheries development Action Plan (PNDPC). The following are the objectives of the strategies:

Objectives of the Management Strategies

1. To restaure degradated inland fisheries resources ans wetlands, and manage them in a sustainable way.
2. To improve fish processing level and meet fish products demand.
3. To strengthen capacity of Inland fisheries administration and actors.
1. To improve and mordernize production means (artisanal boats, nets, ..)
2. To improve the financial system to allow fishing professionnals funding.
3. To promote sub régionale, régionale et internationale coopération in terms of inland fisheries.

Perspectives to Development of Guidelines for Management Policies

1. Review obsolete Inland fisheries laws.
2. Harmonization of laws relevant to inland fisheries for shared resources.
3. Carry out Inland fisheries ressources assessment studies.
4. Set up an information system on inland fisheries for the follow up.
5. Stock enhancement of inland waters.
6. Gorvernance improvement of the sub sector/ renew local fish Counsels in all the continental provinces and reinforce their intervention capacity.
7. Improvement of technical et managérial skills of professionnals.
8. Boat/ Canoes Immatriculation programme in continental areas.
9. Building basical infrastructures such as artisanal fish processing areas, fish markets, etc.
10. Strengthen fishery offices and centers (training, équipement and logistics).

CHAPTER SEVEN

CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusion

Despite its high potential, inland fisheries is still not developped, compared to the marine sector, due to ecological and socio economic context such as droughts, climate changes, poverty. The publics policies are conformed with the actuel diagnostic and are aware of the challenges of the sub sector; However, they are faced with funding, legislative and logistics challenges. Therefore, it is necessary to improve the institutional and legal framework of the sector.

7.2 Recommendations

The following actions are recommended in order to sustainably improve the deliverable of the inland water basins.

7.2.1 Management of the Basins

The AU-IBAR should facilitate creation of partnership / collaborations and networks for:

1. Information exchange through regional workshops and training in member countries;
2. Manpower development and provision of technical assistance for stakeholders in fisheries sector in member countries;
3. Mitigate against the impacts of insurgency and climate change in member countries;
4. Policy formulation on regional social and management issues as it relate to the member countries;
5. Strategic plans must be developed for the management of the Basin;
6. Women should be trained for improved participation in fisheries sector and modern technology for fish processing and input supplies;
7. Encourage community fishing management.

7.2.2 Policies and Legal Frameworks -Entry Points for AU-IBAR Intervention on the Three River Basins

Due to the observed gaps, interventions will be needed in the following areas:

1. Interventions through training, capacity building and equipment provision, towards the improvement of the Internet Communication Technology (ICT) capacity and facilities for the Lake Chad Basin, River Senegal and Niger Basins;
2. Assistance in the harmonization and coordination of the Policies, Legislations and Management and Action Plans in the three Regional Water Bodies;
3. Technical support in terms of Data Collection, Stock Assessment, Fisheries Management and Fisheries Law Enforcement capacity;
4. Strengthening security through support and provision of equipment and training of relevant Agencies to beef up security of lives and property of stakeholders in the three Regional Water Basins;
5. There is need for interventions in reduction of post-harvest fish losses in the three regional water bodies through capacity building in fish handling, processing and storage, as well as provision of facilities and equipment;
6. Intervention should also include improvement of access roads to fishing sites by fisheries stakeholders.

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APPENDIX I

Summary of Work Schedule

S/N	ACTIVITY	LOCATION	DURATION (Days)	DATES
1	Inception Phase		5	27 May -1 June, 2015
2	Field Phase (Field visit to selected sites and desk consultation for others)	LCBC- République du Tchad NBA – Niamey, Niger OMVS –Dakar, Senegal	6	2 – 7 June, 2015
3	Synthetic Phase 1. Revision and Analysis of Documents 2. Diagnostic Analyses of Trans-boundary issues in the shared water bodies 3. Production of final draft documents		11 11 11	8 – 18 June, 2015 19 – 29 June, 2015 30 June – 10 July, 2015
4	Compilation of the required reports as outlined		5	11 – 15 July, 2015
TOTAL (duration)			**49**	