Mano River Ecosystem Conservation and International Water Resources Management (IWRM) Project

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TRANSBOUNDARY DIAGNOSTIC ANALYSIS OF PRIORITY BASINS

Great and Little Scarcies, Moa-Makono and Cavally Rivers

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REGIONAL SYNTHESIS

Final definitive report

– 23/08/2022

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

AECOM	:	Consulting company/firm (USA)
AfDB	:	African Development Bank
AGEE	:	*Agence Guinéenne d'Evaluation Environnementale* (Guinean agency for environmental ebaluations)
ANDE	:	*Agence Nationale de l'Environnement (Côte d'Ivoire)*
ARHS/RASS	:	Annual Report on the Health Status (Cote d'Ivoire)
BRGM	:	French Geological and Mining Research Center
CBD	:	Convention on Biological Diversity
CEGENS	:	Centre de Gestion de l'Environnement des Monts Nimba -Simandou (Guinée)
CEMMATS GROUP LTD	:	Consultancy Company / Firm, Sierra Leone
CEPF	:	Critical Ecosystem Partnership Fund
CIAPOL	:	Centre Ivoirien Antipollution
CILSS	:	Interstate Committee for Drought Control in the Sahel
CITES	:	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CIWA	:	Cooperation in International Waters in Africa (World Bank Program)
CRC	:	Cavalla Rubber Company, Liberia (Private Company)
D4D	:	Diamond for Development (International Alert Program)
DACDF	:	Diamond Area Community Development Fund
DEL	:	Mining Development License
DOP	:	Duru Oil Pam - Sierra Leone)
DPDDA	:	Proprietary Rights and Artisanal Diamond Development (USAID Project)
ECOWAS	:	Economic Community of West African States
ECREEE	:	Regional Center for Renewable Energies and Energy Efficiency (ECOWAS)
EDF	:	Electricity of France (Company)
ELEP	:	Light Survey for the Evaluation of Poverty (Guinea)
EP/PR	:	Exploration Permit (mining)
EPA -SL	:	Environmental Protection Agency - Sierra Leone
EROS	:	Earth Resources Observation and Science Center (USA)
ESIA/ EIES	:	Environmental and Social Impact Assessment
FAO	:	Food and Agriculture Organization of the United Nations
FAO-AQUASTAT	:	FAO-Global Water Information System for Water and Agriculture
FMC	:	Forest Management Contract (Liberia)
FNDE	:	Fonds National de l'Environnement (Côte d'Ivoire)
GCM	:	General Circulation Models
GDP	:	Gross Domestic Product
GEF	:	Global Environment Facility / Global Environmental fund
GIZ	:	German Development Cooperation Agency
GKNP	:	Grebo-Krahn National Park (Liberia)
GRNP	:	Gola Rainforest National Park (Sierra Leone)
GVL	:	Golden Verodium Liberia (Private Company)

Ha	:	Hectare
HDI	:	Human Development Index
ICZ	:	Intertropical Convergence Zone
IMF	:	International Monetary Fund
INDC	:	Intended Nationally Determined Contribution
INDUSBOIS	:	Private company, Cote d'Ivoire
IPCC/GIEC	:	Groupe d'experts intergouvernemental sur l'évolution du climat */Intergovernmental Panel on Climate Change*
IPBES	:	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IUCN	:	International Union for Conservation of Nature
IWMI	:	International Water Management Institute
JICA	:	Japan International Cooperation Agency
KBA	:	Key Biodiversity Area
LAMCO	:	Liberia-American-Swedish Mining Company
LHS	:	Liberian Hydrological Service
LISGIS	:	Liberia Institute of Statistics and Geo-Information Services
LWSC	:	Liberia Water and Sewer Corporation
MDA	:	Mining Development Agreement _
MDG	:	Millennium Development Goals
MEL	:	Mining Exploration License
MICS	:	Multiple Indicator Cluster Surveys
MOPP	:	Maryland Oil Palm Plantation, Liberia (Private Company)
MRU	:	Mano River Union
MRU / UFM	:	Mano River Union
MSHP	:	Ministry of Health and Public Hygiene (Cote d'Ivoire)
MW	:	Megawatt
NAFAA	:	National Fisheries and Aquaculture Authority (Liberia)
NAPA / PANA	:	National Adaptation Programme of Action / Programmne d'Action National d'Adaptation (Climate change)
NBA	:	Niger Basin Authority
NDC /CDN	:	Nationally Determined Contributions (changement climatique / Contributions déterminées au niveau national /
NDH	:	National Directorate of Hydraulics (Guinea)
NSI	:	National Institute of Statistics, Guinea
NSI/INS-CI	:	National Institute of Statistics, Cote d'Ivoire
NTP	:	Tai National Park (Cote d'Ivoire)
NWASH	:	National Water, Sanitation and Hygiene Commission (Liberia)
OIPR/IOPR	:	Ivorian Office of Parks and Reserves
OMVS	:	Organisation pour la Mise en Valeur du Fleuve Sénégal
ONAD	:	Office National de l'Assainissement et du Drainage (Côte d'Ivoire)
ONEP	:	Office Nationale de l'Eau Potable (Côte d'Ivoire)
ORSTOM	:	Office for Scientific and Technical Research Overseas
PALMCI	:	Private company (Cote d'Ivoire)
PTEP	:	Priority Transboundary Environmental Problem

RG- TDA	:	TDA-Stakeholder Analysis Report Republic of Guinea (within the framework of the TDA /Guinea)
RSPO	:	Roundtable on Sustainable Palm Oil _
SA	:	Public limited company
SAP	:	Strategic Action Plan
SARL	:	Société Anonyme Limited Liability
SDG	:	Sustainable Development Goal
SFF	:	Société Foret Forte, Guinea (Private company)
SMFG	:	Guinea Iron Mines Company
SMI	:	Société des Mines (Company, Cote d'Ivoire)
SNP	:	Sapao National Park (Liberia)
SODECI	:	Cote d'Ivoire Water Distribution Company
SODEFOR	:	Forest Development Company (Cote d'Ivoire)
SOFRELEC	:	Private company /firm
SP	:	Sub-Prefecture (Guinea)
SRG	:	SAMA Resources Guinea (Private company)
SSL	:	Statistics Sierra Leone
TDA	:	Transboundary Diagnostic Analysis
TDA -CI	:	Border Diagnostic Analysis - Cote d'Ivoire (Report)
TDA -GR	:	Border Diagnostic Analysis - Guinea (Report)
TDA-LIB	:	Transboundary Diagnostic Analysis - Liberia (Report)
TDA-SL	:	Transboundary Diagnostic Analysis - Sierra Leone (Report)
UN	:	United Nations
UN	:	United Nations
UNDP	:	United Nations Development Program _
UNEP	:	United Nations Environment Program
UNESCO	:	United Nations Educational, Scientific and Cultural Organization
UNFCCC	:	United Nations Framework Convention on Climate Change
UNSO	:	United National Sudano - Sahelian Office
US / USA	:	United States of America
USAID	:	United States Agency for International Development
USD	:	Dollar ((USA)
WABICC	:	West Africa Biodiversity and Climate Change (Program, USAID)
WAPP	:	West Africa Power Pool (ECOWAS Specialized Institution)
WCMC (UNEP)	:	World Conservation Monitoring Center (UNEP)
WHC	:	World Heritage Center (UNESCO)
WHO	:	World Health Organization
WRCC	:	ECOWAS Water Resources Coordination Center
WRI	:	World Resources Institute (USA)

EXECUTIVE SUMMARY

The Mano River Union (MRU) is a regional economic integration organization made up of four member countries: Cote d'Ivoire, Guinea, Liberia and Sierra Leone. MRU covers an area of 751,000 km2 and has a population of 52 million. The MRU space has impressive natural resources - water, forestry and mining. The availability of renewable freshwater per capita in the MRU area –(13.409m2) is triple of the African average (3.699m2) and double the world average (5.732 m2). The member countries of the MRU are also well endowed with raw materials, including mineral resources (bauxite, iron, gold, diamonds, etc.). This mining potential is a major asset in the fight against poverty, job creation and sustained economic growth.

But the MRU area today faces many challenges for the conservation and development and sustainable management of these resources. The transboundary diagnostic analysis process - conducted within the framework of the IUCN-GEF Ecosystem Conservation and Integrated Water Resources Management Project of the Mano River Union - provided the opportunity to identify and analyze the socio-environmental problems and threats which are highly prominent in the MRU Area, and in particular in the three river basins which are primarily targeted within the framework of the GEF Project. This are the complexes of the Scarcies Basins (Great Scarcies or Kolente and Litte Scarcies or Kaba), the Moa-Makona Basin and the Cavally Basin.

Transboundary Diagnostic Analysis (TDA) is a process of technical study and diagnosis of the state of the environment and shared water resources as well as identification and analysis of threats to the basin ecosystem and the socio-economic and environmental conditions of the human populations that depend on it. The peculiarity of the TDA of the MRU area is that it relates not to one but to three transboundary hydrographic basins, one of which, the Scarcies is comprises of two contiguous basins sharing the same water source.

The TDA process included several phases, which sometimes overlapped: (a) a phase of stakeholder identification for the TDA-SAP process and their capacity building needs - studies having been carried out in each of the four countries members of the MRU; (b) a training phase for stakeholders and national consultants on the purpose and methodology of the TDA and SAP processes through face-to-face national workshops and an online workshop with national consultants; (c) a phase of formulating national contributions to the TDA process - each of the four national contributions having been prepared by a team of consultants; (d) a regional synthesis phase of TDA. This synthesis, of which this document is the product, was based on the results of the aforementioned phases, and in particular on the national reports on the mapping of actors and the assessment of their training needs and on the national contribution reports to the TDA. The regional synthesis, conducted by a team of regional consultants, also consisted of undertaking an extensive review of several documents and visiting each of the member countries as well as the national portions of the target basins for direct observations and interviews with representatives of the communities and national officials and experts from different sectors of the society.

The regional synthesis places particular emphasis on studying the state of water resources and the biophysical environment in each of the targeted basins as well as the socio-economic profile and use of natural resources. For each basin, threats to the health of ecosystems and to the use of resources were identified and analyzed.

During a period of rapid assessment of the basins, nine major transboundary environmental problems were identified. These are: (1) loss of biodiversity; (2) Deforestation; (3) degradation of mangroves and

estuarine ecosystems; (4) degradation of water quality; (5) climate variability and change; (6) water-related diseases; (7) changes in river morphology - bank erosion; (8) invasive aquatic plants; (9) erosion, degradation of soils and head sources of rivers.

These issues were then prioritized by applying criteria such as: the impact of the issue under consideration on ecosystems; socio-economic impacts; the problem's interaction with other problems and / or its effect of amplifying impacts on other problems; the transboundary dimension; the level of generality of the problem (i.e. whether the problem arose in the other basins).

Under the application of the selected criteria and the classification of the major problems inventorise, the following four (4) appear as priorities: (1) Deforestation ;(2) degradation of water quality; (3) loss of biodiversity and, (4) soil erosion and changes in river hydrodynamics.

Deforestation. Deforestation concerns the loss of forest areas and / or the degradation of existing forests. Loss of trees is also a process that leads to overlall forest loss if it is not accompanied by compensatory reforestation actions. The MRU space is subject to an intense process of deforestation. Forests are declining twice as fast as on the continental scale. More worryingly, the rate of deforestation is increasing rapidly, accelerating dramatically over the past decade. Deforestation consequences include loss of habitat for biodiversity, the agricultural expansion and the practice of extensive slash-and-burn agriculture and mining. This results in the loss of biodiversity habitats, the acceleration of erosion, the degradation of forest ecosystem services as well as negative impacts on local incomes (which depend on the exploitation of non-timber forest products), health and nutritional status of local populations. In response to the deforestation process, the following solution options could be considered:

- Identify and classify as protected areas (classified forests, national parks, nature reserves) the residual primary forests and those which perform functions and provide first-class ecological services.
- Undertake reforestation and re-afforestation activities while reforesting degraded forests
- Limit the need to convert forests into cropland by promoting sustainable agriculture practices
- Promote employment and income-generating activities that can be viable alternatives to unsustainable logging and informal and clandestine mining
- Ensure rigorous regulation of forest harvesting and rigorous supervision to ensure compliance with the conditions for granting timber harvesting permits
- Supervise mining activities while preserving protected areas, primary forests and forest ecosystems of particular interest.

The degradation of water quality. It refers to the alteration of the chemical, physical and biological characteristics of water resulting from the uses of the resource: human or animal consumption of water, use of water in agriculture, mining, industry, etc. There is a significant knowledge gap on this issue. Nevertheless, there are various indications and testimonies, which attest to the degradation of water quality in the three target basins. In different reaches of basins in focus, local populations deplore the degradation of surface water quality. This is confirmed by microbiological analyzes carried out in the Cavally, which show that the waters of this river do not meet the quality standards accepted by the WHO. The main causes of water quality degradation are: mining activities (excavation and accumulation of soil, ore mining, use of mercury and cyanide, etc.); drainage to rivers or the infiltration of water contaminated with chemical fertilizers and pesticides used in agriculture. Contamination of surface and groundwater leads to the degradation of ecosystems with implications for animal and human health. It contributes to the degradation of the productivity of agricultural land. Water pollution affects ichthyological fauna, which, combined with the effects of the degradation of water

quality on land productivity and on livestock, has negative effects on the livelihoods of the populations of the MRU area. Some solution options to these problems include:

- Implement information and awareness-raising activities for populations, and for miners, about good practices to minimize the damage caused by mining to the environment, ecosystems and water resources (eg alternatives to mining) and mercury amalgamation);
- Ensure the best management of waste dusts to prevent mercury or cyanide from contaminating ecosystems, and surface and groundwater;
- Promote agroforestry and improvement of agricultural irrigation and drainage systems;
- Ensure the operationalization and implementation at national and regional levels of the relevant provisions of the Stockholm conventions on Persistent Organic Pollutants and the Minamata conventions on mercury.

Loss of Biodiversity: This concerns the decrease in and the loss of the diversity and the variability of living organisms, terrestrial, marine and aquatic ecosystems. The manifestations of loss of biological diversity in the MRU area and the target basins are numerous. Various reports indicate a decrease in fish catches, probably resulting from the decline in fish stocks in the rivers of the target basins. In the Cavally Basin for example, the Mount Nimba Nature Reserve (Guinea and Cote d'Ivoire) was listed in 1992 onto the list of world heritage in danger. The Liberian part of the same ecosystem as well as the parks of Taï (Cote d'Ivoire), Grebo-Krahn and Sapo (Liberia) face many threats. Causes of biodiversity loss include: Deforestation and habita destruction, which does not affect protected areas; the expansion of agriculture (extensive, irrigated, plantation) as well as the massive use of chemical fertilizers and pesticides; mining (soil erosion, water degradation, etc.); poaching; bush fires; opening up of new road infrastructure; logging; unsustainable fishing (overfishing, small mesh fishing nets). Among the existing or potential consequences of the loss of biodiversity are: the general degradation of the conservation status of flora and fauna in the Guinean Forests Hotspot of West Africa; lower resilience of ecosystems which become more vulnerable in a context of climate change; negative impacts on the food and nutritional security of the populations. Possible solution options include:

- Ensure better conservation and sustainable management of existing protected areas through the implementation of sustainable management plans.
- Identify and classify as protected areas ecosystems sheltering a rich biodiversity or forming part of the last refuges for rare or threatened species
- Ensure the identification and designating on the list of Ramsar sites of wetlands which have or may be of international importance from an ecological, economic, cultural and scientific point of view
- Ensure the effective implementation at national and regional levels (MRU) of the relevant provisions of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora)
- Ensure the establishment of an early warning system against the introduction and proliferation of invasive animal and plant species such as the water hyacinth that is present in the Sassandra Basin (near Cavally)

Erosion, degradation of land, banks and source of water: Land degradation concerns the reduction or disappearance of biological or economic productivity and of agricultural land, livestock ranges, forests or wooded areas in general. The entire MRU area and in particular the target basins of the MRU are confronted with land degradation: active and abandoned mining sites, extensive cultivation areas, some of the river sources and their tributaries, the banks of some of the dams of the main rivers. Some of the reasons for the main causes of erosion and land degradation are: extensive agriculture which, as a result of the population pressure leading to more needs for more land, therefore more clearing of

new land and less fallow time; the increase in the number of livestock, leading to overgrazing, with the negative effects of which are accentuated by the practice of bush burning and cutting of trees; deforestation and logging of trees (which is itself one of the main environmental problems of the MRU area); mining which takes place in a lawless and unregulated way in several regions of the MRU area.

Among the many consequences of land degradation are the following: destruction of habitats of flora and fauna and ecosystems of high value; decline in primary and agricultural land productivity which negatively affects the food security of populations; pollution of water from increase in their solid load. Possible solution options include:

- Promote agroforestry with the aim os sustainably increasing agricultural yields and hence reverse or slow-down land degradation related toextensive slash-and-burn agriculture
- Develop and implement restoration and rehabilitation plans for the most degraded water sources
- Ensure the identification and mapping of the banks most exposed to erosion and implement actions for the restoration and stabilization of the banks
- Implement reforestation, re-afforestation and regeneration activities for soils most exposed to erosion
- Ensure the adoption and promotion of soil and water management techniques (bunds, stone bunds, hill dams) on degraded lands on the sides of mountains and hills and plateaus

Alongside the above priority problems, the TDA identifies cross-cutting themes of strategic interest for the protection and sustainable management of the resources of the MRU space. The first relatates to climate change. Although there are marked differences in climate projections for the MRU space, all studies converge on the conclusion that the future climate will be different from that of the past, with amplied annual and inter-annual variability of rainfall and river discharge as well as higher frequency and magnitude of extreme events. The changing context and associated uncertainties will require strengthened adaptative capacities and resilience by humans, production systems and natural ecosystems. The second theme of interest is the misunderstandings and disputes noted between States of transboundary rivers about the drawing of borders and the control of the resources associated with these rivers or located in their watersheds. The third theme cross-cullting theme relates to the gender dimension and the need to ensure greater equity in access to resources for men and women, combined with the empowerment of the latter.

The MRU has an important role to play, in support of its member states, to ensure the sustainable, equitable, collaborative and peaceful management of the vast natural resources available to the MRU area. It also assumes that the challenges and threats highlighted in this TDA - particularly in the four priority areas identified as well as the cross-cutting thematic issues- are effectively addressed. The TDA recommended these options as measures - far from being exhaustive - which, during the formulation phase of the Strategic Action Plan (SAP) should be analyzed in more detail and compared with other options, in order to '' arrive at a portfolio of consensual actions to be implemented over the next few years.

GENERAL INTRODUCTION

The Mano River Union (MRU) is a regional economic integration organization of four West African states: Cote d'Ivoire, Guinea, Liberia and Sierra Leone. The MRU area covers an area of 751,000 km2 and has 52 million inhabitants. Three of the four MRU countries (Guinea, Liberia, Sierra Leone) are among the 15 poorest nations in the world according to the Human Development Index – Cote d'Ivoire being ranked 165 out of 189 countries. The MRU area is also marked by strong inequalities: It's GDP / per habitant is on average US $ 1220, it is two, three and four times higher in Cote d'Ivoire than in Guinea, Sierra Leone and Liberia, respectively.

Yet the MRU space is not lacking in assets. This area has impressive natural resources - water, forestry and mining in particular. The MRU area is one of the best-watered sub-regions in Africa. It records an average annual rainfall of 1,700 mm, varying from just under 1,400 mm / year in Cote d'Ivoire to 2,500 mm / year in Sierra Leone (AQUASTAT, consulted May 2021). This high rainfall explains the importance of the region's availability of surface fresh water and groundwater. While many countries face the threat of freshwater deficits, those in the MRU enjoy abundant freshwater resources.

The quantities of renewable water resources per capita vary from 3,000 m3 / year (Cote d'Ivoire), to 17,000 and 20,000 m3 / year (Guinea and Liberia respectively), and even to 45,000 m3 (Sierra Leone) (see table 1 below)[1]. The average per capita availability of renewable water resources in the MRU area (13,409 m3) is more than triple the average per capita in sub-Saharan Africa (3,699 m3) and more than double the world average (5,732 m3). Another illustration of the privileged situation of the MRU area in terms of water: the 3 countries best provided with fresh water (in terms of volume of renewable fresh water per year) in West Africa are from the MRU area: Liberia, Guinea and Sierra Leone – Cote d'Ivoire coming in 6th position[2].

The abundance of water - green water (rainfall) and blue water (surface water and groundwater) - translates into great agricultural opportunities for the MRU countries. The abundant rainfall and a dense network of surface water courses also form the basis of the diversity and richness of the ecosystems of the MRU area, the most emblematic of which is the Upper Guinea Forest. Stretching from southern Guinea to the southern region of Togo, this vast forest ecosystem was identified two decades ago as a "hotspot" for global biodiversity, due to the size of the primary forest areas. it shelters, due to the high concentration of endemic species but also due to the rapid degradation of the landscape and natural habitats. Today the MRU area is home to 80% of the forest stands that remain intact in the Upper Guinea Forest ecosystem (CILSS, 2016).

[1] It should be noted than countries with less than 500 m3 / per capita / year are considered to be facing an "absolute scarcity"; those registering between 500 and 1000 m3 / per capita / year are in a situation of "chronic scarcity" while the countries having 1000 to 700 m3 of renewable fresh water per capita per year are considered to be in a situation of "water stress). Source: FAO. 2013

[2] Source : World Bank data and AQUASTAT : Renewable feshwater resources per capita : https://data.worldbank.org/indicator/ER.H2O.INTR.PC

Table 1. Availability of water resources in the countries of the MRU area

	Cote d'Ivoire	Guinea	Liberia	Sierra Leone
Average Annual Rainfall (mm/an)	1348.00	1 651.00	2 391.00	2 526.00
Renewable surface water (km^3/an)	81.30	226.00	232.00	150.00
Renewable Underground Water (km^3/an)	37.84	38.00	45.00	25.00
Overlapping surface water / underground water[3]	35.00	38.00	45.00	15.00
Total renewable water (km^3)	84.14	226.00	232.00	160.00
Population (2020)	26 378 000	13 132 000	5 057 000	7 796 000
Renewable water per capita (m^3)	3 190	17 210	45 877	20 523
Dependence Ratio (%)	8.68%	0.00%	13.79%	0.00%

Sources: Water data: FAO / AQUASTAT: http://www.fao.org/aquastat/en/countries-and-basins/country-profiles/country; Demographic data: Worldometers: https://www.worldometers.info/world-population/population-by-country/

The member countries of the MRU are well endowed with raw materials, including mineral resources. Guinea holds ¼ of the world's bauxite reserves, and vast iron reserves that are also found in the other MRU countries. The four countries hold significant deposits of gold and diamonds (a resource on which Sierra Leone is heavily dependent, which is the largest producer in Africa), not to mention oil and gas reserves. This mining potential is a major asset in the fight against poverty, job creation and sustained economic growth.

So, although consisting of a well-drained area with abundant vegetation, the MRU area faces many challenges of conservation and development and sustainable management of these resources. Among the threats facing the region include: the proliferation of mining sites, the exponential growth of the population (doubling every 25-30 years), the rapid expansion of urban spaces and agricultural land, the deforestation, etc. Added to this is the loss of biodiversity following the destruction of the natural habitats of animal and plant species, some of which are rare and / or threatened. Climate change and the high incidence of poverty are accelerating the trends of resource degradation in the region.

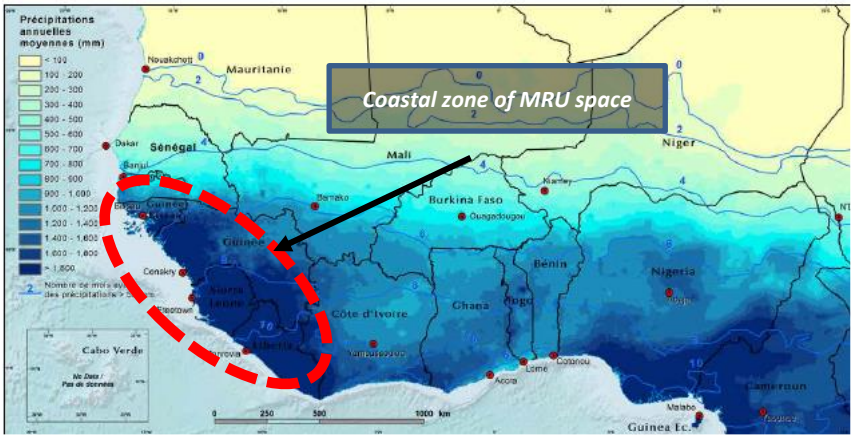
Faced with these challenges, the role of the MRU is to promote unity, solidarity and peaceful coexistence between Member States and in particular to encourage the mobilization of Member States and the combination of efforts to ensure sustainable development, management and concerted use of the Union's natural resources, and in particular shared resources. It is within the framework of these efforts that the Mano River Union Ecosystem Conservation and Integrated Water Resources Management Project, supported by the Global Environment Facility (GEF), was developed and implemented by IUCN and MRU.

[3] Surface water flows can contribute to groundwater replenishment through seepage in the river bed. Similarly, aquifers can discharge into rivers and contribute to their base flow, especially during dry periods. Therefore, it is important to avoid double counting of the same resource. In AQUASTAT, the part of the country's water resources that is common to surface waters and to aquifers is called "overlap".

One of the objectives of this Project is to carry out a Transboundary Diagnostic Analysis (TDA) of the region and to foMRUlate a Strategic Action Program (SAP) for the integrated management of shared resources in the priority transboundary basins of the region of the Mano River Union, as well as to lay the groundwork for its implementation.

This report focuses on Transboundary Diagnostic Analysis (TDA).

Figure 1. The MRU Area - one of the wettest sub-regions in West Africa



Source: (CILSS, 2016)

The report is structured into seven (7) chapters. **Chapter 1** covers the presentation of the context of the MRU Basin and the TDA methodology and process, emphasizing the three basins targeted under the MRU TDA. **Chapter 2** is devoted to the basin complexes, including the Scarcies basins (Great Scarcies / Kolenté and Little Scarcies / Kaba). **Chapters 3** and **4** relate respectively to the Moa-Makona Basin and that of Cavally. Each of these three chapters (2, 3 and 4) describes the biogeographical and hydro-climatic context, studies the democratic and socio-economic profile (with an emphasis on the incidence of poverty and then analyzes the main forms of resource use of the basins (agricultural, fish, forestry, mining, water resources, etc.). The analysis of the uses of the resources makes it possible to discuss some of the issues such as unsustainable uses, pressure on the resource, competition and conflicts cross-sectoral potentials, as well as opportunities and challenges for transboundary collaboration.

The following chapters (5 to 7) are common to the three basins, which is justified by the existence of great similarities between basins. **Chapter 5** is devoted to the analysis of the governance framework, i.e. the relevant legal and institutional framework in light of the issues highlighted in the analysis of the uses of basin resources. **Chapter 6** identifies and prioritizes the priority socio-environmental problems facing the three basins - common problems as well as those specific to each basin. **Chapter 7** illustrates the causal analysis of the priority issues identified in the previous chapter. Based on the causal analysis, a series of options are recommended to address the problems identified. It is understood that these proposed options will be the subject of an in-depth review and analysis during the formulation phase of the Strategic Action Plan (SAP).

CHAPTER 1. PRESENTATION OF THE GENERAL CONTEXT OF MRU, TARGET BASINS AND TDA METHODOLOGY

1.1. The TDA foMRUlation process

The purpose of TDA

Transboundary Diagnostic Analysis (TDA) is a process of scientific and technical study, diagnosis of the state of the environment and shared water resources as well as identification and analysis of threats to the environment, ecosystem of the basin and the socio-economic and environmental conditions of the human populations which depend on it.

The Transboundary Diagnostic Analysis (TDA) makes it possible to identify, characterize and quantify the transboundary environmental problems that the basins of the MRU Area face and to rank them in order of priority. The TDA analyzes the manifestations, extent and evolutionary trends for each of the problems deemed to be priorities and by: (a) defines the nature and manifestations; describes the impacts; (b) analyze the root and immediate causes; and, (c) discusses possible response options (see diagram below). The TDA thus marks the ground for the SAP, which offers solutions for each of the priority problems identified by the TDA.

Specificities of the Mano River Union TDA and methodological implications

TDA is in principle carried out at the scale of a transboundary basin, representing a single and continuous ecosystem. Within the framework of the MRU, we do not have one but ten small transboundary river basins, three of which are considered as priorities by the GEF-MRU project: Great Scarcies / Kolente, Moa-Makona and Cavally.

These priority basins are also supposed to be representative of the common characteristics and diversity of all ten transboundary basins of the MRU area.

Consequently, the TDA's approach consists in treating each of the priority basins as a separate ecosystem subject to a TDA (with review and identification of the priority problems that arise there) but also as an element of a sample of three (3) basins that is representative of the MRU's transboundary hydrographic network.

In the methodological approach to carrying out the MRU's TDA, two complementary approaches were used: First, the conduct of a nationwide TDA study in each of the four (4) MRU countries. These national studies covered the national portions of the priority basins (Great Scarcies / Kolenté; Moa-Makona; Cavally). Before or at the start of the studies on national contributions to TDA, a series of online trainings were organized on the TDA / SAP process for the national teams of consultants, members of the national committees of the MRU-IUCN / GEF Project as well as key stakeholders in each of the MRU countries.

A regional team of consultants drew on the national studies to develop this regional synthesis document of the MRU TDA. As part of this exercise, short-term field missions were organized, allowing visits to sites of special interest in target basins and interviews with key stakeholders in countries capitals and in the field.
The TDA development mission took place in the context of the COVID-19 pandemic - a context, which required adjustments in the implementation schedule and in the approaches, favoring in particular virtual exchange platforms, instead of physical encounters.

1.2. The Mano River Union: Elements of Genesis; Missions; Target Basins and Object of the TDA

1.2.1. MRU, Genesis and Mission

The Mano River Union (MRU) was established on October 3, 1973 with the signing of the Mano River Declaration by the original member states, namely Liberia and Sierra Leone. Guinea and then Cote d'Ivoire joined the MRU in 1980 and 2008 respectively. The four countries that make up the MRU area cover an area of 751,450 km2 for a population of 52 million people in 2020 (World population data, accessed March 2021).

The assigned mission of the Mano River Union (MRU) comprises three components: (i) the promotion of cooperation in international trade, (ii) the affirmation of an equitable distribution of the benefits of economic cooperation, (iii) the guarantee of peace and cooperation.

The three decades since the establishment of the MRU have not been favorable to significant progress in the achievement of the Union's goals. Indeed, during this period, the MRU countries were affected by turmoil, seeing political and social crises of varying magnitude, sometimes one after another and sometimes concomitantly - Liberia and the Sierra Leone having suffered civil war. Since the beginning of the 2000s, the MRU area has enjoyed a relative calm - despite the political-military crises that rocked Cote d'Ivoire (the Union's greatest demographic and economic power) and, to a lesser extent, Guinea. From 2004 and especially 2008, the member heads of state showed greater political will to relaunch the MRU while assigning it more ambitious objectives. In addition to the overhaul of the governance of the MRU and regional integration, particular emphasis is now placed on the sustainable use and management of the important natural resources of the MRU area, including water and forest resources.

1.2.2. Target basins for TDA

The member countries of the MRU are all well drained, rich in water, underground and surface water resources - most of them being national rivers, i.e. whose basins are entirely within the national territory. Of the 23 river and lake basins in West Africa, 18 cover at least one of the MRU member countries. Among these 18 basins, 11 cover at least two MRU countries: this is the Niger River basin - including Guinea and the Cote d'Ivoire - and ten other small basins. While the Niger River has a transboundary cooperation mechanism - the Niger Basin Authority (NBA) - this is not the case for the small, shared basins of the MRU area. In the area of surface water resources management, the MRU focuses on these ten small transboundary basins.

In addition to the fact that these basins have an elongated configuration while being of small size (on average 21,000 km long for a length of 320 km), the flows are generally from North-East to South-West where they flow into sea. These basins are also called coastal basins given the small distance between their source and their estuary in the Gulf of Guinea (TDA-SL, 2020).

Table 2. Transboundary Basins of the MRU Area

		Cote d'Ivoire	Guinea	Liberia	Sierra Leone	Total	% Total MRU Basins
1	**Moa-Makona**		8 500	1 700	9 300	19 500	9%
2	**Cavally**	16 100	1 400	11 900		29 400	14%
3	**Great Scarcies/Kolenté**		5 200		2 600	7 800	44%
4	Little Scarcies/Kaba		5 500		13 000	18 500	9%
5	St. John		2 700	13 700		16 300	8%
6	St. Paul		9 300	11 000		20 300	10%
7	Loffa		1 400	9 000		10 400	5%
8	Mano-Morro		30	5 700	1 900	7 600	4%
9	Cestos	2 200		10 500		12 700	6%
10	Sassandra	60 000	8 100			68 100	32%
	TOTAL	78 300	42 130	63 500	26 800	210 600	100%
	% Total Basins	37%	20%	30%	13%	100%	

Source: McCracken, M. & A. T. Wolf. 2019

Among the 10 small transboundary basins of the MRU area, four (4) are considered as priorities within the framework of the GEF / IUCN / MRU Project. These are the following basins:

• The first two (Great Scarcies or Kolenté and Little Scarcies or Kaba) are studied together because they form to a large extent a single river complex, distributed between Guinea (66%) and Sierra Leone (34%) of the area of this river complex.

• The Moa / Makona River Basin straddling Guinea (43%), Liberia (9%) and Sierra Leone (48%);

• The Cavally River Basin between Cote d'Ivoire (54%), Guinea (5%,) and Liberia (41%);

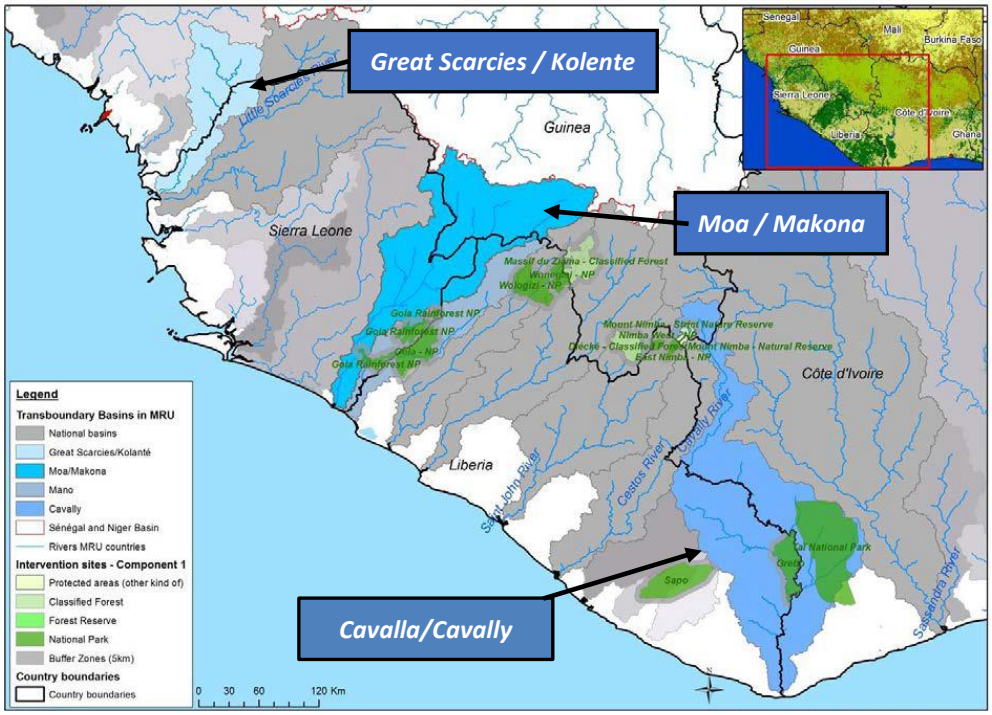
These three basins represent 36% of the area of the 10 river basins in the MRU area (see table above).

Table 3. The three (3) basins targeted under the MRU's TDA

	Total Area (km^2)	Cote d'Ivoire	Liberia	Guinea	Sierra Leone
Moa/Makona	19 500		9%	43%	48%
Cavally	29 400	54%	41%	5%	
Great Scarcies	(7 800)			67%	33%
Little Scarcies	(18 500)			30%	70%
Great & Little Scarcies Complex	26 300			66%	34%
Total Target Basins TDA/MRU	75 200	16100	13600	20600	24900
Proportion of all TDA target Basins in %	100%	21%	18%	27%	25%
Area 10 Transboundary Basins (km^2)	210 600	78 300	42 130	63 500	26 800

Percentage of the 3 TDA target basins compared to all Ten Transboundary Basins (%)	36%	20%	32%	32%	93%

Figure 2. The three (3) basins targeted under the MRU's TDA



Source : IUCN, 2016

1.3. Political and Socio-Economic Context of the MRU Area

Despite the significant natural resources that abounds in its subsoil and on the surface, the MRU area faces high levels of poverty. The region is one of the poorest in Africa: as the 4 member countries of MRU are among the 30 poorest nations in the world according to the classification of the Human Development Index (HDI), three (Guinea, Sierra Leone and Liberia) are among the bottom 15. The development efforts of the member countries of the MRU have been greatly hampered by political instability, skyrocketing demography, rapid urbanization (leading to forest clearing) and excessive dependence on primary resources. To this have been added, for three of the four member countries (Liberia, Sierra Leone and Cote d'Ivoire), periods of tension, political crises and even civil wars, armed conflicts (TDA-SL, 2020).

However, the MRU area is not homogeneous. The member countries are at different levels of the political, economic and social scale. Cote d'Ivoire per capita GDP is nearly double that of Guinea and triple or even quadruple that of Sierra Leone and Liberia, respectively. Likewise, in terms of the institutional strenght and the quality of infrastructure (social, road transport, electricity network, etc.) the differences are very clear from one country to another, including in river basins, targeted under this TDA (TDA-SL, 2020).

During the last decade (since 2010), the MRU countries have enjoyed relative political stability. This situation has favored the renewed dynamism of the economies of the MRU countries, resulting in high

growth rates. In Côte d'Ivoire, for example, GDP growth ranged from 7.4% (estimate for 2018) to over 10% in 2012 (TDA-CI, 2020). In Guinea, the growth rate rose from 4% to over 10% between 2016 and 2017. For Sierra Leone and Liberia, the economy has also experienced a similar, positive development.

Table 4. Demographic and socioeconomic characteristics of the MRU Area

	Area (km^2)	Population (2020)	Density ($pers/km^2$)	PIB per capita (2020) (US$)	Rank according to HDI (2018) (out of 189 countries)
Côte d'Ivoire	322.463	26.378.000	82	1716	165
Guinea	245.836	13.132.000	53	937	174
Liberia	111.369	5.057.000	45	440	176
Sierra Leone	71.740	7.796.000	109	536	181
Total/Average	751.408	52.363.000	70	1222	

Sources: ECOWAS; Demographics: Worldometers: https://www.worldometers.info/world-population/population-by-country/;; HDI: UDNP 2019 DHI Report; for GDP: UN Dat: https://data.un.org/en/index.html

1.4. Main Challenges in the Use and Management of MRU Area Resources

1.4.1. Water Resources - Generalization of practices of degradation of water resources

Although the MRU area has significant water resources (rain, surface and underground), it nevertheless faces growing challenges in the water sector. These challenges are summarized below:

Problems with the availability and quality of water data: The lack of quality data on water resources, especially underground and surface water resources is a serious constraint on their rational and sustainable management. Little is known about aquifers due to the lack of appropriate hydrogeological studies. Where they exist, piezometric aquifer monitoring networks are rarely functional. The same is true for the hydrology of the MRU's watercourses and the instability and internal crises in the various MRU member countries have constitutes serious constraints on the security of equipment and the continuous monitoring of resources. Water quality is rarely a subject to systematic long-term monitoring (TDA-RG. 2020).

Concerning water quality situation. The degradation of the quality of water resources, especially those used for human and animal consumption, is quite feasible. The decline in the quality of water resources also concerns surface water (rivers and lakes), which is home to a variety of animal and plant biodiversity, including the ichthyological fauna, which contributes to the food chain. The expansion of plantation agriculture and the massive use of pesticides and chemical fertilizers associated with land degradation and bank erosion are accelerating transport of debris and increasing suspended matter in surface running water whose turbidity tends to increase. Industrial or artisanal mining (especially gold and diamonds) amplifies the processes of degradation of water quality and sometimes leads to changes in the hydrodynamics of rivers, chemical pollution and muddy waters.

Low level of use and development of water resources. Apart from withdrawals for human consumption needs (boreholes and wells), fresh surface and underground waters in the MRU space are poorly exploited. With regard to Guinea, an evaluation study of the country's hydroelectric potential found that while Guinea has a potential of 6,230 MW at the national level, only 1% of this potential is in the parts of the small transboundary MRU basins: Kaba (Little Scarcies), Kolente (Great Scarcies) and Moa-Makona (AECOM, 2018) (Table 5).

Table 5. Hydroelectric potential in the Guinean parts of small transboundary basins of the MRU

Basins	Number of Dam Sites	Total volume of reservoirs (hm^3)	Total Area of Reservoirs (km^2)	Total installed capacity of dams (MW)
KOLENTE	2	6.291	1.18	4.20
KABA	3	0.404	0.16	9.20
MAKONA	4	36.954	7.73	48.00
TOTAL	9	43.649	9.07	61.40

Source: AECOM. 2018.

For Cote d'Ivoire, an ECREEE study (2012) identified 19 potential sites for hydroelectric projects with an installed capacity of 1,770 MW, including the following in the Cavally Basin: Drou (1.6 MW); Tahibli (19.5 MW) and the Binational Cote d'Ivoire-Liberia Tiboto Project (225 MW).

With regard to Sierra Leone, the hydropower potential has been assessed in the Energy Sector Master Plan (1996). This Plan identifies 27 hydropower project sites with a total of 1,200 MW (JICA, 2009, citing the 1996 Power Sector Master Plan by Lahmeyer International). Ten of these sites are in the Little Scarcies (8 sites) and Moa-Makona (2 sites) basins for a cumulative installed capacity of 350 MW): see table below).

Table 6. Hydroelectric potential in national parts of TDA target basins

Basins	Number of Dam Sites	Name of Site	Total planned installed capacity (MW)
Little Scarcies / Kaba	8	Mange 1&2, Tendata, Kuse 1&2, Maka, Kumba, Kambatimbo	304
Moa-Makona	2	Baraka, Nyandehum	46
Total TDA target basins	10		350
Total Sierra Leone	27		1200

Source: JICA, 2009

For Liberia, the national hydropower potential (referring to the hydropower for the period 1998-2014) has been estimated at 4,478 MW (GIS Hydropower Resource Mapping - Country Report for Liberia cited by Luo et al. 2020). The ECREEE report (2012) estimates the technically and economically exploitable hydroelectric potential at 1,000 MW. The Tiboto Binational Dam project on the Cavally (with an expected installed capacity of 225 MW) is the only significant hydropower site in the TDA target basins (ECREEE, 2012)

The motivation for cooperation around shared water is suboptimal due to the low level of water interdependence between MRU countries. One of the constraints to cooperation in the field of water in the MRU area relates to the fact that member countries are not only well endowed with water resources but each have a low dependency ratio vis-à-vis third countries. (8% and 14% for Cote d'Ivoire and Liberia) or almost zero (Guinea and Sierra Leone) (see above, table No.6). This may result in a weak incentive for cooperation in the development of water resources.

Conclusion [1.4.1]

The first challenge of collaborative governance and efficiency of water resources in the MRU area is linked to the poor knowledge of the resource and its evolution. Added to this challenge is the proliferation of agricultural and mining practices, which accentuate the degradation of water quality. However, despite the large availability of water, the water resources of the MRU area are poorly developed, even though there are a large number of hydraulic and hydroelectric infrastructure projects. These infrastructures often require significant financial resources, which are often difficult to mobilize at the level of an individual State. The fact that the member states of the MRU are each well endowed with natural water resources but also with a low ratio of water dependency on other countries does not always encourage international cooperation of states around major transboundary projects.

1.4.2. MRU forest resources: Pressures heightened on an ecosystem of critical regional and universal importance

The 4 member countries of MRU are home to between3% of Africa's forests, or 19 million ha out of 637 million ha of forests. As shown in Table 7 below, over the past 30 years, forest cover has continued to decline in the MRU area, from 1 to 1.3% per year, or 200,000 to 360,000 ha per year, therefore 1000 ha of forests per day (FAO, 2020).

Table 7. Evolution of forest areas in MRU countries and in Africa

	Forest Area (x1000 ha)				Net Annual Change (ha /year in %)					
Country	1990	2000	2010	2020	1990-2000		2000-2010		2010-2020	
Guinea	7276	6929	6569	6189	-34.7	-0.48%	-36	-0.52%	-38	-0.58%
Cote d'Ivoire	7851	5094	3966	2837	-275.7	-3.51%	-112.8	-2.21%	-112.9	-2.85%
Liberia	8525	8223	7920	7617	-30.2	-0.35%	-30.3	-0.37%	-30.3	-0.38%
Sierra Leone	3127	2929	2732	2535	-19.8	-0.63%	-19.7	-0.67%	-19.7	-0.72%
MRU	26779	23175	21187	19178	-360.4	-1.35%	-198.8	-0.86%	-200.9	-0.95%
Africa	743000	710000	676000	637000	-3300	-0.44%	-3400	-0.48%	-3900.0	-0.58%

Source: FAO, 2020, op. cit.

The rate of forest reduction in the MRU area (7.6 million hectares between 1990 and 2020, i.e. -28%) is twice as fast as on the scale of the continent (106 million ha of forests lost, i.e. -14%) during the same period (See table 7 below). Within the MRU area itself, there are significant differences. Cote d'Ivoire has the highest rate of forest loss, between 3 and 3.5% per year, while Liberia has the lowest rate: less than 0.4% per year. In three decades, the forest area in Cote d'Ivoire has decreased by 64% against an average three times lower (28%) for all four (4) countries of the MRU, as indicated further (See Table below). Deforestation is therefore a major challenge in the MRU area.

Table 8. Areas of lost forest since 1990

	Loss1990-2020 (x1000 ha)	Percentage
Guinea	-1087	-15%
Cote d'Ivoire	-5014	**-64%**
Liberia	-908	-11%
Sierra Leone	-592	-19%
MRU	-7601	**-28%**
Africa	-106000	-14%

Source: FAO. 2020, op. cit.

Despite this level of rapid forest degradation in the MRU area, this sub-region continues to occupy a central place and is positioned to play a leading role in the preservation of forest ecosystems in West Africa and the continent in general. This is illustrated by the fact that the four member countries of the MRU are home to the last vestiges of a single area of high biodiversity value (biodiversity hotspot): the Guinean highland forest eco-region (or Upper Guinea Forest), formerly an ecosystem occupying a continuous zone. This ecosystem is among the 25 global priority areas for biological diversity and presents the greatest diversity of mammals in the world (TDA-CI. 2020).

Today this area is not only geographically fragmented but it is in constant decline, due to the rapid expansion of agro-industrial plantations, the frequency and increasingly popular slash-and-burn cultivation practices, the multiplication of industrial and artisanal mining, as well as poaching (CEPF, 2015; TDA-SL,2020).

Due to the pressures on the natural resources of the region, the Key Biodiversity Areas (KBAs)[4] and in particular the protected areas are the rare privileged places sheltering the relics of the eco-region, itself one of the 36 biodiversity hotspots[5] in the world (TDA-RG, 2020). Among these ecosystems of high biological value, the complexes of transboundary protected areas are of strategic importance in particular, both from the point of view of their extent and the stock of biodiversity they shelter and from the point of the transboundary management of such sensitive ecosystems. These transboundary complexes are: (1) the complex formed by the Sapo National Park and the Grebo National Forest (Liberia) and the Taï National Park (Cote d'Ivoire); (2) the complex formed by the Gola Tropical Forest National Park (Sierra Leone) and the Gola National Forest (Liberia); (3) the Mount Nimba Integral Nature Reserve (Guinea and Cote d'Ivoire) and the Classified Forest of Diecké, and; (4) the Ziama Forest Integral Nature Reserve (Guinea) and the Wonegisi National Forest (Liberia) and (Guinea) (CEPF, 2015; ECOSYS, 2020). It should be noted that the first three complexes mentioned are entirely or partially located in one of the four target transboundary basins of this TDA (See table 9 below). Although having a formal protection status, these protected areas are continually eaten away and invaded by the

[4] The *Key Biodiversity Areas* (KBAs) are areas that significantly contribute to the persistence and preservation of global biodiversity.

[5] A *biodiversity hotspot* (or biodiversity hotspot) is an area with high levels of biodiversity that is threatened with destruction. To qualify as a hotspot, a region must meet two criteria: it must contain at least 1,500 endemic vascular plant species and must have lost at least 70% of its primary vegetation. Biodiversity hotspots are home to nearly 60% of the world's plant, bird, mammal, reptile, and amphibian species, with a very high share of endemic species (Source: Conservation International)

advancing agricultural front and mining activities and come under assault from poachers and loggers (TDA-SL, 2020).

Table 9. Key Biodiversity Zones in TDA / MRU target basins

Basin	Country	Code	Key Biodiversity Zones (KBZ)	Area (ha)	Obs
Little (Kaba) and Great (Kolenten) Scarcies	Guinea	GIN7	Kounounkhan	10.644	
	Sierra Leone	fw8	The Rhombe Marshes and river mouths Outamba Kilimi National Park	88.460 xxxxxx	
Moa-Makona	Sierra Leone	SLE2	Kambui Hills Forest Reserve	14.012	
		SLE7	Tiwai Island Game Sanctuary	1.251	
		SLE1	Gola Forest Reserve	74.612	Gola-Lofa-Mano Transboundary Complex
	Liberia	LBR11	Lofa-Mano Complex	437.854	
Cavally		LBR4	Gio National Forest	48.826	Cavally ?
		LBR18	Zwedru	64.458	Cavally ?
		LBR7	Grebo	282.195	Tai-Sapo-Grebo-Krahn Complex
		LBR13	Sapo - Grebo Corridor	197.421	
		LBR14	Sapo National Park	155.084	
	Cote d'Ivoire	CIV11	Taï National Park and the N'Zo Wildlife Reserve	539.376	
		CIV3	Cavally Classified Forests and Goin - Débé	197.925	
		CIV14	Mont Nimba Integral Reserve	6480	Mont Nimba Complex
		CIV8	Mount Nimba (part of Mount Nimba transboundary AZE)	27.035	
	Guinea	GIN9	Mount Nimba	14.562	
	Liberia	LBR12	Nimba mountains	13.254	
		LBR15	West Nimba	11.625	

Source: https://www.cepf.net/sites/default/files/fr_profil_ecosysteme_forets_guineennes.pdf

1.4.3. Mineral Resources - a blessing for development or a curse for the environment and social peace?

As underlined above, the four countries of the MRU are each well endowed by nature in mineral resources. In addition to the many formal and informal jobs generated in this sector, mining poses many dangers.

Mining (especially gold and diamonds) occupies a central place in the economies of WAEMU countries. GIZ (2020) estimates that there are more than 1,200,000 people working directly in artisanal mining in the MRU space and no less than 4.5 million people indirectly benefiting from the activities of this sector (See Table 10 below). According to the UNDP, 750,000 people are employed (formal and informal jobs) in the industrial and artisanal gold and diamond mining sub-sectors (UNDP & International Alert, 2006). As for the diamond mines, they could employ only 400,000 people including 200,000 for Guinea, 150,000 for Sierra Leone, 40,000 for Liberia and 10,000 for the Cote d'Ivoire. This is to say that the

mining sector - both industrial and artisanal - plays a leading socio-economic role in the economies of the MRU countries.

Table 10. Estimate of direct and indirect jobs linked to mining in MRU countries

Country	People directly involved in Artisanal Small-Scale Mining	People indirectly Benefiting from activities related to Small Scale-Mining
Guinea	300,000	1,500,000
Sierra Leone	300,000	1,800,000
Liberia	100,000	600,000
Cote d'Ivoire	500,000	600,000
Total	1,200,000	4,500,000

Source: GIZ, 2020

The mining sector in the African context can be compared with the Janus face, with one shiny side and the other rather hideous. In the first case, the sector offers fabulous opportunities in the area of job creation, revenue generation for the state, and contributes to poverty reduction efforts. Mining industries scattered in different parts of the national territory can help relieve congestion in capitals and create growth poles and contribute to the multiplication and modernization of infrastructure in rural areas.

The other side of the coin is also that mining in developing countries - and the MRU space is no exception - poses real governance challenges with implications in all sectors. The economics of mining - from the exploration, exploitation, marketing of minerals, gold and diamonds in particular - tend to spiral and to some extent escape state control. As parallel economy is being created, the struggles for control of segments of the gold and diamond industries intensified and gained momentum, ultimately destabilizing the state. The ensuing chaos quickly evolves into factional wars and then civil war. This is how Liberia and then Sierra Leone were plunged into particularly deadly fratricidal wars: causing hundreds of thousands of dead, hordes of displaced people populating refugee camps in neighboring countries, not to mention the multiple abuses endured by populations including men and women. The export of the minerals by armed gangs made it possible to purchase weapons and thus perpetuate the war, not hesitating to recruit children into their ranks. For a decade, the MRU space has experienced a relative calm but the era of the blood diamonds, child soldiers, refugees, abuse and successive coups d'état has left wounds that will take time to heal.

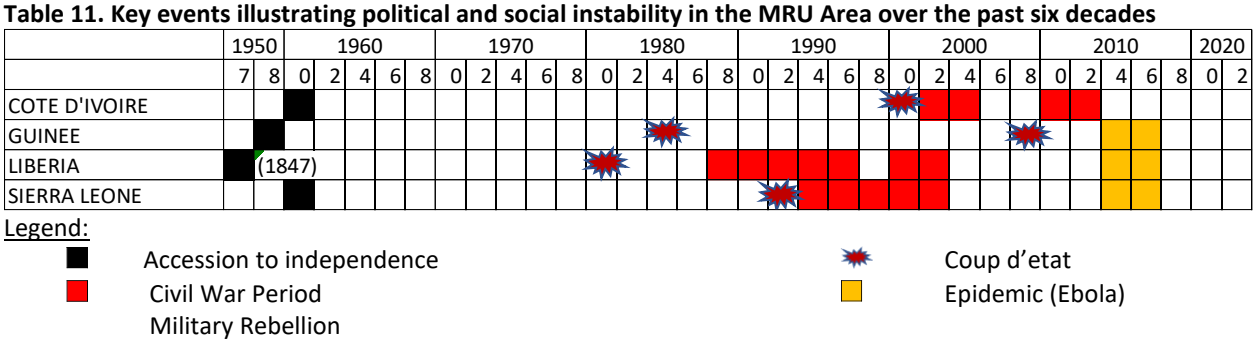
From an environmental and social perspective, the consequences of mining (both industrial and artisanal) are equally significant. Traces of mining in the MRU area are pervasive everywhere, visible in the form of active or abandoned mining wells, deforestation, erosion of soils or river banks, water contamination by discharges of pollutants such as mercury or cyanide, high turbidity of river water, all resulting in the loss of natural habitats, and the decline in biodiversity.

1.4.4. Decades of social crises and political instability

The member countries of the MRU all became independent between 1957 and 1961, except for Liberia whose independence dates from 1847, have had a turbulent political history over the past 50 years. The civil war in Liberia (1989-1996 then 1999-2003) and that of Sierra Leone (1991-2002) were particularly deadly. The civil war in Sierra Leone has spanned a decade with nearly 200,000 deaths for more than 2 million displaced. The two civil wars in Liberia - more or less at the same time as that in

Sierra Leone - were just as violent: 200,000 dead, more than a million people displaced for the first war and a similar toll for the second civil war with more than 150,000 dead and hundreds of thousands displaced. Cote d'Ivoire has experienced two periods of violent internal crisis: a rebellion which resulted in the de facto splitting of the country into two entities (the north and the south) and then a bloody post-election crisis (in 2010). Guinea's political history has been marked by two coups d'état. In addition, during periods of violent internal crises (in Liberia, Sierra Leone, Cote d'Ivoire, the other MRU countries have had to accommodate hundreds of thousands of refugees.

Table 11. Key events illustrating political and social instability in the MRU Area over the past six decades



To all this is added the fact that three of the four MRU countries (Guinea, Sierra Leone and Liberia) were severely affected by the Ebola epidemic, especially between 2014 and 2015, with a toll of more than 10,000 dead (See Table 12 and Fig. 3).

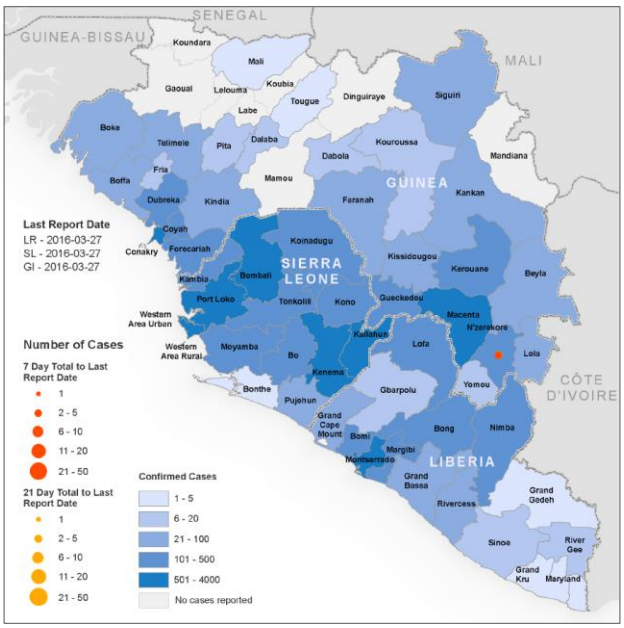
The context of the MRU space over the past four (4) decades has been particularly turbulent, violent and politically unstable. As a result, internal and transboundary security issues have taken precedence over concerns for the preservation and sustainable management of the basin's resources. These crises have even led to a more or less pronounced disorganization of the state and the disruption in the functioning of the government, with a neglect in the protection and management of natural resources, including rivers and forest heritage. Population movements (forced displacement, human concentrations in refugee camps) have accentuated soil erosion and deforestation and encouraged poaching activities.

Table 12. Incidence of the Ebola epidemic in MRU countries (end of 2013 to end of 2015)

Pays	Registered Cases	% of registered cases	Number of Deaths	% of Number of Deaths
Guinea	3,811	13.3%	2,543	22.5%
Liberia	10,675	37.3%	4,809	42.5%
Sierra Leone	14,124	49.3%	3,956	34.9%
Cote d'Ivoire	0	0.0%	0	0.0%
Total MRU Countries	28,610	99.9%	11,308	99.9%
Other Countries	36	0.1%	15	0.1%
Total	28,646	100.0%	11,323	100.0%

Source: WHO, 2016

Figure 3. Geographic distribution of Ebola cases in Guinea, Liberia and Sierra Leone



Source: WHO, 2016, op.cit.

After tumultuous decades, the MRU enjoyed relative calm, which was disrupted by the Ebola epidemic, which now seems to be under control. The situation is therefore favorable to address the condition of the environment and to design and implement measures for the restoration, rehabilitation, protection of sensitive ecosystems and the sustainable management of natural resources in the MRU Area - ecosystems and natural resources, which still maintains great value both from the point of view of their biodiversity and of their potential to support sustainable actions in the fight against poverty and development.

The following chapters (2, 3 and 4) describe and analyze in more detail the characteristics and conditions of the particular ecosystems and natural resources of the target basins (Great Scarcies / Kolente; Moa-Makona and Cavally). The use of these natural resources, the threats to their conservation and sustainable management will then be the subject of a systematic analysis.

CHAPTER 2 – KOLENTE (GREAT SCARCIES) AND KABA (LITTLE SCARCIES)

Introduction

The Kolenté River - also called Great Scarcies - has its source in Guinea, about forty kilometers north of Kindia, in the sub-prefecture of Bangouyah (Prefecture of Kindia). From its source, the Kolente takes a southerly direction, crossing the sub-prefectures of Bangouya, Kolenté and Madina Oula in the Prefecture of Kindia and the sub-prefectures of Sikourou and Moussaya in the Prefecture of Forécariah. After having traveled 187 kilometers in Guinean territory, the Kolenté forms the 87 km border between Guinea and Sierra Leone. It then flows into the sea in Sierra Leonean territory (RG-TDA-Stakeholders, 2020). With a length of 257 km, the Kolenté has a basin covering an area of 7,800 km2, of which two-third (2/3) is in Guinea and one-third (1/3) in Sierra Leone. However, the national parts of the basin represent respectively only 2% and 4% of the surface area of Guinea and Sierra Leone (Table 13 and Fig. 4).

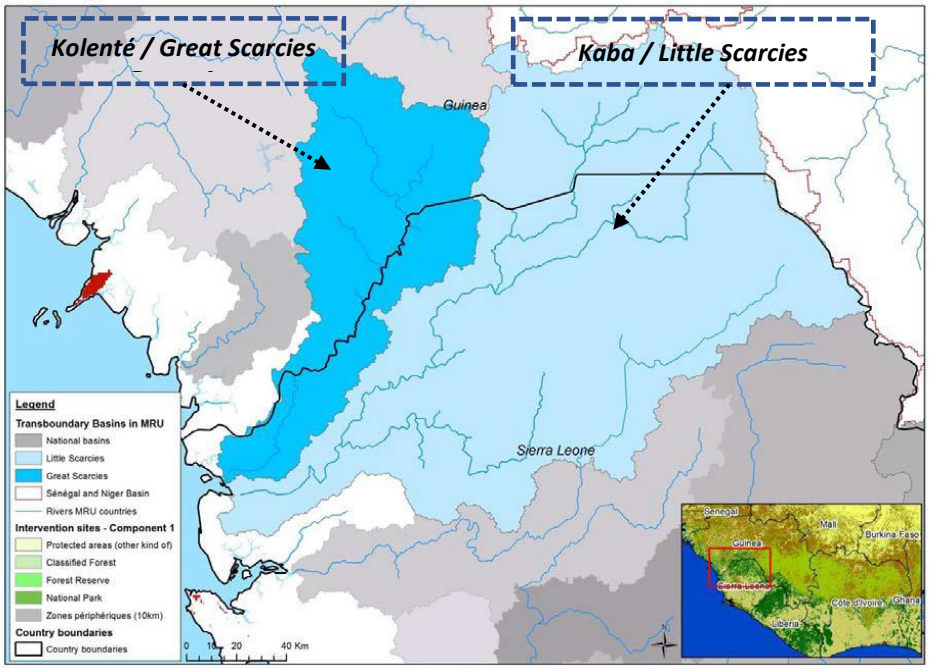
The Kaba River (also known as Little Scarcies) also has its source in Guinea, in the Sub-Prefecture of Saramousaya (Prefecture of Mamou). It then takes a south-easterly direction, flowing into Guinea for a distance of 90 km before entering Sierra Leonean territory (TDA-RG, 2020). One-third (1/3) of the area of the Kaba is in Guinea, upstream country, and two-third (2/3) in Sierra Leone (downstream country).

The area of the Kaba Basin is more than double that of the Kolenté. The Kolenté and Kaba Basins cover only 2% and 6% of the total cumulative surface area of the States of Guinea and Sierra Leone respectively. The two basins therefore cover 8% of the area of the two countries: 4% of the area of Guinea and 22% of Sierra Leone.

Table 13. Distribution of the area of the Kolenté (Great Scarcies) and Kaba (Little Scarcies) Basins between riparian countries

	Kolenté (Great Scarcies)			Kaba (Little Scarcies)		
	Guinea	Sierra Leone	Total	Guinea	Sierra Leone	Total
National Area (km^2)	245 857	71 740	317 857	245 836	71 740	317 576
Area of the country in the basin (km^2)	5 200	2 600	7 800	5 500	13 000	18 500
Area of the Basin in the country	67%	33%	100%	30%	70%	100%
Percentage of the country in the Basin	2%	4%	2%	2%	18%	6%

Figure 4. Kolenté (Great Scarcies) and Kaba (Little Scarcies) Basins



Source: IUCN, 2016

This chapter is divided into six sub-chapters. The first describes the physical framework of the two basins of Kolenté and Kaba: geomorphology, hydro-climatic context, biogeographic conditions (fauna and flora). The second sub-chapter describes the general demographic and socio-economic characteristics of the two basins. The third subchapter deals with the use of basin resources (fishing, agriculture, animal husbandry, forest exploitation and wildlife resources, mining, use and development of water resources, etc.).

2.1. Main Geophysical Characteristics of the Scarcies Basin

The physical framework of the Scarcies (Great and Little) basins is understood by distinguishing between the high basins (to simplify, the Guinean parts of the two basins) and the middle and low valleys (comprising the parts of the two basins located in Sierra Leone) and also the border reach of Kolenté between Guinea and Sierra Leone).

2.1.1. Geology and Geomorphology

Upper Basin of the Scarcies Region:

In the upper basin of the Scarcies complex, the landscape is, as a whole, dominated by sea-facies rocks which testify to a marine submersion of the ancient basement in the primary era from the lower coast to the Fouta Djallon plateaus. The Kindia, Maférenya and Dalaba sand quarries as well as the Benna mountain range and the Pita sandstones plateau are illustrative examples of marine facies (RG-TDA-Stakeholders, 2020).

Geologically, the main layers and rocks found in the Scarcies complex basin include Devonian and Ordovician sandstones, Calcoalkaline granites; sandstones, schists, marine alluvium from the Upper Quaternary and finally ferruginous and aluminous laterites (RG-TDA-Stakeholders, 2020)

From a geomorphological point of view, the high basins of Kolenté and Kaba are marked by a succession of terraces and plateaus interspersed by valleys and plains that stretch as far as the eye can see (RG-TDA-Stakeholders, 2020).

From a pedological point of view, the soils of the upper Scarcies basin are not very evolved, characterized by a shallow profile and a high load of coarse elements. These soils are fragile and vulnerable to sheet erosion and gullying under the action of heavy rains and degradation of the plant cover (RG-TDA-Stakeholders, 2020).

Middle and Lower Course of the Scarcies Region:
In its middle and lower course, the Scarcies basins are located in a vast sandstone plateau whose slope - which is very steep upstream (up to 3 m / km) becomes increasingly weak. The basins are thus presented in the form of a vast zone of low altitudes. At 50 km from its source, the altitude of the main bed of the Kolenté is 150 meters and gradually drops to 75 meters downstream at the border between Guinea and Sierra Leone at Forécariah (RG-TDA-Stakeholders , 2020).
The low valleys of the Scarcies rivers are the domain of alluvial soils occupied in the coastal fringe by mangroves. The constraints for the development of these mangrove soils concern, among other things, the high amplitude of the tides, their salinity and the difficulty of reducing the salt content of these soils which are highly susceptible to acidification (RG-TDA-Stakeholders, 2020).

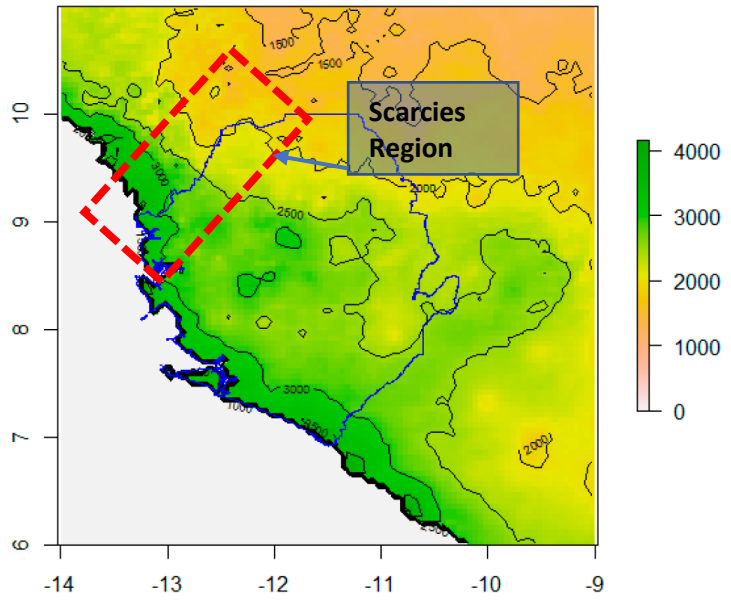
2.1.2. Hydro-Climatic Context of the Scarcies Region

The Scarcies region belongs to the tropical climate zone, the main characteristic of which is the alternation of rainy and non-rainy seasons throughout the year. This alternation of seasons is governed by the north-south oscillations of the intertropical convergence zone (ICZ), (RG-TDA-Stakeholders, 2020). The ICZ is the virtual low-pressure line where hot, humid air masses converge, creating the conditions for rainfall. In the upper Scarcies basin (Guinean part) there is a so-called Sudanese climate, marked by a rather long dry season (ranging from November to June) and a fairly short rainy season (between July and September-October) (AECOM, 2018). In northern Africa, the Sudanese climate generally begins north of the 10th parallel. In low latitudes, as is the case in the middle and lower Scarcies valley, the duration and intensity of rainfall increases: indicating the Guinean regime. The Sudanese regimes in the north and Guinean in the south largely define the rainfall conditions in the region and the hydrological regime of the Kolenté and Kaba rivers and their tributaries.

2.1.2.1. Rainfall

The average rainfall in the Scarcies basins increases from the source of the two rivers to their mouths, following a northeast to southwest gradient, from the 1500 mm / year isohyet to the 3000 mm / year isohyet (over the period 1981 -2018) (See Fig 5).

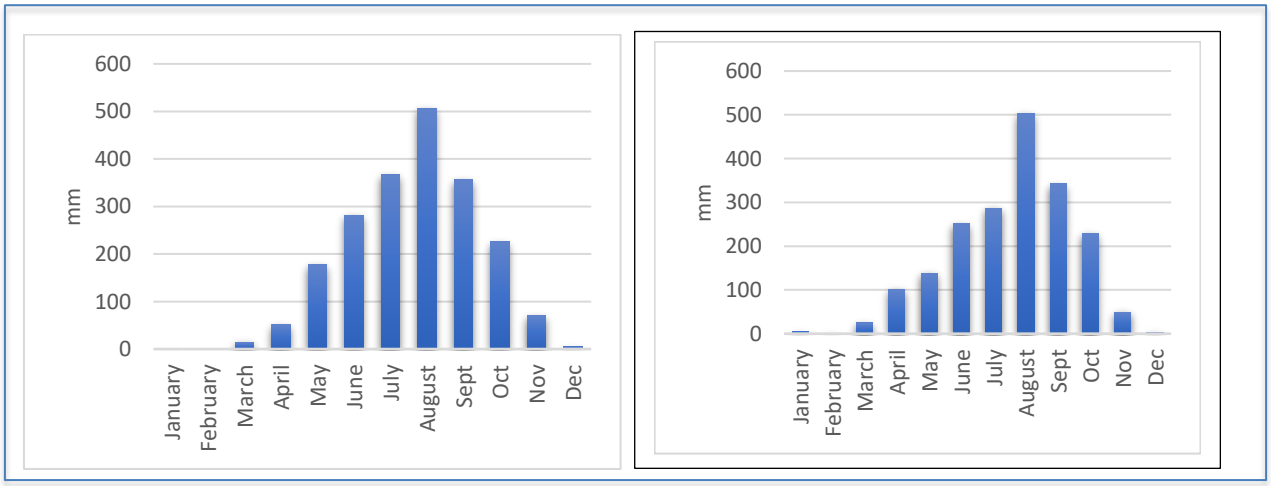
Figure 5. Average rainfall in the Scarcies Basins - Reference period 1981-2018



Source: Wadsworth & Lebbie, 2019

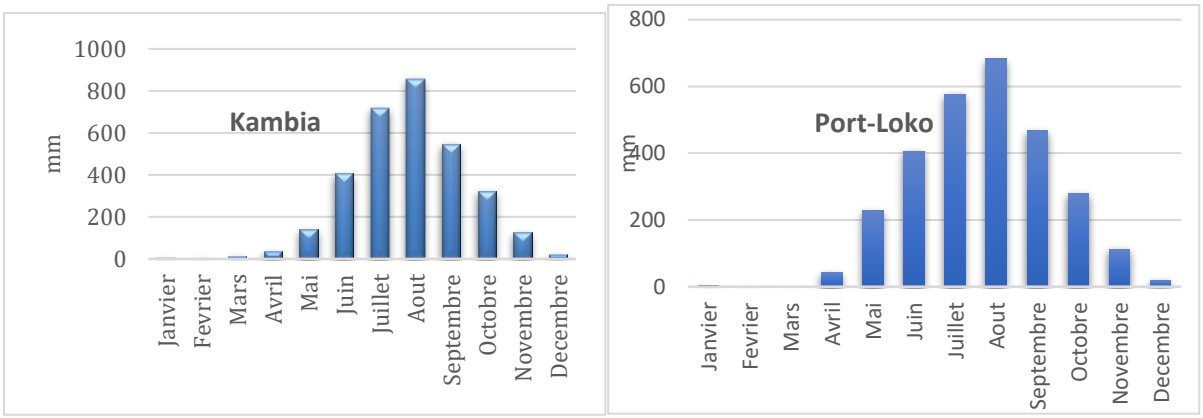
The Scarcies region is therefore well watered, even if the wet period lasts for a few months (a little longer in the Lower Valley than in the Upper Basin). The stations of Mamou (near the source of the Kaba) and Kindia (source of the Kolenté) recorded 1900 to over 2000 mm of rain per year against 2800 mm in Port-Loko and 3200 mm in Kambia, in the middle valley of the Kaba and Kolenté, less than a hundred km from the mouth): see Fig 6 & 7.

Figure 6. Average monthly rainfall in the Upper Basin of the Scarcies complex: (a) Kindia (Kolenté) for the period 2009-2019 (left) and (b) Mamou (Kaba) for 2009-2013 (right)



Source: TDA Team/Guinea

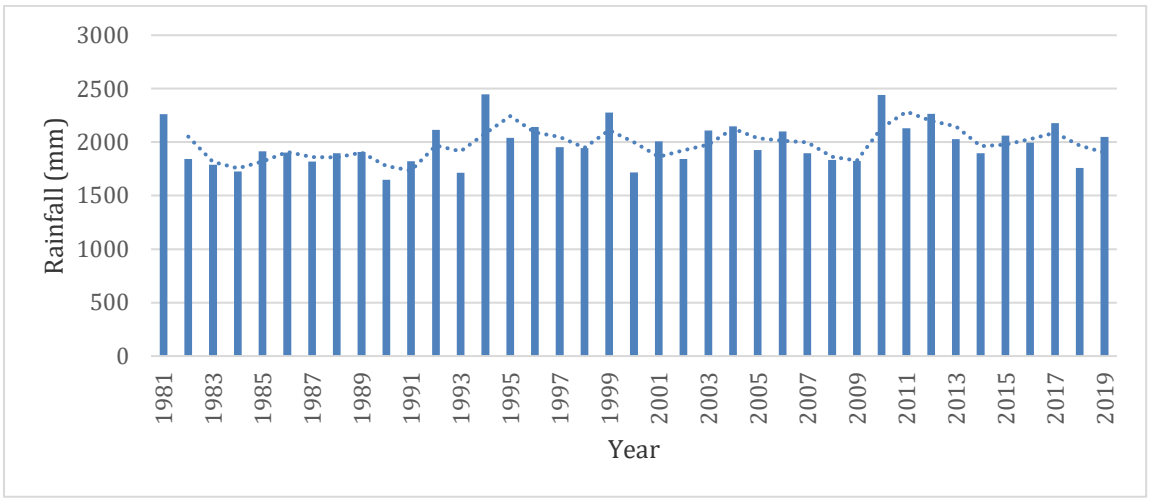
Figure 7. Average monthly rainfall in the middle-low valley of the Kolenté (Kambia over the period 2009-2020) and Kaba (for the year 2015)



Sources : Station de Kambia : Worldweather, Accessed in July 2021; Kaba Station: www.salonewatersecurity.com, accessed in July 2021.

With regard to the rainfall trends in the Scarcies region, observations over a period of around forty years (1981 to 2019) in Kindia has shown that the annual average rainfall of 1984 mm has exceeded 18 out of 39 years (TDA-RG, 2020). The inter-annual variability is also illustrated by the fact that, over the same observation period, the most rainy year was that of 2010, with an annual cumulative rainfall of 2440 mm while the least rainy one was 1990 with an annual total of 1648 mm of water, a difference of more than 30% (see Fig. 8). There has been a trend of increasing rainfall in recent years since, as indicated earlier, the average rainfall in Kindia since 2009 has exceeded 2000 mm / year.

Figure 8. Inter-annual variations in rainfall in Kindia (Upper Kolenté basin for the period 1981-2019)



2.1.2.2. Hydrology of the Kolenté and the Kaba

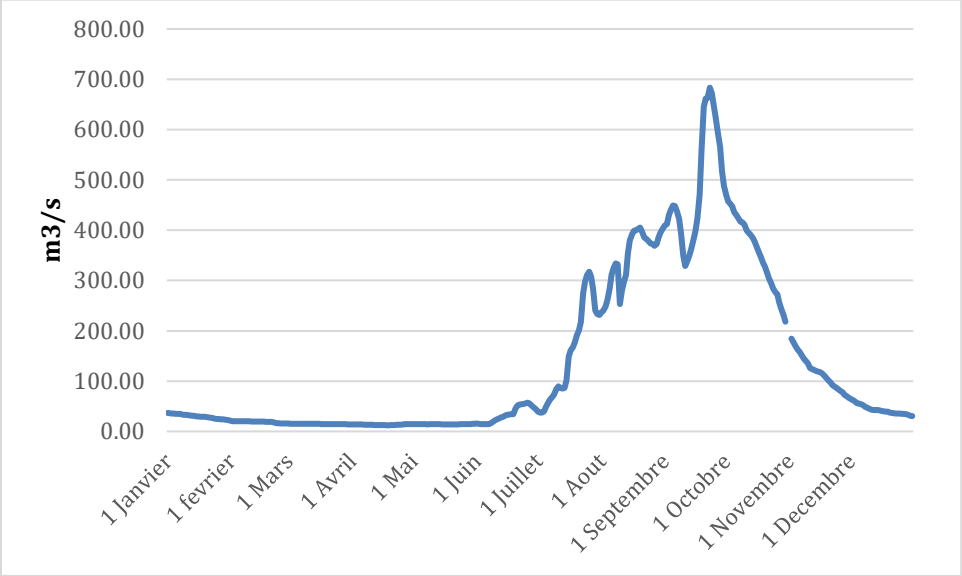
The Kolenté and Kaba rivers originate and flow into the ocean after traveling relatively short distances. They are thus part of the short coastal rives of the MRU area. Despite their small size, the Kolenté and Kaba Rivers, located in a very wet region (average rainfall of 1900-2300 mm), receive a multitude of tributaries along their routes.

The annual hydrograph of these rivers largely follows the time distribution of annual rainfall. This is how the highest flows are recorded between July-August and September, which also corresponds to the period when the rainfall is highest in the region.

a. Kolenté River / Great Scarcies

In its upstream part, in Guinean territory, the Kolenté River and its main tributaries drain the southern foothills of the Fouta Djallon foothills, north-east of Kindia. Among the thirty tributaries of the Kolenté in the Guinean reach, the main ones are, on the left bank the Kora (90 km long), and, on the right bank, the Santa (75 km) and the Kilissi (74 km) (TDA-RG, 2020). In the border reach between Guinea and the Sierra Loene - about a hundred kilometers long - the Kolonté receives a series of small tributaries on the right bank that flow into Sierra Leonean territory for about forty kilometers before emptying into the sea.

Figure 9. Annual Hydrograph from Kolenté to Tassin (Guinea) on the border with Sierra Leone - Year 2000



Source: National Directorate of Water Resources of Guinea database, via TDA-RG Team, 2020

b. Kaba River / Little Scarcies

At 445 km long, the Kaba River has its source in the foothills of the Fouta Djalon Ridge (World Bank, 2017). It flows over a distance of 90 km before entering Sierra Leone where it joins on the left the tributary of Mongo which also has its source in Guinea not far from that of the Kaba. After the confluence between the Kaba and the Mongo, the river also bears the name of Little Scarcies. The other main tributaries of the Kaba / Little Scarcies are the Lolo, the Pinselli and the Mamouwol, all on the right bank (See Table 14 below).

Table 14. Main tributaries of the Kaba River in Guinea

Watercourse	Bank	Length (km)	Area of Sub-Basin (km²)
Mamouwol	Droite	58	539
Pinselli	Droite	67	937
Lolo	Droite	63	1064
Mongo	Gauche	82	1229

Source: TDA-RG, 2020

The hydrograph of the Kaba, like that of the Kolenté, is unimodal and broadly reflects the annual distribution of rainfall (See Fig. 10 and 11 below).

The average river flow increases considerably from upstream to downstream. It is only 30-35 m3 / s per year at the Koromayo station in Guinea (for the period 1981-2016) and more than 600 m3 / s at Mange in Sierra Leone (period 1951-1989), after the confluence between the Kaba and its main left bank tributary, the Mongo (World Bank, 2017).

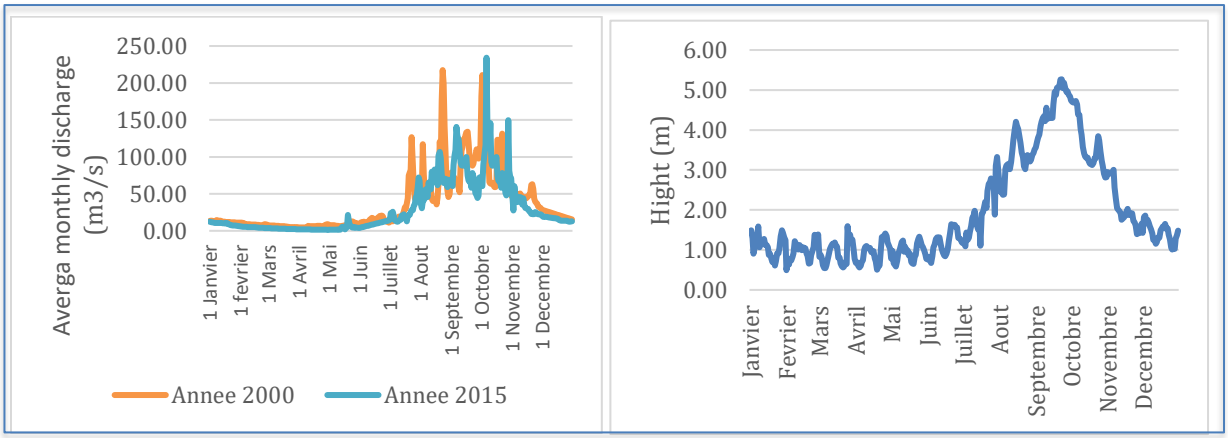
c. Seasonal and interannual variability of the hydraulicity of the Scarcies

The average flow of the Kolenté (measured at Tassin in the border reach between Guinea and Sierra Leone) varies between 65 m3 / s and 135 m3 / s per year, i.e. an annual flow volume of 2 to 4.2 billion m3 . The same station records 80% of the annual volume of flows from the Kolenté between July and November.

Similar characteristics are also observed for the Kaba. At the Koromaya station in Guinea, more than 75% of the annual volume of flows from the Kaba is recorded between July and November and nearly 60% between August and October (Fig. 10 & 11).

Figure 10. Annual Hydrograph in Koromaya (Kaba / Little Scarcies) in Guinea in 2000 and 2015

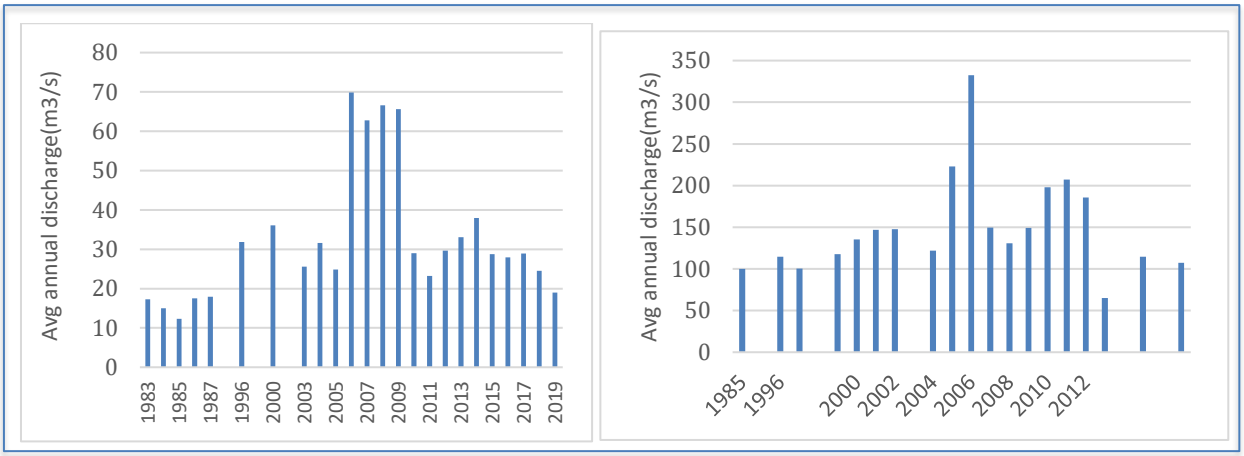
Figure 11. Annual Hydrograph (year 1975) of the Kaba (Little Scarcies) at Mange (Sierra Leone).



Source: www.nwrm.gov.sl/data/surface-water

Figure 13. Evolution of average annual flows of the Kaba at Koromaya (Upper Kaba Basin, Guinea

Figure 12. Evolution of the average annual flows of the Kolenté at Tassin (middle-lower valley of the Kolenté, Guinea-Sierra Leone border).



Source: DNH database, Guinea via TDA-RG Team, 2020)

2.1.2.3. Hydrogeology and groundwater resources

The Guinean parts of the Scarcies basins are in the Fouta Djallon foothills to the west and north-west and the Guinean Ridge to the east and south-east.

The rocks of the Fouta Djalon foothills (forming in a large proportion part of the granite basement) generally have a very low aquifer capacity. In granites and sandstones, water can be found in cracks or pockets of permeable rocks.

Where they exist, aquifers are localized, contain small volumes of water and are discontinuous with a depth not exceeding 100 m. These aquifers are recharged by rainwater. In this zone, the boreholes are therefore located locally, with a productivity that varies from 0.7 to more than $2m^3$ / hour depending on the geological sectors (World Bank, 2017).

The middle valleys of Kolenté and Kaba are largely located in Sierra Leone, a country covered with more than 75% by the Precambrian basement. The basement consists of a weathered upper layer and an underlying fractured rock. The upper layer shelters the groundwater exploited by wells and boreholes 15 to 60 meters deep. In the underlying crystalline rock, water is found in faults exploited by boreholes varying in depth on average from 35 to 60 m. Given its depth, the existence of a clay layer below the upper layer, the underlying crystalline rock waters are relatively protected against pollutants associated with practices such as mining, agriculture and land degradation (Fileccia et al. 2018).

The hydrogeology of the low valleys of the Scarcies, in the coastal zone, is characterized by sandy-clay sedimentary soils where the aquifers have greater water productivity compared to those of the basement countries upstream ”(RG-TDA-Stakeholders, 2020).

2.1.3. Bio-geographic context

In a simplified form, three types of biogeographical zones can be distinguished in the basins of the Scarcies. At the sources of the Kolenté and the Kaba in the Fouta Djallon foothills and the Guinean Ridge, the Sudanese-type landscape presents various formations ranging from open forest, to wooded, shrub or grassy savannah.

The middle courses of the Scarcies are located in the Guinea-Congolese / Sudanese transition zone. The dominant vegetation here consists of a mosaic of rainforest and grassy formations dotted with patches of clear forest. (Yoboue, 2017; White, F. 1986).

The low valleys and estuaries of the Scarcies belong to the humid coastal zone with soils generally of the ferralitic type. The red-brown soils of the lowlands and marl-limestone or black clay of the depressions and those of the mangrove contribute to the pedological diversity of this zone (Yoboué, 2017).

2.1.3.1. Flora and fauna

a. Flora

The high basins of Kolenté and Kaba (Guinean parts) are characterized by the alternation of degraded wooded savannah and old or recent fallows. Gallery forests line the banks of rivers (RG-TDA-Stakeholders, 2020; TDA-RG, 2020). The main ones found in the high basins of the Scarcies are: *Alchornea cordifolia* (which one meets especially in gallery forests), *Prosopis africana*, *Parkia biglobosa* (the néré), *Pterocarpus erinaceus* (the veen whose wood is very sought after), *Erythrophleum guineensis, Afzelia africana, Borassus aethiopum* (the palm tree), *Milicia regia* (simme in Guinea or iroko), *Ceiba pentandra* (also called fromager or kapok), *Cola cordifolia, Cassia sieberiana, Daniellia oliveri, Mitragyna stipulosa*, etc. (TDA-RG , 2020)

Three main types of landscapes can be distinguished in the high basins of the Scarcies:

- Xerophilic savannas comprising islets of *Anisophyllea laurina, Elaeis guineensis* (oil palms) or even *Parinari excelsa* (guinea plum) of the plains.
- The vast expanses of forest with a tropophilic tendency today presenting the largest formations of post-forest shrub recruits on the slopes. The species most represented in these recruits are *Albizia zygia, Berlinia grandiflora, Clerodendrum sinuatum* and *Clerodendrum splendens, Euadenia trifoliata, Napoleona heudelotii, Nepenthes vogelii, Spondianthus preussii, Syzygium guineense var. macrocarpum*.
- Plantations of Tectona grandis (teak tree) or *Gmelina arborea*, in the classified domain but also in community and private forests which are well developed in the Guinean parts of the Scarcies and which, in addition to Teak and Gmelina, are also devoted to species such as *Australian acacias* (*Acacia mangium* and *Acacia auriculiformis* mainly), *Gliricidia sepium* and *Anacardium occidentalis* (cashew tree). (TDA-RG, 2020).

The middle valleys of the Scarcies shelter a landscape similar to that of the high basins. This is the "farm bush" landscape, generally referring to a degraded form of primary forest, the degradation process having been brought about by practices such as bush fires used as an agricultural technique, logging. , or deforestation linked to mining activities. E (CEMMATS Group Ltd. 2012)

In the lower valleys and the Scarcies[6] estuarine zone, the mangrove is the dominant feature of the landscape. The area covered by mangroves in the valleys (sometimes up to 15 km upstream) and coastal areas of the Scarcies was estimated in the 1970s at 13,000, or 7% of the total mangrove area in Sierra Leone at the time. (FAO, 1979; EPA-SL, 2016; TDA-SL, 2020)

The mangroves of the Scarcies estuary are mainly composed of Avicennia and Rhizophora. The dominant species is *Avicennia germinans* or *Avicennia africana* (black mangrove) Other main mangrove species include *Rhizophora racemosa* (red mangrove) and *Rhizofora harrisonii*, *Laguncularia racemosa* (white mangrove), etc. (FAO, 1979; TDA-SL, 2020).

Due to demographic pressure and overexploitation, the mangrove has declined sharply in recent years. USAID estimates that nationally, Sierra Leone's mangrove area has declined by an average of 25% since 1990, with notable variations in levels of decline from location to location. In the Scarcies estuarine zone, a higher level of degradation (46%) was recorded, mainly due to the expansion of rice fields to the detriment of mangrove areas (USAID, 2017a).

Despite its decline in terms of area occupied, the residual mangrove swamp of the lower valleys and the Scarcies estuary seems to maintain a good conservation status, which is reflected by it's great species diversity. The area is still today one of the key stages in the seasonal migrations of Palearctic birds (USAID / WaBICC, 2018; TDA-SL, 2020)

b. Wildlife

The diversity and spatial distribution of fauna largely reflects the evolution of flora. Areas of high density and diversity of flora are generally areas of high concentration of fauna. The landscape of the Scarcies basins is in areas of degraded wooded savannah with relics of dense forest preserved in gallery forests and protected areas. It is in these areas that we find the highest concentrations of the most representative species of the area.

In the upper Guinean basin of the Kolenté, the main representative species of fauna are found in the Kounounkhan forest. These include chimpanzees, harnessed bushes, yellow-backed duikers, warthogs, bush pigs, monkeys, rodents and avifauna (TDA-RG, 2020).

In the upper Kaba basin, the numbers and diversity of wildlife have declined sharply, due to hunting and loss of wildlife habitat following deforestation and bush fires. The dominant species are chimpanzees which benefit from full protection status, buffaloes, hippopotamuses, waterbucks, duikers, warthogs, monkeys, rodents (agoutis, porcupines, squirrels), reptiles and avifauna specimens" (ADT-RG, 2020).

[6] The Scarcies Estuary is formed by the merger of the mouths of the Great and Little Scarcies. It is one of the three largest estuarine systems in Sierra Leone, alongside the Sierra Leone River and Sherbro River Estuaries

In the Sierra Leonean parts of Scarcies, large fauna (elephants, leopards, lions, hyenas and buffaloes) can still be seen, albeit in reduced quantities, in national parks and reserves. Chimpanzees and different species of monkeys are found in forest areas, while other species such as antelopes are more common in savannah areas.

Hippos include the rare species of the pygmee hippopotamus (*Choeropsis liberiensis*), crocodiles and manatees in waterways. Rivers, coastal and estuarine waters are home to a great diversity of aquatic species - fish and crustaceans, including tuna, barracuda, herring, mackerel, lobster (TDA-SL, 2020).

As indicated above, the avifauna of the Scarcies estuary were able to survive without much damage to the period of crisis that Sierra Leone experienced. Avian species such as *Chrysococcyx cupreus* (cuckoo foliotocol) are still found in the estuary. the owl, the vulture's swift, etc. (TDA-SL, 2020).

2.1.3.2. Biodiversity hotspots and ecosystems of critical importance in the Scarcies basins

A biodiversity hotspot is a biogeographical region which is a reservoir of biodiversity of great importance threatened with destruction. There are 36 hotspots in the world including the Guinean Forest of West Africa which covers the primary forests that stretch from Guinea in the West to Cameroon via Sierra Leone, Liberia, Cote d'Ivoire, Ghana, Togo, Benin and Nigeria. It is estimated that this ecosystem is home to 936 animal and plant species that are part of the list of threatened species in the world. The Guinean Forest offers unique habitats for primates, some of which are endemic to the region. It also plays a role in regulating the global climate (CEPF, 2015). Of the 1,709 species of mammals, birds, reptiles and amphibians inventoried in the hotspot, 251 (or nearly 15%) are threatened.

Within the Guinean Forest hotspot, CEPF identifies 124 key biodiversity zones (KBAs) including 53 in the MRU countries: 15 in Côte d'Ivoire, 11 in Guinea, 18 in Liberia and 9 in Sierra Leone . Two of these KBAs are the Scarcies basins: the Kounounkhan (or Konoukan) forest and the Scarcies estuary watershed. A KBA is defined as a place that contributes significantly to the persistence of biodiversity on a global scale, for example, by supporting threatened species and species with sharply reduced ranges globally. The KBA is an area of land and / or water that is actually or potentially manageable as a single unit (e.g. a protected area or other managed conservation unit) (CEPF, 2015). (Table 15)

Table 15. Key Biodiversity Zones in the Scarcies Basins

Basin	Country	Code	Key Biodiversity Zone (KBA)	Area (ha)
Scarcies	Guinée	GIN7	Kounounkhan	10.644 (including 5,000 for the classified forest)
	Sierra Leone	fw8	Rhombe Marsh and the mouth of the Little and Great Scarcies Rivers	88,460 (including 10,200 for the marine protected area _

Source: CEPF, 2015

Located in the Guinean part of Kolenté, the forest of Kounoukan (or Kounounkan), Prefecture of Forécariah, was set up as a reserve in 1994. It corresponds to the old classified forest of Kamalaya covering around 10,000 ha.

In addition to the Kounoukan Wildlife Reserve, the Kolenté basin is home to 3 designated forests, the largest of which is Botokoly, covering 23,000 ha east of Kindia. The others are those of Balandoudou (2,800 ha) and Sountouyanfou (11,000 ha) (TDA-RG, 2020; Republic of Guinea, 2010; UNEP-WCMC. 2021).

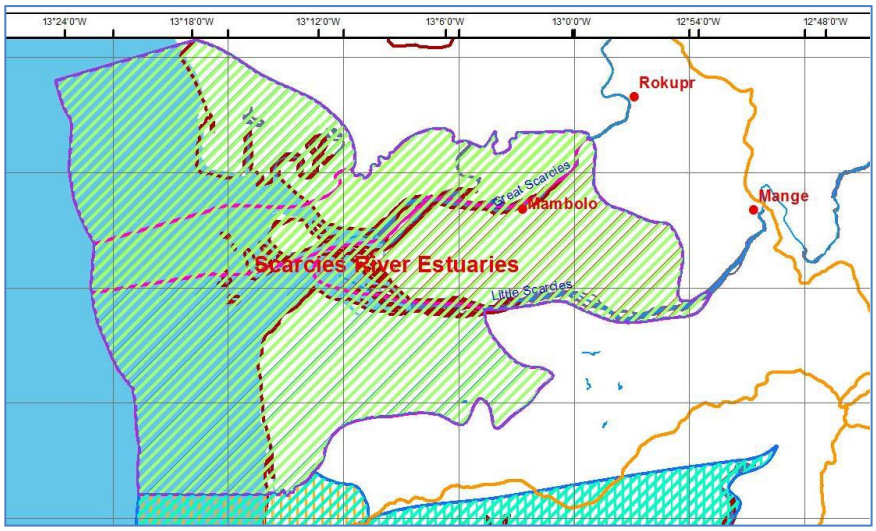
In the Guinean part of the Kaba, the classified state domain includes seven (7) forests including three (3) in Saramoussaya, two (2) in Kégnéko, one (1) in Soyah and one (1) in Ourékaba (TDA-RG, 2020). There are also about twenty community forests (including 14 in the Prefecture of Kindia and 4 in that of Forécariah) (TDA-RG, 2020).

In the Sierra Leonean parts of the Scarcies, the most biologically important ecosystem is Outamba-Kilimi National Park, located along Sierra Leone's northwest border with Guinea. The park is made up of two separate units: Outamba (78,300 ha) in the east and Kilimi (27,400 ha) in the west. Both sections are mainly covered by wooded savannah with some small areas of forest, gallery forest and open savanna. In general, Outamba is more wooded than Kilimi and has more marked relief. The park was established in 1995 in response to pressure from hunting which threatened the survival of the region's wildlife. It is Sierra Leone's first national park (CILSS, 2016).

The protective measures implemented have up to 2010 relatively contributed to limit human influence in the park and ensure the survival of the populations of nine species of primates including the chimpanzee, the red colobus monkey, the black and white colobus monkey, the olive baboon. , etc. The park is also home to varying numbers of large mammals including elephants, hippos, warthogs, bush pigs, leopards, African buffaloes, bushbucks, bongos, duikers, gazelles and other antelope species. Over 250 species of birds have been counted in the park. (CILSS, 2016; WAPP, 2011). In recent years, bushfires, poaching and mining have become major threats to the park (CILSS, 2016; WAPP, 2011).

Other sensitive ecosystems in the Sierra Leonean parts of the Scarcies include the Scaricies River Estuary Marine Protected Area - Scarcies River Estuary - designated in 2012 and covering 10,200 ha (UNEP-WCMC, 2021). The protected area includes a marine zone and an intertidal zone (Fig. 14). As indicated above, the estuarine zone is formed by the merger of the Little and Great Scarcies rivers giving a common mouth to these two rivers. The mangrove covers the estuarine area of the coast nearly 15 km upstream from the Scarcies river basins. It represents nearly 8% of the mangrove areas in Sierra Leone. The area offers a rich diversity of aquafauna: 152 inventoried species, including gwangwa (*Pseudotolithus elongatus*), various species of captains (*Pseudotolithus spp .*; *Galeoides decadactylus*), coastal pelagic species such as sardinella (*Sardinella spp*), Bonga (*Ethmalosa fimbriata*), manatee (*Trichechus senegalensis*), shrimp (especially pink shrimp or *Penaeus notialis*). The area is also home to endangered species such as sea turtles, phocoenids or porpoises, sawfish (*Pristis pristis*), crocodiles (*Crocodylus niloticus*). The estuary is a seasonal staging area for migratory birds (Sankoh, 2019). Despite its classification as a protected zone, the Scarcies Estuary is undergoing a significant process of mangrove degradation, due in particular to the expansion of rice fields and the development of infrastructure (roads in particular) (Konoyima. 2020).

Figure 14. Marine Protected Area of the Scarcies Estuary



Source Sankoh, 2019.

2.2. Demography and Incidence of Poverty in the Scarcies Region

The socio-economic analysis of the Scarcies basins is largely based on national and international statistics disaggregated at the sub-national level - Administrative Regions, Prefectures and Sub-Prefectures for Guinea and Provinces, Districts and Chiefdoms in Sierra Leone.

The Great Scarcies / Kolenté and Little Scarcies / Kaba Basins fully or partially cover the following territorial units:
Guinean parties (TDA-RG, 2020):

- Great Scarcies / Kolenté:
  - o Prefecture of Kindia in particular the following sub-prefectures: Urban Commune of Kindia; Bangouyah; Kolenté; Souguéta; Molota; Madina- Oula.
  - o Prefecture of Forécariah, in particular Sub-Prefecture of Moussaya
- Little Scarcies / Kaba:
  - o Prefecture of Mamou in particular the following sub-prefectures: Urban Commune of Mamou; Kegneko; Saramoussaya; Konkouré; Ouré-kaba; Soyah.

Sierra Leonean parts:

- Great Scarcies / Kolenté:
  - o Kambia District
- Little Scarcies / Kaba: Districts of Port Loko; Bombali; Koinadu; and those of Karene and Falaba, after the reorganization and redistribution of the territorial administration in 2017, the new Kanene Districts having been constituted on the basis of punctures mainly on the territories of the Districts of Port Loko, Bombali and Koinadu.

2.2.1. The demography of the Scarcies Basins

The population of the Scarcies Basins - based on the available data of the population in the territorial entities fully or partially covered by the said basins - can be estimated at 2,147,000 people in 2011-2014, or 12% of the cumulative population of Guinea. and Sierra Leone at the time (17,785,752

people). For Guinea, the inhabitants of the national portions of the Scarcies represent only 5% of the total population of the country, against 25% for Sierra Leone[7]. This is to be put in relation to the fact that it is only 4% of the Guinean territory (10,700 km2) which is located in the hydrographic basins of the Scarcies while Sierra Leone is covered at 22% (15,600 km2) by the basins of the Scarcies. (Table 16)

Table 16. Estimated population of the Great Scarcies and Little Scarcies Basins (Situation in 2014 for Guinea and in 2011 for Sierra Leone)

Great Scarcies/Kolenté Basin			Little Scarcies/Kaba Basin		
Prefecture /District	Sub-Prefecture	Population	Prefecture /District	Sub-Prefecture	Population
Kindia	Commune Urbaine	170 557	Mamou	Commune Urbaine	83 008
	Bangouyah	52 923		Kegneko	19 134
	Kolentê	31 312		Saramoussaya	23 216
	Sougueta	41 581		Konkouré	13 039
	Madina-Oula	23 381		Ouré-kaba	31 804
	Molota	12 109		Soyah	22 782
Forécariah	Moussaya	38 005	Total Guinean Part		192 883
Total Guinean Part		369 868	Port Loko		515 302
			Bombali		456 125
Kambia		311 454	Koinadu		301 414
Total Sierra Leonean Part		311 454			
			Total Sierra Leonean Part		1 272 841
Total Great Scarcies/Kolenté Sub Basin		681 322	Total Little Scarcies/Kaba Sub Basin		1 465 724
Total Population of the two basins					2 147 046

Sources: For Guinea, INS, 2014; For Sierra Leone: World Bank, 2014

2.2.2. Incidence of Poverty

The incidence of poverty in the Prefectures and Sub-Prefectures (Guinea) and the Districts (Sierra Leone) located in the Scarcies Basins is higher than the national averages. In 2011-2012, 62% of the population of the national portions of the Scarcies lived below the poverty line compared to a national average of 52.5%. (62.5% for the national portion of Kolenté and 69% for that of the Kaba). (See Table 17 and Table 18 below)

The incidence of poverty in the two national portions of the Scarcies are very similar: 62% for Guinea and 57% for Sierra Leone. Poverty is therefore a critical issue in the Scarcies river complex, in particular as a cause or consequence of the unsustainable use or degradation of available resources.

[7] This is largely overestimated, given the Districts (equivalent of the Prefectures) are taken into account and not the Chiefdoms (equivalent of the Sub-Prefectures with the implications that many Chiefdoms located outside the basin could be taken into account.

Table 17. Poverty incidence in the administrative regions covered by the Scarcies Basins in Guinea (2014)

Basin	Region	Population	No of Poor (**)	Percentage
Great Scarcies	Kindia	1 899 668	1 187 292	62,5%
Little Scarcies	Mamou	955 808	581 131	68,8%
Basin Regions		2855476	1 768 423	62%
National		11 947 592	6 272 487	52,5%

Source: INS-Guinea 2012.
Note:
(*) In the absence of statistics at the level of the Sub-Prefecture or the Prefecture, the data available at the level of the Region are used here
(**) Based on the poverty line of 3,217,305 GNF (approximately 450 USD in 2012) per person and per year, i.e. 8,815 GNF (1.25 USD per person per day)

Table 18. Poverty incidence in the Scarcies Basin Districts in Sierra Leone (2011)

Basin	Districts (*)	Population	No of Poor (**)	Percentage
Great Scarcies	Kambia	311 454	167 774	54%
Little Scarcies	Port Loko	515 302	308 927	60%
Little Scarcies	Bombali	456 125	263 825	58%
Little Scarcies	Koinadu	301 414	165 151	55%
Scarcies		1 584 295	905 677	57%
National		5 838 160	3 090 961	53%

Source: World Bank, 2014
Note:
(*) Districts before redistribution of 2017. In 2017 new districts were created, including those of Karene and Falaba, following the redistribution of the districts of Port Loko, Bombali and Koinadu
(**) = The poor are defined here as people living in households with consumption per adult equivalent of less than 1,625,568 Leones in 2011 (approx 380 US $)

2.3. Main uses of the Resources of the Kolenté and Kaba Basins

As we have seen despite its significant natural resources (water, forests, mines), the Scarcies Region is one of the poorest in Guinea and Sierra Leone. This paradox stems from the sub-optimal and unsustainable use of available resources, illustrating their practices and performance in the main sectors of activity dependent on natural resources such as agriculture, livestock, fishing, 'exploitation of forest products or mineral resources.

2.3.1. Agriculture

a. Upper Kolenté and Kaba - Guinea

The dominant agricultural production system in the high basins of the Scarcies and in much of middle Guinea and forest Guinea is extensive slash-and-burn agriculture on the slopes of the hills (the hillsides) and on the plains. The clearing of virgin land is done by burning trees, shrubs and bushes. The first

post-clearing crops often focus on upland rice, which can be associated with millet or maize. With declining soil fertility, crops such as fonio and / or peanuts can replace rice. If yields continue to decline, the land can be left fallow for a few years. This form of agriculture is therefore extensive due to the fact that it is itinerant, but also because the yields are generally low. With demographic pressure, the fallow time is shorter and shorter, leading to the rapid degradation of plant cover and soils as well as to the continuous decline in yields (RG-TDA-Stakeholders, 2020; TDA-RG, 2020; JICA, 2013).

Rice cultivation is also widely practiced during the rainy season (hence high water) in the marshy lands of the lowlands and flood plains. Even if the yields are low, they are generally higher than those obtained in the plains and hillsides.

Whether practiced in the lowlands or in the plains and hillsides, rice cultivation is essentially intended for self-consumption (up to 85% of production).

In the dry season, the bottomlands and the banks of rivers are used for market gardening. The main vegetable crops in the Moussaya Sub-Prefecture are; cucumber, Bulgarian eggplant, okra, chili, watermelon and onion leaves (RG-TDA-Stakeholders, 2020). The expansion of market gardening around rivers and streams, the cutting of wood for the fences of market gardens thus sometimes results in the decline of gallery forests (RG-TDA-Stakeholders, 2020).

The Scarcies Basins offer significant potential for fruit crops. Guinea's "Banana Triangle" - of Benty (Forecariah Prefecture in Kindia and Mamou - reputed to be one of the main fruit and vegetable production areas and Guinea is partly located in the basins of these two rivers. bananas, the basin also produces mangoes, pineapples, citrus fruits and various fruits. Prefectures of Forécariah, Kindia and Mamou Women play a major role in all operations of the production chain, from processing to the marketing of fruits and market garden products (RG-TDA-Stakeholders, 2020).

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b. Middle and Lower Valley: Sierra Leone

If the Guinean part of the Scarcies basins is called the “Banana Triangle” because of the importance of fruit and vegetable production, the Sierra Leonean parts, and in particular the lower valleys and the estuary (in particular the Districts of Kambia and Port Loko) constitute the “Rice bowl” of Sierra Leone. Rice cultivation - one of the main commodities consumed in Sierra - occupies 52% of cultivated land nationwide (SSL, 2017a; Atolojanahary, 2019). Part of the Districts of the Scarcies Basins - Koinadugu, Bombali, Kambia and Port Loko - account for more than a third (37%) of rice-growing areas and a little less than half of national rice production (Atolojanahary, 2019).

Much of the rice is grown in lowlands, floodplain and swampy areas, especially Kambia and Port Loko Districts. Lowland and alluvial plain rice represents 28% of the cultivated areas in the Districts of the Scarcies basins against 35% for upland rice on the slopes and plateaus (see Table 19 below). In recent years, national efforts to achieve food security have resulted in a sharp increase in the area cultivated

with rice - which has grown by 35% nationally (Atolojanahary, 2019, op. Cit). The expansion of rice lands in the middle and low valleys of the Scarcies is often done by the conversion of areas occupied by mangroves.

Besides rice, the other main crops in the Scarcies basins are yam, cassava, peanuts, sweet potatoes, maize (38% of cultivated land).

Table 19. Share of Scarcies Basin Districts in agricultural production in Sierra Leone: rice and other main crops

Districts	Upland Rainfed Rice (ha)	Lowland Rice (ha)	Total Rice (ha)	Other Crops (ha)	Total Cultivated Land Area (ha)
Bombali	77478	45264	122742	74070	196812
Kambia	39250	106041	145291	51302	196593
Koinadugu	107047	67928	174975	77920	252895
Port Loko	101556	78774	180330	129964	310294
Total Scarcies	325331	298007	623338	333256	956594
Total National	1127775	556774	1684549	1532185	3216734
Scarcies Portion (%)	29%	54%	37%	22%	30%

Sources: SSL. 2017a.

The perverse effects of the increasing use of chemical fertilizers, pesticides and herbicides in rice cultivation are increasingly noted. These practices result in the contamination of water and soil with significant damage to flora and fauna. (TDA-SL,2020).

Concluding section - agriculture.

From an agricultural point of view, the Scarcies region is of prime importance for both Guinea (Banana Triangle) and Sierra Leone ("Rice bowl"). Agriculture, which pre-occupies the vast majority of the population, leaves its mark on the landscape. As practiced today in the Scarcies Basins and in the two riparian countries (Guinea and Sierra Leone), agriculture is almost entirely dependent on rainfall or the natural process of alternating floods and recession in the main stream beds and in the alluvial plain. Water control is almost non-existent. As a consequence of this, agricultural activity is mainly concentrated on the short rainy season (July to October-November), which also corresponds to the high-water season in rivers. The long "agricultural off-season" is a major shortfall that the populations of the Scarcies, who are among the poorest of the two countries, could do without.

Current agricultural practices in the Scarcies Basins pose significant challenges to the environment and to human and animal health. As population pressure increases, fallow times are shortened. Soils quickly become depleted and yields decline. New land is then cleared, which implies the multiplication and intensification of the practice of burning, with the consequence of deforestation and forest retreat.

National efforts (in Guinea but especially in Sierra Leone) aimed at increasing cereal production, in particular rice production - a commodity of strategic interest for food security - are leading to the conversion of more and more mangrove land which is replaced by rice fields.

The increasing use of chemical fertilizers, pesticides and herbicides has so far had no tangible effects on agricultural yields and productivity in general. But the resulting environmental and health cost is very significant: pollution of water and soil, contamination of flora and fauna as well as groundwater with major impacts on biodiversity and the health of populations.

2.3.2. Fishery resources - fishing

Fish consumption is very important in the Scarcies region. Fish is used in many local dishes, especially those based on rice. Fish is therefore one of the main sources of protein for the populations of the Scarcies Basins.
The main purpose of freshwater fishing in the Scarcies Rivers and their tributaries is to meet local consumption needs, which explains why fishing activity is quite limited.

During field visits to the Kolenté Sub-Prefecture (in Guinea), officials questioned about this confirmed that there was relatively little fishing activity in the Kolenté River and its tributaries. The situation is comparable in the Kaba River. For the leaders of the communities encountered on the banks of the Kaba (Mamou Prefecture), it is migrants from Mali in small numbers who are the main fishermen in the Kaba.

In the downstream parts of the Kolenté and the Kaba (Sierra Leonean parts), fishing activity appears to be more important than upstream. The consumption of fish associated with rice also seems to be more important. The District of Kambia (middle and lower Kolenté) and to a lesser extent that of Port-Loko (lower valley of the Kaba) are the "Rice Bowl", the granary, one of the most important rice production areas of Sierra Leone. In the lower valleys and the Scarcies estuary, freshwater fish are caught more often during the rainy season, while in the dry season the activity is oriented more towards sea fish, mainly small pelagic species such as *Ethmalosa fimbriata* (bonga), *Sardinella madarencsis* (flat herring) and *Ilisha africana* (latti) (Sankoh et al. 2018).

In the Scarcies Basins, in particular in the Bombali , the migration calendar and the fish reproduction cycle punctuate the fishing activity. At the start of the rainy season, when the fish leave the minor bed of the rivers to migrate towards the breeding grounds (spawning grounds), the tributaries and especially the flood plains and the marshes, the populations install barriers or dig holes to trap fish. Some of the main species of freshwater fish caught in the area include Clarias species (freshwater catfish); *Heterobranchus* longifilis (African Catfish); *Synodontis annectens* (African Rock Catfish); *Hepsetus odoe* (African Pike).

Aquaculture is an important dimension of fisheries in the Scarcia basins, especially in the Sierra Leonean parts of the middle and lower valleys of both rivers. Of the more than 2,000 fishponds identified in 2018 by USAID in this area, 85% were made through individual or family farms. The highest concentrations of ponds are Chiefdoms of Konike Barina and Konike Sanda in Karene District in the Little Scarcies Basin. However, it must be said that a small proportion of private and family ponds inventoried in the two Districts, only 131 were operational (Sanko et al. 2018 op.cit.). The middle and

lower valleys of the Scarcies therefore offer great potential for aquaculture - potential for the moment underexploited.

Regarding the challenges, the populations encountered in the upper basin of Guinea have raised the increasingly important arrival of immigrants using unauthorized boats and fishing equipment and practicing fishing activity illegally. Further downstream, respondents in Mange (PortLoko District in the Great Scarcies Basin) and Kaba Ferry (Little Scarcies) mentioned the decline in fish stocks due to overfishing facilitated by the use of unsuitable fishing nets.

2.3.3. Livestock

In the Scarcies Region, in both Guinea and Sierra Leone, most rural households practice animal husbandry, an activity often integrated with agriculture. In the high basins in Guinea, between 20 and 25% of the country's cattle, sheep and goats are raised in the Kindia and Mamou Regions, which are partially in the Scarcies Basins (See Table 20). Cattle breeding is more developed there upstream of the Scarcies, for example in the sub-prefectures of Bangouya (Mandina Fanta and Koreah), Kolenté and Madina-Oula (RG-TDA_Stakeholders, 2020; TDA-Guinea, 2020).

Table 20. Livestock numbers in the upstream zone of Scarcies (Kindia and Mamou regions in Guinea). Ref. Situation 2018

Regions	Cattle	Sheep	Goats	Pigs
Kindia	954	348	313	1 977
Mamou	716	326	335	33
Total for Scarcies Region	1 670	674	648	2 010
National	**7 520**	2 709	3 196	140 255
Scarcies Region's Portion in %	22%	25%	20%	1%

Source: TDA-RG Team, 2020

In Sierra Leone, households in the Scarcies Districts (Northern Province) have by far the largest proportion of the national herd: 84% of cattle, 64% of sheep and 55% of goats, against however 22% of pigs (SSL, 2017). The District of Koinadugu, partly in the Little Scarcies Basin, on the northeastern border with Guinea, holds 80% of the cattle and about 50% of the small ruminants in the Scarcies Region.

Table 21. The share of the Scarcies Basin Districts in the distribution of livestock in Sierra Leone

DISTRICTS	Cattle	Sheep	Goats	Pigs
Bombali	47 592	56 684	78 727	3 190
Kambia	16 375	50 719	63 983	1 755
Koinadugu	309 291	191 788	212 634	2 892
Port Loko	20 105	68 581	92 740	4 801
Scarcies Total	393 363	367 772	448 084	12 638
Total National	465 817	574 706	814 269	57 877
in %	84%	64%	55%	22%

Source: SSL, 2017

If the Scarcies zone (in Guinea as in Sierra Leone) is a prediction zone for the breeding of small and large ruminants, it owes it to the fact that it offers vast areas of grassy savannah.

2.3.4. Exploitation of forest resources

Forests in the MRU area have declined sharply over the last four decades, by around 30% between 1990 and 2020. As shown in Table 22 & 23 below, in Guinea and Sierra Leone - which share the Scarcies Basins —A decrease of 15% and just under 20% was observed in the two countries, respectively (FAO, 2020a).

Where forests have survived, they are often in an advanced state of degradation. Thus, according to the FAO (2020b), if the forest today (2020) covers 2,535,000 ha, i.e. nearly 33% of Sierra Leonean territory, primary forest only represents 0.8% (57,000 ha) of national territory, which means that they cover only ¼ of their area in 1990, a period during which it is estimated that they covered 224,000 ha (3% of the country's area). The mangrove forests, a large proportion of which are found in the Scarcies Estuaries, cover an area of 85,000 ha (2020), a decrease of 40% compared to the situation in 1990 (145,000 ha). The area of plantation forests has tripled from 6,680 ha in 1990 to 21,310 ha today (FAO. 2020b).

This trend of accelerating deforestation can be observed more clearly at the scale of the Scarcies Districts in Sierra Leone. The Global Forest Watch database notes that forest cover in these Districts has declined on average by 1.2% from 2000 to 2010 and then by 20% from 2010 to 2020. Over the past 20 years, the Middle and Low Districts Scarcies valley in Sierra have lost 21% of their forest cover. The Districts of Port Loko (36%) and Kambia (30%) are the most affected by the deforestation process (see Table 22 & 23. Below).

The rapid decline and degradation of forests is explained by the exploitation of timber (timber such as wood used as an energy source), the almost generalized practice of bush fires, whether or not associated with slash-and-burn agriculture, the conversion of mangrove forests into rice fields, or the unsustainable exploitation of non-timber forest products. For the populations of Kaba Ferry (downstream area of Little Scarcies), deforestation is largely linked to the strong demand for charcoal for the towns. Otherwise, on the road to Kaba Ferry one also encounters a large number of logging trucks carrying tree trunks from the interfluve zone between Little and Great Scarcies. These trucks use the Kaba Ferry to access their supply point.

Table 22. Evolution of forest cover in the Districts of the Scarcies basins from 2000 to 2020

District	Total Area (ha)	Forest Cover 2000 (ha)	Loss 2001-2010 (ha)	Forest Loss 2001-2010 (%)	Forest Loss 2011-2020 (ha)	Forest Loss 2011-2020 (%)	Forest loss 2001-2020 (ha)	Forest Loss 2001-2020 (%)
Bombali	821549	389516	4192	1,1%	65453	17,0%	69645	17,9%
Kambia	308172	130436	2084	1,6%	35983	28,0%	38067	29,2%
Koinadugu	1239824	1059418	13140	1,2%	155612	14,9%	168752	15,9%
Port Loko	594937	394945	5651	1,4%	138069	35,5%	143720	36,4%
TOTAL	2964482	1974315	25067	1,27%	395117	20,01%	420184	21,28%

Source: WRI, 2021

Table 23. Evolution of forest areas in the countries sharing the Scarcies Basins

	Forest Area (x1000 ha)				Annual Net Change (thousands of ha /year and in %)					
Country	1990	2000	2010	2020	1990-2000		2000-2010		2010-2020	
Guinea	7276	6929	6569	6189	-34.7	-0.48%	-36	-0.52%	-38	-0.58%
Sierra Leone	3127	2929	2732	2535	-19.8	-0.63%	-19.7	-0.67%	-19.7	-0.72%
MRU	26779	23175	21187	19178	-360.4	-1.35%	-198.8	-0.86%	-200.9	-0.95%
Africa	743000	710000	676000	637000	-3300	-0.44%	-3400	-0.48%	-3900.0	-0.58%

Source: FAO. 2020a

2.3.5. Exploitation of mining resources

Mining activity moves large amounts of rock and various earth materials, changes configuration and hydrodynamics, mobilizes large volumes of water and uses various pollutants in quantity. To better understand how mining affects the physical and human environment, this subsection uses the example of diamonds. The types of diamond mining and the processes used - which are very similar to those used for gold mining - are very succinctly described.

a. Types of mineral deposits and forms of mining

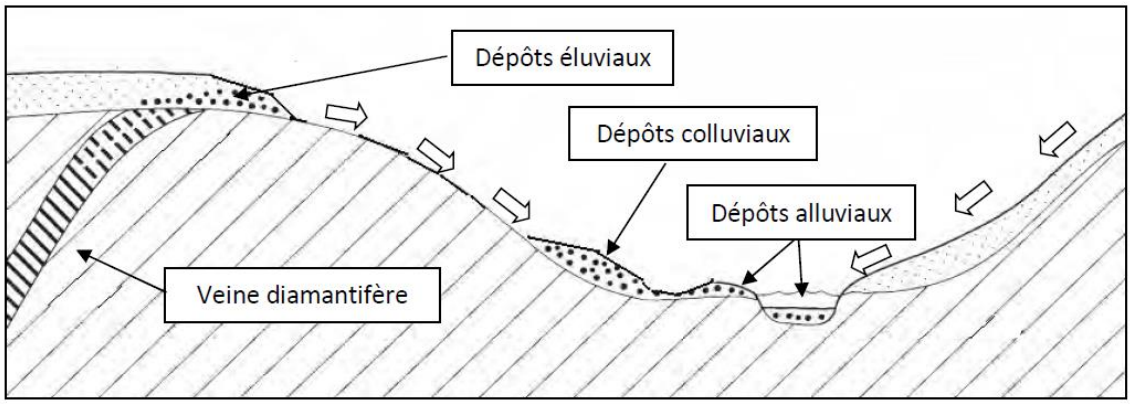
Diamond forms in the bedrock and is then transported to the surface by rocks such as kimberlite and lamproite of volcanic origin. The primary deposits (located in the rock itself) are made up of pipes and dykes, which contain kimberlitic or lamproite rocks. Primary deposits are generally subject to industrial exploitation because they require heavy means. As for the secondary deposits, also called "placers", they result from the erosion of the rocks containing the primary deposits and the concentration of diamonds released in rocks or specific deposits, which are the diamondiferous sediments. These include:

- Eluvial deposits develop in situ from weathering of the main source rock.
- Colluvial deposits are eroded rocks that have been transported downward by gravity, and are usually found at the foot of slopes.
- Alluvial deposits have been transported downstream from their bedrock by river systems, and eventually settle in rivers or on their banks.

Likewise, gold can occur in its native state in the form of a vein, can also be included in ultrabasic rocks or be found in alluvial deposits (ESIES, Daapleu),

Artisanal or small-scale diamond and gold mining generally involves secondary deposits and, in the MRU / UFM Area, primarily alluvial deposits.

Figure 15. Diagram of the types of diamond deposits in a secondary deposit



Source: Yoboué. 2017.

In artisanal gold mining, artisanal miners dig the ore with pickaxes and shovels. The ore is then collected using containers such as buckets, cans and then stored in piles. Water can be poured into the holes (pits or wells) to make the rock loose and easier to extract. As you dig, you can reach the water table, which will therefore have to be extracted using motor pumps (ESIA, Daapleu). The ore taken out of the pit is then subjected to crushing, pulverization or kneading of the ore using grinders to obtain powder. The amalgamation of the powder makes it possible to reduce the volume of ore – we can then end up with a volume to be treated 100 times smaller than the initial volume. The amalgam is then heated to extract the gold as porous gold, which must then be smelted to obtain ingots.

The amalgamation process uses large amounts of mercury: 3 to 50 units of mercury per unit of gold extracted from the ore. The burning of the amalgam can be done by processes, which capture a good part of the mercury rather than releasing it entirely to the open air. Amalgamation residues can still sometimes contain significant amounts of gold that can be extracted by leaching with cyanide. Cyanide - itself highly toxic - dissolves mercury and increases its mobility in aquatic ecosystems and also releases it into the atmosphere. The cyanide leaching of mercury-containing materials is particularly harmful to health and the environment (UN-Environment, 2019). However, this cyanide leaching step is not always included in the artisanal gold mining process.

b. Importance of mining in the MRU and Scarcies

Mining - diamond, gold, bauxite, etc. - plays a central role in the economies of the MRU countries, and in particular in the Scarcies basins between Guinea and Sierra Leone. A GIZ report (2020) estimates that in each of these two countries nearly 300,000 people live directly from artisanal mining and 1.5 million to 1.8 million people benefit indirectly (GIZ, 2020). When it comes to diamonds in particular, Sierra Leone is the largest producer in West Africa. Diamond mining is estimated to employ at least 150,000 people in Sierra Leone and 200,000 in Guinea, compared to 450,000 for the entire MRU area (UNDP & Alert International. 2006).

c. Main mining areas in the Scarcies Basins

In the upper Scarcies basin (Guinean part), mining activities are limited to artisanal gold mining in places and through the exploitation of bauxite and limestone. However, major mining projects are in the offing there (TDA-RG, 2020). Among the many bauxite deposits found in or near the Guinean part of the Scacrcies, we can mention the sites of Débélé and Kindia (locality where the Compagnie de

Bauxite de Kindia is based). Added to this is the limestone deposit discovered at Sougueta, near the Kolenté source (RG-TDA-Stakeholders, 2020).

Although in Sierra Leone the main diamond mining areas are the Districts of Kono and Kenema (Tongo site), the Scarcies Basin has a few number of diamond mining sites mainly artisanal, particularly in the area between the two rivers and in particular in the area which extends from the chiefdoms of Sella-Limba-Kamakwe (District of Karene) and Kamuke and Wara-Wara Bafodea (District of Koinadugu) (Yoboué, 2017) and also artisanal gold mining around Laminaya in the Karene Districts.

d. Who are the mining operators?

Artisanal mining is an important source of employment and a crucial livelihood for communities living in the Scarcies Basin. During discussions with villagers from Kampala (Chiefdom of Sanda Loko, District of Karene, between the two Scarcies), we learned from the testimonies received that gold panning is one of the main sources of income for more than 65% (TDA-SL, 2020). In the Chiefdom of Sella Lima (with Kamakwe as the capital), in the years 2006-2007 there were more than 10,000 young people engaged in artisanal mining (Yoboué, citing other sources).

Besides bauxite in the Guinean part of the Scarcies, large-scale industrial mining companies are virtually absent from the Scarcies basin. Semi-industrial mining companies run by foreigners (in this case Chinese) are reported in diamond deposits in the Sierra Leonean parts of the Scarcies. However, the majority of foreigners active in the sector - mainly nationals of neighboring West African countries - are in gold mining.

e. Impacts and challenges related to mining in the Scarcies Region

The Scarcies Basins, like the MRU member countries, are rich in various mineral resources. They are home to several mining sites including bauxite and diamonds. Mining mobilizes large amounts of rock, often in beds or near streams. The mining process also uses large volumes of water. Consequently, mining has a profound effect on the environment of the basins and constitutes one of the main challenges for the sustainable management of basin resources. Some of the impacts of mining on water resources and the environment include the following:

Sampling of large quantities of water. Large amounts of water are pumped from streams (the main arms of rivers as well as tributaries) either to facilitate digging or to wash off the powdered ore.

Rivers and their tributaries as dumping grounds in mining processes: Both artisanal and industrial gold mining sites dump on yards or allow wastewater to infiltrate, which either has high turbidity or is contaminated with mercury or cyanide and various heavy metals. Mining companies and gold miners thus use rivers and their tributaries as dumping grounds for mineral residues and waste and polluted water.

Modification of the configuration and hydrodynamics of rivers: Artisanal mining in alluvial deposits often leads to the modification of the route and configuration of river beds, following interventions such as the construction of dams and gutters of variable length, the deposit of large quantities of waste water, rock and ore residues on the banks or in watercourses, which leads to the narrowing of the bed or the diversion of the flows. (Yoboue, 2017)

Contamination of surface water with heavy metals, with effects on ecosystems and animal and human health: As mentioned above, both artisanal diamond and gold mining activities accumulate large amounts of waste rock and tailings. Exposed to the open air, this residue undergoes oxidation phenomena on contact with water, facilitating the appearance of heavy metals such as iron, zinc, lead, manganese, etc. which affects water quality, especially surface water (Yoboué, 2017).

With the massive use of mercury and cyanide, industrial and artisanal mining poses a major environmental and social challenge for the region. The quantities of mercury and cyanide used in mineral exploitation pollute water and soil and, in some cases, enter the food chain if not controlled through rigorously managed processes. This is valid for artisanal and small-scale gold mining, more than diamond which uses less input of pollutants to extract the ore (Yoboue, 207, op. Cit)). Industrial gold mining also uses large amounts of cyanide. For example, it is estimated that in some cases, up to 0.3 to 2 kg of cyanide per tonne of an ore is required to dissolve and extract the gold (Moisan & Blanchard, 2012).

Acceleration of the process of deforestation and land degradation: The proliferation of mining sites, soil stripping, the excavation and mobilization of large quantities of roles, the use of wood products for the burning of amalgam, the clearing of the areas of residence of immigrant miners, are as many factors that contribute to the acceleration of deforestation and soil erosion. Even protected areas are not spared. This is how intense mining activities are noted in several areas on the outskirts and even inside Outamba Kilimi National Park (Yoboué, 2017)

The negative effects of mining on the waters of the Scarcies Basins are visible in some localities, such as in the two Scarcies river basins, in the vicinity of Kamakwie (Karene District). A Chinese mining company operating in the area and gold miners active in sites such as those of the Chiefdom of Sanda Loko zone seem to be the source of significant negative impacts on the quality of water resources, soils and vegetation (TDA-SL, 2020).

2.3.6. Exploitation of water resources

The Scarcies Region, like the other MRU countries, has large quantities of water, rainwater and surface water. The fact that the Scarcies region is one of the poorest of the two riparian countries (Guinea and Sierra Leone) is certainly related to the low level of use, development and development of fresh water resources.

2.3.6.1. Current situation

a. Water in irrigation

Agriculture in the Scarcies Basins is mainly rainfed and to a certain extent flooded, therefore linked to the seasonal submersion of part of the basin by the annual flooding of the river. Irrigated cultivation - consisting of checking, taking or storing part of the water, which is then used to supply cultivated land - is almost non-existent in the Scarcies Region.

b. Water for fishing

Fishing activities follow the seasonal variation of river regimes. The ichthyological fauna itself adapts its cycle of reproduction and growth to this regime. In addition, as indicated earlier, fish farming is quite developed in the Scarcies Basins, even if a small percentage of the existing ponds are functional. These ponds retain and store some of the flood and rainwater, but there is no data on the volumes of water involved and the streams from which this water is taken.

c. Water in the mines

Both artisanal and industrial mining use large amounts of water, especially, during the digging of wells or washing of minerals. Here again there are no studies on the volumes of water involved.

d. Drinking water and sanitation

One of the primary needs of populations in relation to water is to have it in sufficient quantity and in appropriate quality for human and domestic consumption. In regions facing scarcity or even scarcity of water, it is not surprising that the level of satisfaction of this need for drinking water is poorly satisfied. But when there are abundant groundwater, rain and surface water resources, the failure to meet basic human needs appears to be a paradox. This is however the case of the MRU countries in general and in particular in the countries sharing the Scarcies: Guinea and Sierra Leone.

In the Scarcies Basins, access to drinking water is below national averages in Guinea and Sierra Leone - averages which themselves lag significantly behind the SDGs, in this case the first (6.1) of SDG 6. The data used in this section relate to the Millennium Development Goals (MDGs), in particular Goal 7, target 7.c., which aimed to *"half by 2015, the percentage of the population without access to safe drinking water and basic sanitation services."* One of the indicators for this target relates to the *"proportion of the population using improved sources of drinking water"*. These sources relate to those relating to one of the following types of supply: running water in the residence, the concession or the neighborhood; well or borehole or a protected water source or rainwater collected for human consumption. While the level of access to improved sources of drinking water is nearly 80% nationally in Guinea, it is only 64% in the administrative regions partially covered by the Kolenté and the Kaba Basins. In other words, the proportion of the population without improved water sources is double the national level (see Table 24 below).

Table 24. Access to improved sources of drinking water by region in the Guinean part of Scarcies

Regions	Sample size	Access to improved water source	Unenhanced source access
Kindia	7281	63.2	36.8
Mamou	4099	63.8	36.2
Région Scarcies	11380	**63.4**	36.6
National	49106	79.9	20.1

Source: INS. 2019

The situation is comparable in the Sierra Leonean parts of the Scarcies Region. While the level of access to improved sources is nearly 68% nationally, it is only 53% in Districts fully or partially covered by the Scarcies Basins. The Districts of Kambia and Koinadugu have the lowest access levels in the Scarcies

Region. We also note that the proportion of the population with running water is particularly low in the Districts of Scarcies: (6.4%) against 19% nationally.

In Sierra Leone, it is groundwater rather than surface water that is most used to meet human and domestic consumption needs. Almost 80% of the populations with access to improved sources of drinking water (57% of the total) depend on wells and boreholes for their water supply (about 50% of the 57% with access to water from improved sources): see Table 25 below. Surface water resources are therefore little used to meet the drinking water needs of the population of the Scarcies Area.

Table 25. Access to improved sources of drinking water by District in the Sierra Leonean part of the Scarcies

Districts	Size of the population in the sample and percentage		Total access to improved sources (%)	Access to improved sources (by type of source) (%)						Non enhanced Sources (%)
				Running water	Well with drill Pumps	Protected wells	Protected sources	Collection Wells	Other Enhanced Sources	
Bombali	6.214	31%	73.8	7.3	22.4	37.6	0.6	2.3	3.5	20.1
Kambia	3.418	17%	**42.2**	11.2	8	17.8	0.2	4.3	0.8	35.3
Koinadugu	4.000	20%	**47.3**	4	24.8	15.9	1.5	0.7	0.4	41.8
Port Loko	6.614	33%	54.5	2.6	28.4	17.5	0.9	2.8	2.3	33
Scarcies Region SL	25.177	100%	**56.9**	**5.8**	**22.4**	**23.4**	0.8	2.5	2.0	31.1
National SL	74.602		67.8	16.9	19.5	23.3	1.6	1.5	4.9	22.2

Source: SSL. 2018

2.3.6.2. Major current and planned water resources development projects

The Kolenté and the Kaba as well as their tributaries can be qualified as "intact rivers" in that they have not yet been the subject of major human interventions likely to modify the natural regime of their flows or their physical configuration. Neither the Kolenté nor the Kaba, for example, has any dams or water transfer systems from or to these rivers., part from the small water supply reservoirs at the Great Scarcies (Kolenten) at Kambia and little Scarcis also an hydrodam (Bankasoka) at the little Scarcies that supplies electricity to PortLoko
A large number of dam sites have however been identified by the two riparian countries in each of these rivers.

In Guinea, the Atlas of the country's hydroelectric potential (AECOM, 2018) identifies five hydroelectric dam sites on the national parts of the Scarcies including 3 on the Kaba (all large dams in terms of their height which exceeds 15 m) and two on the Kolenté (including a large dam). From the point of view of their reservoir volume as well as the installed hydroelectric power, these dams are very modest (See Table 26 below). And no indication is given regarding the irrigation potential of these dams.

Table 26. Hydroelectric dam sites in the Little and Great Scarcies (Kaba and Kolente) Basins - Guinean parts

Basin	Kaba			Kolenté	
Stream	Mamou	Kaba	Kaba	Kambo	Soukou
Name of Dam	**Laafou**	**Berteya-1**	**Berteya-2**	**Fansija**	**Kondeya-1**
Height (m)	23	20,1	5,12	18,40	36,30
Reservoir Volume (mln m^3)	`	0,208	0,164	2,882	3,409
Area of Reservoir (km^2)	0,02	0,04	0,1	0,94	0,24

Installed Capacity (MW)	3,9	4,3	1	2,0	2,2
Reference Number	A-KAB-6601-2	A-KAB-6701-1	A-KAB-6701-2	A-KOL-6101-1	A-KOL-6090-1
Locality	SOYAH	BERTEYA	BERTEYA	FENDEMODA	FOSSIKHOURE
Sub-Prefecture	Soyah	Soyah	Ouro-Kaba	Moussayah	Mambia
Prefecture	Mamou	Mamou	Mamou	Forecariah	Kindia
Longitude	-11,97806	-10,122469	-11,836266	-12,956317	-13,086667
Latitude	10,192173	11,852772	10,14174	9,608949	9,690397

Source: AECOM, 2018

In Sierra Leone, the Energy Sector Master Plan prepared by Lahmeyer International in the mid-1990s (cited by EPA-SL, 2016) identifies 27 potential sites for hydroelectric dam projects nationwide including 8 in the Little Scarcies Basin (none in the Great Scarcies). The installed capacity of the 8 projects on Little Scarcies represents 34% of the total estimated installed capacity of the 27 identified sites (See Table 27 below). This shows the leading role that Little Scarcies should play if Sierra Leone is to embark on a program to develop its hydroelectric potential.

Table 27. Potential hydroelectric dam sites in the Little Scarcies Basin

Project	Potential installed capacity (MW)
Mange I	35.2
Mange II	12.8
Tendata	28.6
Kuse I	28
Kuse II	91
Maka	21
Kumba	48.9
Kambatimbo	65.7
Bankasoka	1.5
Total Little Scarcies (9 sites)	331.2
Total Sierra Leone (28 sites)	974
Portion of National Hydro Potential	34%

Source: EPA-SL, 2016

Conclusion on 2.3

The water resources of the Scarcies Basins are subject to suboptimal use. Thus, from the point of view of water withdrawals from river networks and aquifers, the volumes concerned are low. There is therefore still no competition between sectors for available water, let alone conflicts of use. Agriculture, which occupies most of the population and covers most of the region's non-forest area, is mainly rainfed and to a lesser extent flooded when it depends on the annual flooding of rivers. There is hardly any irrigated cultivation.

Fishing also depends on seasonal variations of the flow of rivers - which reflect migratory movements and disrupt the reproduction cycles of ichthyological fauna. Ponds exist in large numbers in the Sierra Leonean parts of the Scarcies, however, only a small proportion of the existing ponds are operational. Consequently, the level of water retention in the ponds is presumed to be low compared to the total volume of flows in the rivers and streams of the Scarcies Basins.

With regard to the level of access to water for human and domestic consumption, the Scarcies Basins - both in Guinea and in Sierra Leone - lag far behind the access rates at the national level within the region. These two countries themselves are at the back of the pack compared to other countries in their efforts to meet the SDG water targets.

From the point of view of the quantities of water withdrawn, even the industrial and artisanal mining sector has not yet reached levels that could affect access to the resource for other sectors. It is, however, important to stress that certain mining practices affects the morphology of rivers, with potentially significant consequences on the overall stability of riverbeds and on the health of ecosystems that depend on natural flows.

It is in terms of the impact on the quality of the resource that certain uses pose the most worrying challenges. Current practices in mining (accumulation of mineral residues, soil erosion, use of pollutants such as mercury or cyanide, etc.) and in agriculture (use of chemical fertilizers, pesticides and herbicides) contribute to the degradation of water resources, as well as of soils, with negative consequences for the long-term agricultural productivity of land, forests, aquatic fauna, ecosystem health and human well-being of the populations of the Scarcies Basins.

Regarding the outlook, the large number of dam projects deserves special attention. If these dams (in total of which 5 in the Guinean part of Scarcies and 8 in the Sierra Leonean part) are built or even if part of these projects materialize, this could lead to profound changes in the flows and hydrograph of the rivers before its impact on ecosystems that depend on rivers. The Little Scarcies River offers more potential for hydroelectric dams than Great Scarcies: 11 of the 13 hydroelectric dam sites identified in the Scarcies relate to the Little Scarcies River. Consequently, the construction of these dams will lead to a high level of fragmentation of the course and disrupt the modes of adaptation of flora and fauna to the environment of this basin.

Other challenges are related to the fact that the Little Scarcies River offers more hydroelectric potential and certainly also opportunities for developing its water resources for irrigation. Unlike the Great Scarcies which is a boundary (between Guinea and Sierra Leone) on part of its river reach (about a hundred km long), the configuration of the Little Scarcies is what is refers to as a successive river, in that it includes in its basin an upstream country (Guinea) and a downstream country (Sierra Leone). This type of river - a category to which the Niger and Nile rivers belong – lends itself less to transboundary cooperation than fully or partially boundary rivers such as the Senegal River. But there are innovative models for sharing the benefits that promote win-win cooperation between upstream and downstream countries. This is what Guinea and Sierra Leone might consider in the future, although there are good reasons to preserve the Scarcies as intact rivers.

These are some of the current challenges and threats for the future that the Scarcies Region is facing or could face in the short or medium term. It is therefore important to identify and analyze in more detail these present challenges in order to resolve or mitigate them and to better understand the future risks to prevent them or best manage them when they arise. This is the primary purpose of this TDA.

3. CHAPTER 3 – MOA-MAKONA BASIN

Introduction

The Moa-Makona River takes its source at the foot of Mount Lombé near the town of Macenta, in the Guinean Ridge massif in Kérouané in Guinea. Called Makona in Guinea, it crosses the Prefectures of Macenta and Guéckédou there and receives the Melli River with which it forms the Moa in Sierra Leone "(TDA-RG, 2020). 425 km long, the Moa-Makona River drains a basin of 17,900 km2. The basin is shared by Guinea, Liberia and Sierra Leone (TDA-LIB, 2020). In Sierra Leonean territory, the Moa Basin covers the Districts of Koinadugu in the north, Kono, Kailahun and Kenema in the east and Pujehun in the south of the country (TDA-LIB, 2020).

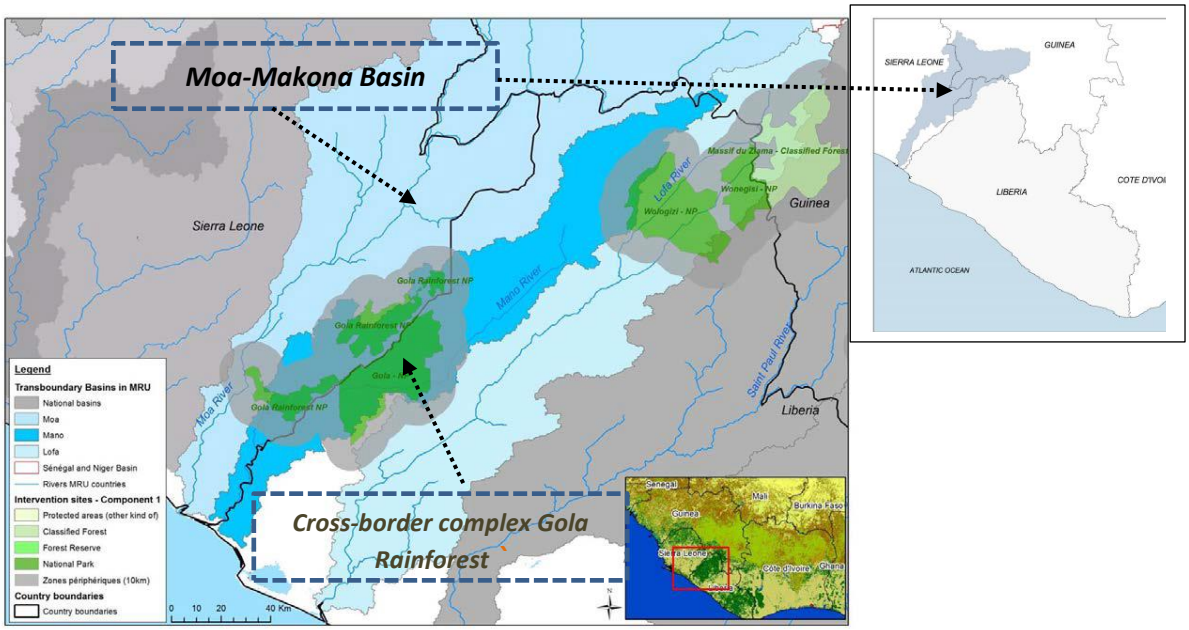
The area of the Moa-Makona Basin is unevenly distributed between riparian states: 47.7% and 43.6% of the basin are located respectively in the territories of Sierra Leone and Guinea, against only 9% in Liberia. While the basin covers nearly 14% of Sierra Leonean territory, it represents only 3.5% and 1.5% of Guinean and Liberian territories respectively (Table 28 & Fig. 16). It can be inferred from all this that the strategic and economic importance of the basin may be higher for Sierra Leone than for other riparian states.

Table 28. Distribution of the area of the Moa-Makona Basin in each of the riparian countries

	Guinea	Sierra Leone	Liberia	Total
National Area (km^2)	245 836	71 740	111 369	428 945
Area of country in the Basin (km^2)	8 500	9 300	1 700	19 500
Percentage of the Basin in the country	43,6%	47,7%	8,7%	100%
Percentage of the country in the Basin	3,5%	13,9%	1,5%	4.5%

This chapter is divided into three sub-chapters. The first describes the physical framework of the Moa-Makona Basin: geomorphology, hydro-climatic context, Bio-geographic conditions (fauna and flora). The second sub-chapter describes the demographic and socio-economic characteristics and in particular the incidence of poverty in the basin. The third subchapter deals with the use of basin resources (fishing, agriculture, animal husbandry, exploitation of forest and wildlife resources, mining, use and development of water resources, etc.).

Figure 16. Moa-Makona Basin



Source: IUCN, 2016

3.1. Main Geophysical Characteristics of the Moa-Makona Basin

In the analysis of the physical framework of the Moa-Makona Basin, we distinguish the upper basin corresponding roughly to the Guinean part of the basin; the middle valley covering the Liberian part of the basin as well as the Districts of Koinadugu, Kono and Kailahum in Sierra Leone and the north of the County of Lofa (in particular the Districts of Voinjama, Kolahun and Foyah) in Liberia. The lower valley roughly corresponds to the eastern part of the District of Pujehum in Sierra Leone (as per second level administrative map produced as part of the MRU-GEF/TDA process).

3.1.1. Geology and geomorphology

From a geomorphological point of view, the upper Makona basin originates from the Guinean Ridge. The region is marked by a very rugged relief formed by the alternation of numerous granite mountains of low altitudes separated by more or less wide valleys where the rivers circulate. The altitudes vary from 200 to 1200 meters with an average of 550 to 650 meters. The dominant rocks are granites, dolerites, kimberlites and micaceous peridotites. These geological characteristics explain the presence of diamond deposits. The diamond fields of Forest Guinea or Upper Guinea Region extend from Kissidougou to Kérouané, thus encompassing the area from the Makona Rivers to the Diani (Saint-Paul) river in the east. (RG-TDA-Stakeholders, 2020)

From a pedological point of view, the soils of the Makona basin belong to two main classes of soils: the class of ferralitic soils and that of tropical hydromorphic soils, alluvial terrace (RG-TDA-Stakeholders, 2020).

Sierra Leone occupies the central part of an Archean craton, which has had to undergo a marine incursion. The eastern unit covering the middle valley of the Moa-Makona basin is part of the West

African Precambrian stable craton. It consists of high-grade metamorphic rocks and granitic gneisses. These ancient rocks are covered by escarpments from the end of the Precambrian to the end of the Ordovician and much younger sediments dating from the Tertiary and recent age (sand, clay). Before these Tertiary deposits, periods of intensive igneous activity caused intrusions in the Mesozoic, giving rise to a series of dolerite layers and dykes, including kimberlite dykes and pipes.

In places, and in particular in the lower valley of Moa-Makona, there are outcropping lateral formations and relatively weakly consolidated sediments. Quaternary sands and gravels are found in river valleys, including those of the Moa-Makona and its tributaries. These Quaternary deposits were covered with alluvium and colluvium in valleys and along coastal estuaries.

From a hydrogeological point of view, we can distinguish, on the one hand, the ancient hard rocks of the Precambrian basement with low permeability and, on the other hand, the sandy layers with a higher water storage capacity and a higher permeability. The formations of the old basement are the most important in terms of their extent: they cover 75 of Sierra Leone, and all of the middle and part of the lower valley of Moa-Makona. Sandy upper layers are also widespread and constitute the main source of groundwater for wells dug throughout the basin (Fileccia et al. 2018; TDA-SL, 2020).

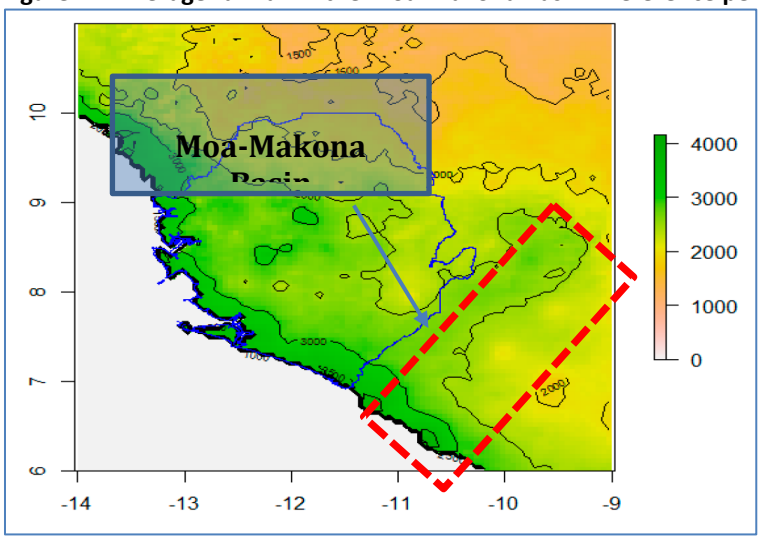
3.1.2. Hydro-climatic context

There are stark similarities between the upper basins (Guinea) of Moa-Makona and Cavally in terms of climate and in particular rainfall (RG-TDA-Stakeholders, 2020). These similarities also apply to the Moa Makona in Liberia.

3.1.2.1. Rainfall

As for the other small coastal basins of the MRU Area, the rainfall in the Moa-Makona Basin increases from the upper basin to the estuary, passing from 1600-2000 isohyets upstream to the 3.500 mm isohyet / year at the mouth. (See Fig. XXX below)

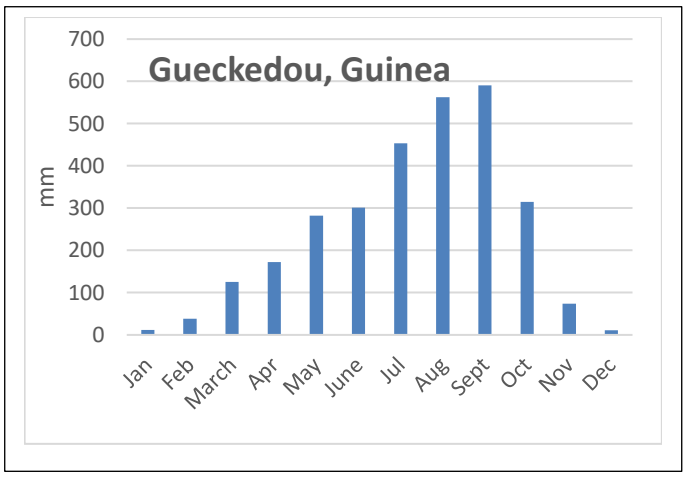
Figure 17. Average rainfall in the Moa-Makona Basin - Reference period 1981-2018

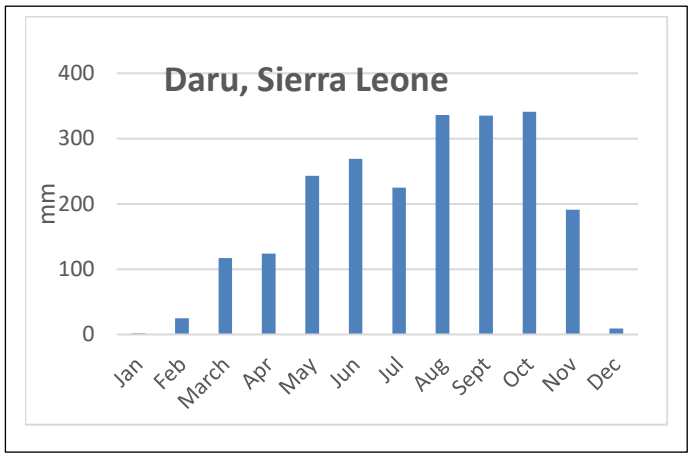


Source: Wadsworth & Lebbie, 2019

As shown by the distribution over time of rainfall in Guéckédou (Guinea) and Daru (Sierra Leone), it rains all year round in the basin with the exception of a sharp drop or even a break in January-February. The most-wet period is between May and October. These are very favorable factors for agriculture (allowing a double or even triple annual cultivation without irrigation). These factors are particularly favorable to perennial crops and plantations and provide the conditions for dense primary forests with a high diversity of flora and fauna.

Figure 18. Average monthly rainfall: (a) in Guéckédou (in the upper valley of Moa-Makona in Guinea) for the period 2009-2020 and in Daru, Middle valley (Sierra Leone) for the period 2009-2011





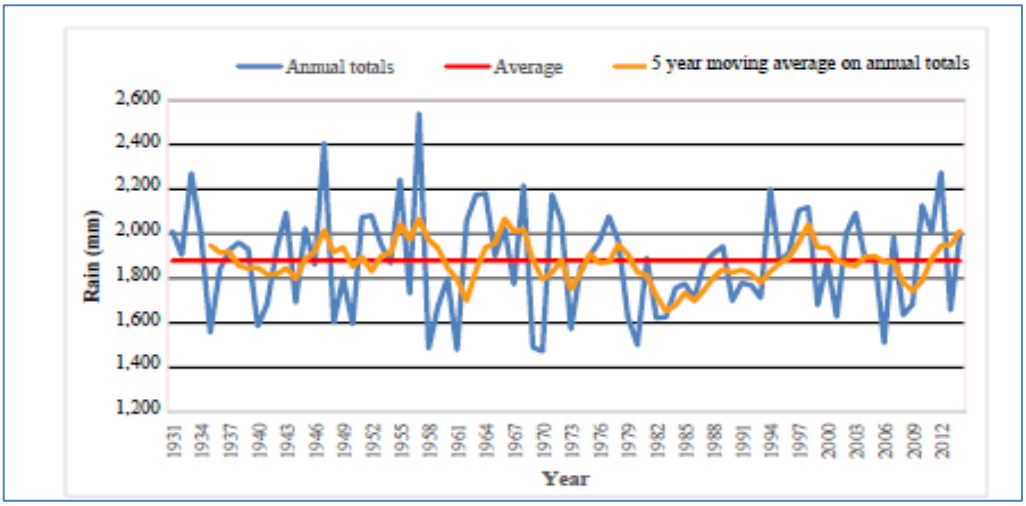
Sources: Guéckédou: Worldweather accessed in August 2021; Daru: CEMMATS, 2012

With regard to the interannual variation in rainfall, the information available concerning the Nzérékoré station, in the periphery of the upper basin in Guinea[8], makes it possible to distinguish three sequences (Loua et al, 2017): (a) a wet sequence between 1931 and 1977; (b) a dry sequence between 1978 and 1994 and; (c) a sequence of high variability between 1995 and 2014, a period which extends into the following decade. For Loua et al, the variability that has prevailed since 1995 is the direct result of climate change, manifested by:

- The narrowing of the growing season which tends to start late in the year and end earlier than before.
- The increase in interannual and annual evaporation (Loua et a, 2017).

[8] For the localities in the basin (ex Guéckédou), comparable information on the long-term evolution of rainfall could not be found.

Figure 19. Interannual variations in rainfall in Nzérékoré (in the periphery of the Moa-Makona Basin) from 1931 to 2014

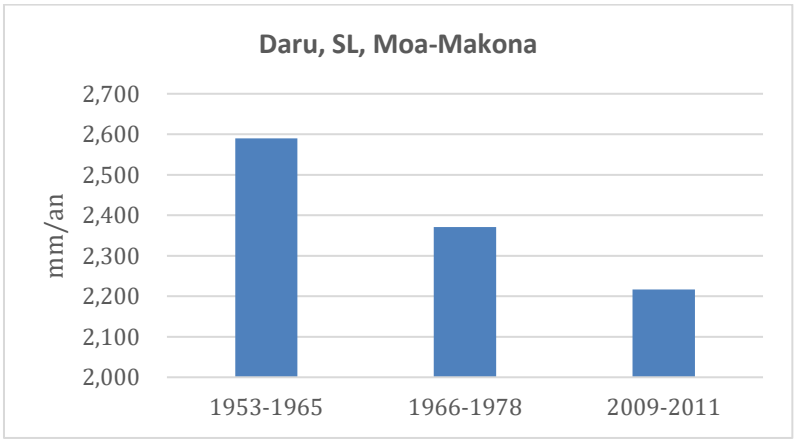


Source: Loua et al. 2017

Observation of the evolution of rainfall downstream seems to indicate a downward trend in rainfall at least for the period 1953-2011. Using the data available for the Daru station (Sierra Leone), we note an 8% drop in average annual rainfall between the period 1953-1965 and that between 1966-1978. The annual rainfall recorded at the same station between 2009 and 2011 represents a drop of just over 10% compared to the average between 1953 and 1978 (2484 mm / year) (Fig. 20 below).

With the unavailability of more recent data relating to rainfall in the stations analyzed above (Nzérékoré and Daru), it is not possible to say whether the downward trend in rainfall has been maintained or has continually reversed over the past decade.

Figure 20. Evolution of annual rainfall in Daru (middle valley, Mao-Makona, Sierra Leone); for the periods 1953-1965 (13 years); 1966-1978 (12 years) and 2009-2011 (3 years).



Sources: For 1953 to 1978 (SOFRELEC, 1981) and for 2009-2011 (CEMMATS Ltd 2012);

3.1.2.2. Hydrology of the Moa-Makona River

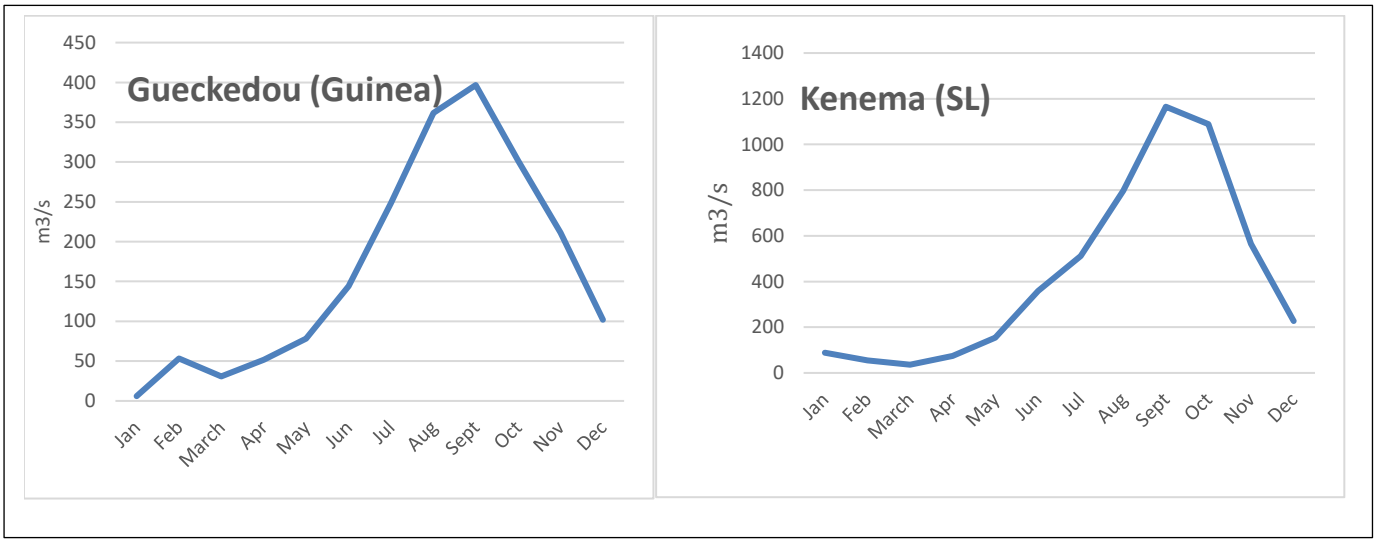
At 475 km long, the Makona River, also called Moa in Sierra Leone, has its source at an altitude of 962m under the foot of Mount Lombé in the center of the Guinean Ridge foolhills. The Makona receives

several important tributaries in its upper reaches. Among these tributaries, the most important is the Méli, which joins the Makona in Fangamadou, forming the "Bec de Perroquet" (Parrot's beak)[9]. Besides the Méli, the other important tributaries having their source in Guinea are: Songbonkoi and Fadhako upstream in the prefecture of Kérouané near the source of the main arm of the river; Maceni and Melou in the prefecture of Macenta; Boya and Waou in the prefecture of Guéckédou "(RG-TDA-Stakeholders, 2020).

The Liberian portion of the Moa-Makona Basin is located in the northern part of the country in Lofa County. The length of the Moa-Makona in Liberia is just over 70 km, in fact forming the northwest border between Liberia and Guinea and then with Sierra Leone (TDA-Liberia, 2020).

Although small in size, the Moa-Makona River carries large volumes of water. The average river flow increases upstream to downstream as the basin becomes better watered and the main arm of the river receives inputs from tributaries. Thus, the flow of the Moa-Makona which is 171 m^3/s (i.e. an annual water volume of 5.4 billion m^3) increases to 427 m^3 / s (13 m^3 billion m^3 per year) at Kenema in the lower middle valley[10].

Figure 21. Mean hydrogramme of the Moa-Makona at Guéckédou, Upper basin in Guinea (for the period 1972-2001) and at Kenema, Middle valley in Sierra Leone (period 1971-1974)



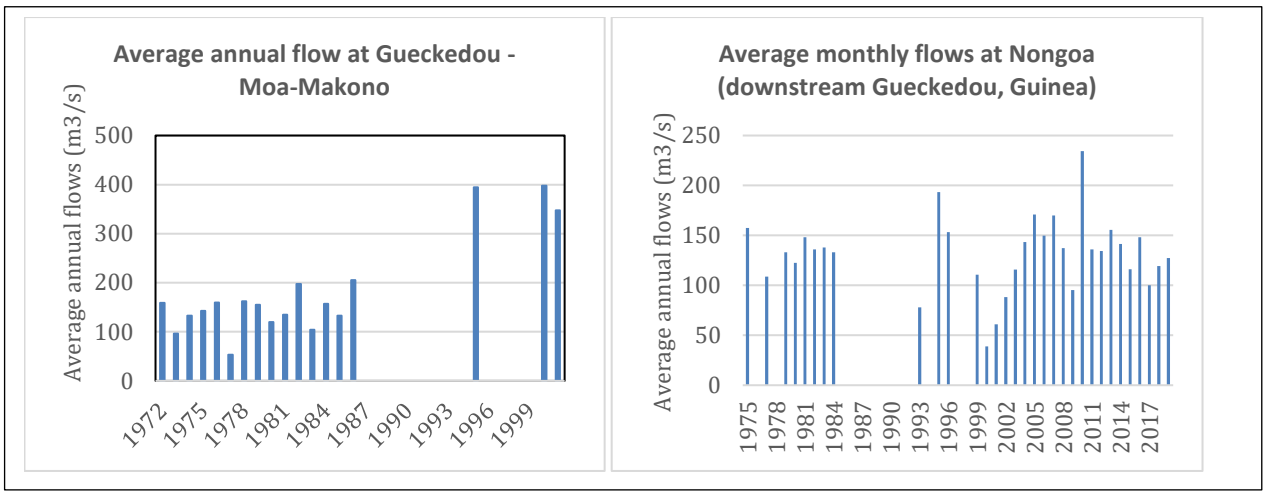
Sources: Guéckédou: DNH Data via Tda-RG, 2020; Kenema: UNDP, 1976.

The regime of the Moa-Makona River is unimodal, with a period of low water between December and March-April and a period of flooding from June-July to October. The contrast between the period of high water and those of low water is very marked: between July and November, the stations of Guéckédou (upper basin) and Kenema (lower middle valley) record respectively 74% and 80% of the total flows of the river annually, i.e., in 5 out of 12 months (Fig. 22).

[9] What has come to be known as the Parrot's Beak is an advance from Guinean territory towards Sierra Leone. The curved shape of the territory with a pointed end where the Makona River meets its tributary Meli gives the rough image of a parrot's beak.

[10] Discharges covering the period 1972-2001 for Gueckédou (DNH data via TDA-RG, 2020) and over the period 1971-1974 for Kenema (UNDP data, 1976).

Figure 22. Evolution of the average annual flows of the Moa-Makona (upper course) at Guéckégou and Nongoa



Sources : DNH data via TDA-RG Team, 2020

Regarding the inter-annual variation in flow volumes, there are significant variations from one year to the next, as shown by the average annual flows from the Gueckédou and Nongoa[11] stations in the upper basin. But the significant gaps in the available hydrological series do not allow a rigorous analysis of the trends concerning the volume of flows (TDA-RG. 2020)

3.1.2.3. Hydrogeology and groundwater resources

From the point of view of the geology of the Moa-Makona Basin, conditions are not exceptionally favorable for the existence of abundant underground resources. As previously indicated, Sierra Leone is more than 75% covered by the Precambrian basement having an altered upper layer (exploited by wells and boreholes generally less than 60 m deep) and an underlying fractured rock whose faults are exploited by boreholes whose depth varies on average from 35 to 60 m, with a productivity of 3.5 to 5 m3 / hour (EPA-SL, 2016). However, with this relative availability of groundwater, the populations of certain areas of the basin face serious difficulties in accessing water, particularly in the sub-prefectures of Watanka, Kassadou, Temessadou and Binikala in the Guinean part of the basin (RG-TDA-Stakeholders 2020).

3.1.3. Bio-geographic context

3.1.3.1. Flora

The vegetation of the Moa-Makona Basin alternates between forest and savannah landscapes. In the Guinean upper basin, forests are essentially secondary with varying densities. Among the representative species of secondary forests of the upper basin, we can mention mahogany (Khaya spp), framire (*Terminalias superba* and ivorensis), kapok (*Ceiba pentandra*), Kobi or Kowi in Sierra Leone

[11] Nongoa is about 30 km downstream from Guéckédou, on the Moa-Makona on the border between Guinea and Sierra Leone.

(Carapa procera) . African Oak or Teak or Iroko (Milicia excelsa), Koso or Bani in Fulani (*Pterocarpus erinaceus)*, *Gmelina arborea*, *Triplochiton scleroxylon* (Samba in Cote d'Ivoire), *Afzelia africana*, etc. Some of these species are particularly valued as timber and are priority targets for timber operators and exporters. These are, for example, Niangon (*Tarrietia densiflora or utilis*), Dibétou (*Lovoa trichilioides*), Dabéma (*Piptadeniastrum africanum*), Aniegré Blanc (*Aningeria robusta or Pouteria aningeri*), Fraké (*Terminalia superba*), Ako (*Antiaris spp*), Etimoe (*Copaifera salikounda*) which is an endangered species.

Savannah vegetation is represented by shrubs and bushes with combretaceae and legumes (TDA-RG, 2020). In addition to the primary forests largely conserved in protected areas such as Goula Park, the same landscape alternating savannas and shrubs on the one hand and forest relics on the other dominates the Liberian and Sierra Leonean parts of the basin (TDA-LIB, 2020; TDA-SL, 2020). In places, we observe a high level of anthropization of the environment, which is illustrated by the vast spaces occupied by vegetation of the "farm bush" type, itself resulting from the degradation of primary forest following the practice of land clearing, burning, logging or deforestation linked to mining activity (CEMMATS Group Ltd., 2012). The human footprint on the landscape is also manifested by the increasingly large areas occupied by agriculture, including perennial crops, agro-industrial plantations and peri-village agro-forests. (RG-TDA-Stakeholders, 2020).

3.1.3.2. Wildlife

The distribution of fauna in the basin varies to a great extent depending on the level of vegetation conservation. Thus, areas populated by primary forests and forest islands tend to harbor a great diversity of fauna. In these areas we meet chimpanzees (a fully protected species), red monkeys, fassa cob, harnessed bushbucks, buffaloes, warthogs as well as hornbills, squirrels, grasscutters, porcupines, deer, rabbits, a variety of reptile species (TDA-RG, 2020).

3.1.3.3. Critically important biodiversity hotspots and ecosystems in the Moa-Makona basin

In the Guinean Upper Basin of Moa-Makona, the designated/protected forests, although often severely degraded, are home to a large part of the remains of primary forests and the denser secondary forests. Among these protected forests, there is that of Kénéma in the sub-prefecture of Fangamadou, prefecture of Guéckédou with an area of 1,230 ha (RG-TDA-Stakeholders, 2020) and that of Makona (700ha) in the Sous- Boffossou Prefecture, Macenta Prefecture

Due to the richness and diversity of the ecosystems it shelters, the Gola Forest plays a leading role in the conservation of endemic and / or threatened species of the Upper Guinea Forest hotspot. Very early on, this forest was the subject of special attention by public authorities and environmental protection organizations.

Thus, from the years 1926-1930, the blocks of primary forests in the South-eastern Sierra Leone were declared Forest Reserves. With the expansion of this area in the 1950s, forest reserves will extend over more than 70,000 ha. These forest formations are in fact the relics of the Upper Guinea Forest, one of the 25 biodiversity hotspots identified by Conservation International around the world.

Established in December 2010, the **Gola Rainforest National Park** (GRNP), which includes most of the forest blocks in the southeast of the country, is Sierra Leone's first national forest park (Klop et al. 2008). It now covers an area of 99,600 ha.

The Gola Forest in Sierra Leone is located in the Eastern Province, fully or partially covering seven chiefdoms: Koya, Gaura, Tunkia and Nomo in the Kenema district; the chiefdoms of Barri and Makpele in the District of Pujehun; and the Chiefdom of Malema in Kailahun District (Klop et al. 2008). Gola Forest is made up of several forest blocks, the most important of which is Gola North covering an area of 417 km2 for a length of over 60 km, followed by Gola East (205 km2). While these blocks are primarily in the Mano-Morro River Basin, the West Gola Block (67 km2) is fully in the Moa-Makona Basin. (Klop et al. 2008)

The Gola Forest Park is home to more than 300 species of birds and is one of the few ecological units to house the full range of endemic birds of the Upper Guinea Forest hotspot, some of which are the Gola malimbe (*Malimbus ballmanni*) are threatened with extinction, others in vulnerable situations such as White-necked Rockfowl (*Picathartes gymnocephalus*); White-breasted Guineafowl (*Agelastes meleagrides*) (BirdLife International. Nd).

Gola Rainforest National Park is also home to a large number of threatened or vulnerable species of large fauna, including the forest elephant (*Loxodonta cyclotis*), the dwarf hippopotamus (*Choeropsis liberiensis*), the West African chimpanzee (*Pan troglodytes verus*) mainly present in the countries of the MRU but whose numbers have fallen sharply in recent years in countries such as Cote d'Ivoire, the Jentink's duiker (*Cephalophus jentinki*), the zebra duiker (*Cephalophus zebra*), the Liberian mongoose (*Liberiictis kuhni*), as well as primates such as the Diana or Captain monkey (*Cercopithecus diana*), the Sooty Mangabey or Green Mangabey monkey (*Cercocebus atys*) or bay colobus (*Procolobus badius*) (BirdLife International. Nd). According to Lindsell et al (2011), 18 species of large threatened, vulnerable or endemic mammals were identified there before the civil war, to which were added several others including the African buffalo (*Syncerus caffer nanus*) and the aquatic buckshot (*Hyemoschus aquaticus*) (Lindsell & Klop al, 2011).

The **Tiwai Island Wildlife Reserve** (Sanctuary) was established in 1987. Located in the Moa-Makona River, northwest of Gola West, it covers an area of 12 km2. More than 700 species of plants have been identified there as well as more than 170 species of birds. Although the Tiwai Wildlife Reserve is not part of the territory of the Gola Forest National Park, the two ecosystems are strongly linked from an ecological point of view (Klop et al. 2008).

The **Gola National Forest** is the extension in Liberian territory of the Glola Rainforest National Forest (GRNP) of Sierra Leone. Liberia's Gola National Forest covers an area of 99,600 ha. It is one of the largest intact remains of evergreen and semi-deciduous forest in the MRU region (GRNP website, nd.)[12].

[12] GRNP. "The Wider Gola Landscape" Gola Rainforest National Parc (GRNP) website Accessed at: https://golarainforest.org/gola-liberia (Aout 2021)

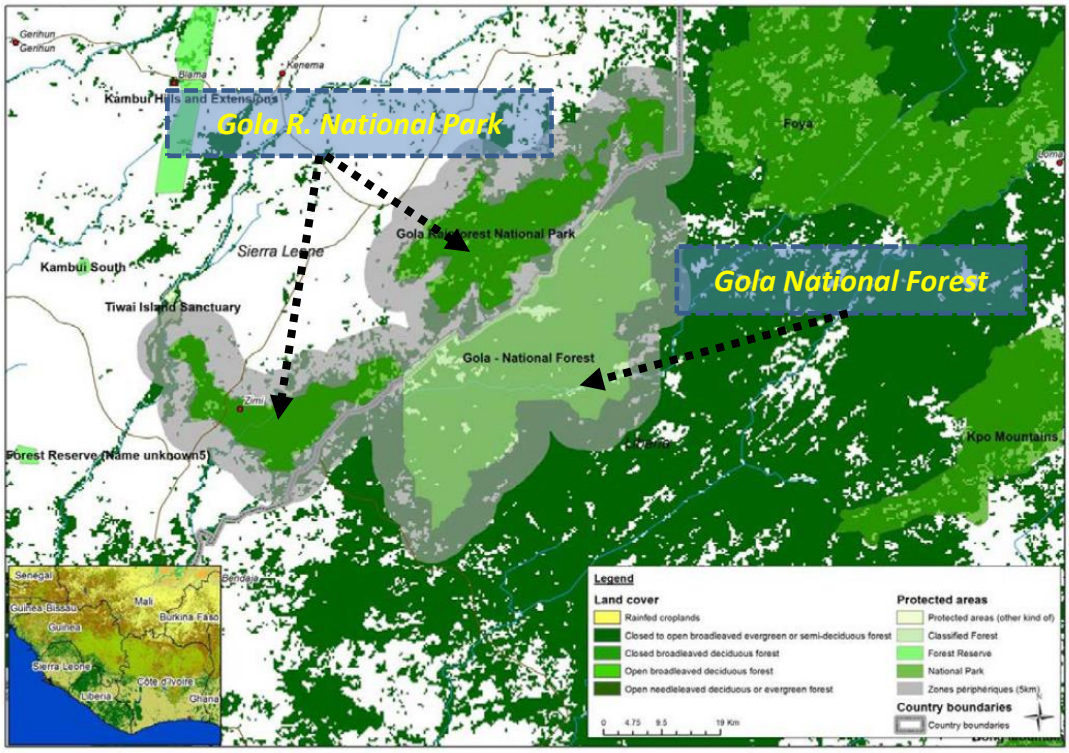
There is a plan to create a **transboundary forest complex** consisting of GRNP in Sierra Leone and Gola National Forest Park - when this park is established by the Liberian state. Such a complex, once set up will have an area of over 170,000 ha, not counting the buffer zones (GRNP website, nd; BirdLife International, nd; IUCN. 2016). See also Table 29 below.

Table 29. Gola transboundary forest complex (IUCN, 2016)

	Total Area (ha)	Sierra Leone	Liberia
Superficie de l'aire protégée [ha]	171 900	99 600	72 300
Superficie de la zone tampon [ha]	194 000	79 000	115 000
Total	365 900	178 600	187 300

Source: IUCN. 2016

Figure 23. Gola Rainforest National Park (Sierra Leone) et Gola National Forest (Liberia)



Source: IUCN. 2016

Today, the flora and fauna of the basin and in particular the protected areas which are their last refuges face many threats. The first is the expansion of peasant agriculture, which perpetuates slash-and-burn agriculture and plantation agriculture, that occupies large areas in the basin. Mining, especially diamond mining, results in the profound disfigurement of the landscape and the destruction of sensitive habitats for flora and fauna. Large-scale logging leads to rapid deforestation, which does not spare normally the protected areas. Poaching targeting animal species - some of which are threatened with extinction - fuels a growing domestic and international market (Lindsell & Klop, 2011, op. Cit).
But despite these challenges - to which can be added the exploitation of firewood, the expansion of housing, urbanization, the galloping demography - the landscape of the Moa-Makona Basin remains green and continues to shelter important forest blocks. (TDA-SL,2020).

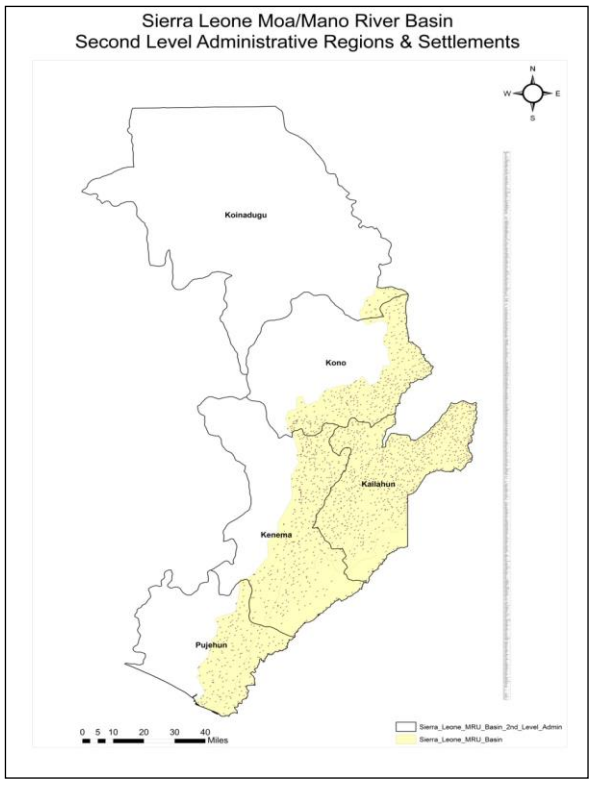
3.2. Demography and Incidence of Poverty in the Moa-Makona Basin

This section makes extensive use of the socioeconomic data available at the level of territorial administrative units located entirely or partially in the Moa-Makona Basin.
The Guinean part of the Moa-Makona Basin covers or less in part the five prefectures and a total of 20 sub-prefectures: Guéckédou (10 sub-prefectures); Macenta (5 SP); Kérouané (2 SP); Kissidougou (2 SP) and Faranah (1 SP) (RG-TDA-Stakeholers, 2020).

In Liberia, Moa-Makona partly covers Lofa County and within it the Districts of Foya, Kolahun and Voinjama.

In Sierra Leone, the Moa-Makona Basin mainly covers 4 Districts: Kailahum, Kono, Kenema, Pujehun and about ten Chiefdoms - the statistics available being mainly at the district level (Fig. 24).

Figure 24. Districts covered by the Moa-Mano/Makona (and Mano) Basin in Sierra Leone
Source: Saata Associates 2016



3.2.1. Demography of the Moa-Makona Basin

The basin population estimate is based on that of the administrative units covered by the basin in each of the three countries concerned: Guinea, Liberia, Sierra Leone. These data are therefore crude, at least for two reasons: first, because many of the territorial units concerned are only partially covered by the basin, which means that part of their inhabitants live outside the basin. Then, the data

concerning the numbers of populations refer to different dates, and are sometimes more than 10 years old. In order to harmonize the dates and have more recent data, the population numbers are updated by applying the national average growth rate of the country concerned: in reality we know that this growth rate varies according to regions and according to whether this is an urban or rural population. Thus, the population data are a rough estimate and the socio-economic characteristics to which these data are associated are approximate.

Based on the general census of the Guinean population, the sub-prefectures of the national portion of the Moa-Makona Basin in Guinea were populated by around 430,000 people in 2014. Applying the growth rate of 2.64% per year (this which corresponds to the annual growth rate of the country's population), the population of this national portion can be estimated at 500,000 people (Table 30 below).

Table 30. Population estimates for the Guinean portion of the Makona Basin

Pefecture	Sub-Prefecture	Census	Estimation (2.64% growth/yr)
		2014	**2020**
Kérouané	Soromaya	20 242	23 668
	Sibiribaro	16 919	19 782
Kissidougou	Koundiadou	15 020	17 562
	Yombiro	14 274	16 690
Faranah	Kobikoro	13 909	16 263
Macenta	Binikala	17 687	20 680
	Balizia	14 692	17 178
	Bofossou	13 803	16 139
	Watanka	6 519	7 622
	Panziazou	8 440	9 868
Guéckédou	Urban Community	66 761	78 059
	Guendembou	31 405	36 720
	Tekoulo	30 724	35 923
	Kassadou	19 881	23 245
	Bolodou	13 643	15 952
	Temessadou	29 680	34 703
	Koundou	28 337	33 132
	Nongoa	14 959	17 491
	Fangamadou	24 516	28 665
	Ouendé Kènèma	29 705	34 732
TOTAL NATIONAL PORTION IN THE BASSIN		**431 116**	**504 074**
NATIONAL POPULATION		**10 599 848**	**12 393 658**

Source: TDA-RG, 2020

The population of the Liberian portion of the basin includes those of Foya, Kolahun and Voinjama Districts, all located in Lofa County. The population of these districts was 175,000 people according to the results of the general population census in 2008 (LISGIS, 2009). The demographics of the Liberian portion of the basin can be estimated at 240,000 people by applying the national annual growth rate of 2.74%. (Table 31 below).

Table 31. Population of Moa-Makona Basin Districts - Liberia portions (Lofa County)

District	Population (2008)	Projection (Growth Rate) 2.74%/Yr)	
		2014	2020
Foya	73 312	86 221	101 403
Kolahun	59 057	69 456	81 686
Voinjama	42 790	50 325	59 186
Total	175 159	**206 001**	**242 274**
National	7 092 113	8 340 902	9 809 579

Source: 2008 National Census data (LISGIS, 2009). Population growth rate: www.Indexmundi.com)

For the Sierra Leonean part of the basin, the demographic data used is at the district level, not the Chiefdom. So the risk of including parts outside the basin is higher and hence a greater risk of exaggerating the demographics of the Sierra Leonean part of the basin. The demography of the four districts of the basin (Kailahun, Kono, Kenema, Pujehun) was just under 2 million people in 2015, estimated to have reached 2.26 million people in 2020, or 28% of the national population of Sierra Leone.

Table 32. Population of Moa-Makona-Sierra Leone Basin Districts

	Census	Estimates based on 2.6% annual growth rate / year	
Districts	**2015**	**2019**	**2020**
Kailahun	526 379	583,295	598 460
Kono	506 100	560,823	575 404
Kenema	609 891	675,837	693 408
Pujehun	346 461	383,923	393 905
Moa-Makona/SL	**1 988 831**	**2,203,877**	**2261 178**
National	7 092 113	7,858,960	8,063,293

Sources: SSL. 2017b.

In general, the population of the Moa-Makona Basin can be roughly estimated at 3 million people, or 10% of the population of the 3 riparian states (Guinea, Liberia and Sierra Leone). Table 33 below. Even if the Sierra Leonean population in the basin could be greatly exaggerated because of the constraints mentioned, the Moa-Makona Basin seems to be a primary development issue, both in terms of the proportion of the area of the basin in the country and its demographic weight.

Table 33. Breakdown by country of the demography of the Moa-Makona Basin

	Area within the Basin		Population		Population Density
	Km^2	% of Basin	Inhabitants	% of Basin	Person/km2
Guinea	8 500	43.6%	504 074	18%	59
Liberia	1 700	8.7%	242 274	8%	142
Sierra Leone	9 300	47.7%	2 261 178	75%	243
TOTAL	19 500	100%	**3 007 526**	100%	154
Total National for 3 countries	428 945		30 266 530		70

3.2.2. Incidence of Poverty

Whatever the methodology used, the surveys on living standards carried out in the riparian countries, and in particular in the two main countries of the basin (Guinea and Sierra Leone), show a high incidence of poverty in the Moa Makona Basin: 77% of poor population in the national portions of the Moa-Makona Basin in Guinea against a national average of 69% and 60% of poor in the districts of the Moa-Makona basin in Sierra Leone against a national average of 53%. Whether in Guinea or Sierra Leone, the most upstream regions (Faranah and Kérouane and Kissidougou in Guinea and Kono, Kailahun, Kenema in Sierra Leone) are the poorest.

Table 34. Incidence of poverty in the national portions of Moa-Makona in Guinea, Sierra Leone and Liberia

GUINEA (2014)				SIERRA LEONE (2011)				LIBERIA (2021)			
Prefecture	Population	Number of Poor	Poverty Indices[13]	Districts	Population	Number of Poor	Poverty Rate[14]	County	Pop	Nb poor	Poverty rate[15]
Kerouane	37 161	31 965	86%	Kailahun	435.381	264.969	61%	Lofa	337,934	233,174	69%
Kissidougou	29 294	24 260	83%	Kono	284.013	174.054	61%	**Bassin**	**337,934**	**233,174**	**69%**
Faranah	13 909	13 603	98%	Kenema	596.081	366.964	62%	National	4,243,475	1,867,129	44%
Macenta	61 141	48 853	80%	Pujehun	232.019	125.543	54%				
Gueckedou	289 611	213,770	74%	**Basin**	**1.547.494**	**931.530**	**60%**				
Basin	**431 116**	**332,450**	**77%**	National	5.838.160	3.090.961	53%				
National	10599 848	7282096	69%								

Sources: Guinea: For 2014 demography: INS. 2017a. 2014 General Population and Housing Census; For the poverty index: INS. 2017b; For Sierra Leone: World Bank, 2014; Liberia: IFM, 2021

In the Moa-Makona Basin, there is a striking contrast between, on the one hand, the diversity and abundance of natural resources - water, fauna, flora, mines, etc. - and, on the other hand, extreme poverty of the Population. This apparent paradox may be explained by the ways in which the resources of the basin are used.

3.3. Main uses of the resources of the Moa-Makona Basin

The high rate and the severity of poverty in the basin are certainly not the consequence of an insufficiency or unavailability of natural resources, but rather are closely related to the forms and levels of use of these resources. To the extent that the information available allows it, this section describes and analyzes the practices and levels of use of the resources of the basin through agriculture, animal husbandry, fishing, exploitation of forest products, mining and the level of development and use of water resources.

[13] Guinea uses ten non-monetary indicators to classify private persons by level of poverty (See INS. 2017b Ref. Below)

[14] In the case of Sierra Leone, are considered here as poor people living in households with an annual consumption per adult equivalent of less than 1,625,568 Leones in 2011 (approx 380 US $) (See Work Bank, 2014 Ref. Below

[15] Refers to people living in absolute poverty, i.e. under US$1.9 a day

In general, agriculture is the dominant form of use of the basin's resources (especially rainwater and edaphic resources). Along with breeding and fishing, it is one of the main sources of income for the populations. Plantation agriculture, logging, and artisanal and industrial mining (especially diamond) are some of the prominent features of the Moa-Makona Basin.

3.3.1. Agriculture

Agriculture - especially rain-fed - is the main source of income for the populations of the basin. In the upper Guinean basin, more than 80% of the population is rural and lives mainly from shifting agriculture, which uses slash and burn for land clearance (TDA-RG). After a few years of exploitation, the land is laid to rest for at least ten years in the past. The fallow time has shortened with population pressure and the shrinking area of cultivable land. For the same reasons, agricultural space is increasingly encroaching on forest areas and virgin land. This explains why deforestation due to the expansion of agriculture has accelerated in recent years, in the upper basin, but also downstream (RG-TDA-Stakeholders 2020; TDA-RG, 2020).

Table 35. Share of the regions of the Upper Moa-Makona Basin in agriculture in Guinea

Regions (Prefectures basin)	Nzerekore (Guéckédou; Macenta)		Faranah (Faranah; Kissidougou)		Kankan (Kérouané)		Total Moa-Mak Regions	National	Total Reg
	Ha	%/national total	Ha	%/national total	Ha	%/national total	Ha	HA	% nal tot
Ric	203000	**31%**	80000	12%	118000	18%	401000	665000	**60%**
Fonio	5000	3%	18000	11%	16000	10%	39000	162000	24%
Sorghum	0	0%	4000	13%	4000	13%	8000	30000	27%
Millet	0	0%	11000	9%	26000	22%	37000	117000	32%
Maize	31000	13%	31000	13%	46000	20%	108000	231000	**47%**
Groundnuts	7000	5%	20000	13%	26000	17%	53000	153000	35%
Cassava	15000	12%	4000	3%	31000	25%	50000	123000	41%
Sub-total	261000	18%	168000	11%	267000	18%	696000	1481000	**47%**
Others	4800	6%	3448	4%	5426	7%	13674	80912	17%
Grand Total	265800	17%	171448	11%	272426	17%	709674	1561912	45%

Source: JICA. 2013.

In the middle and lower valley (Liberia and especially Sierra Leone), the agricultural production systems are almost the same as those in the upper basin. Agrarian practices around Gola Park can be generalized to the whole of the middle and lower valley of Moa-Makona (Sierra Leonean part). In this area, rice cultivation, mainly practiced in the highlands - in the plateau and hill regions - is the main cultivated crop, generally in the form of slash-and-burn agriculture. In general, agriculture in the uplands occupies almost half of the area of family farms, with agriculture in the lowlands and flood plains occupying a quarter of the area of agricultural holdings as well as crop plantations (especially coffee and cocoa) (Greenlife West Africa, 2019).

Table 36. Share of Moa-Makona Basin Districts in Sierra Leonean agriculture

	Upland Rice (ha)	Lowland Rice (ha)			
DISTRICTS	Cultivated Area (ha)	Cultivated Area (ha)	Total Rice (ha)	Other Crops (ha)	Total Cultivated Area (ha)
Kailahun	153 687	51 907	205 594	293 670	499 264
Kenema	140 173	32 238	172 411	177 927	350 338
(Kono)	107 128	52 270	159 398	161 590	320 988
Pujehun	76 343	20 845	97 188	103 301	200 489
Total Mo-Makona	477 331	157 260	634 591	736 488	1 371 079
Total National	1 127 775	556 774	1 684 549	1 532 185	3 216 734
En %	42%	28%	38%	48%	43%

Sources: SSL, 2017b; Ratolojanahary, 2019.

The Sierra Leonean part of the Moa-Makona basin is also renowned for the importance of arboriculture. The four districts of the Moa-Makona basin (Kailahun, Kenema, Kono and to a lesser extent Pujehun downstream) are the main coffee and cocoa growing areas of Sierra Leone. Together, these districts represent 87% and 93% of the areas of coffee and cocoa plantations. Just under half of the area occupied by palm oil plantations is in these districts. (see Table 37 below).

Table 37. Share of Moa-Makona Basin Districts in plantation agriculture in Sierra Leone

Districts	Total	Coffee	Cocoa	Palm Oil	Citrus	Cashew	Legumes
Kailahun	499,264	66,814	114,125	62,658	1,327	44	4,311
Kenema	350,338	34,236	58,086	43,126	1,104	379	4,745
Kono	320,988	61,651	43,231	5,688	947	608	3,604
Pujehun	200,489	3,489	3,533	31,038	362	135	5,673
Total Moa districts	1,371,079	166,190	218,975	142,510	3,740	1,166	18,333
Sierra Leone	3,216,734	191,791	235,749	307,593	9,487	4,368	79,742
Share Moa Districts	**43%**	**87%**	**93%**	**46%**	**39%**	27%	23%

Source: SSL, 2017 [pp.48 et 50]

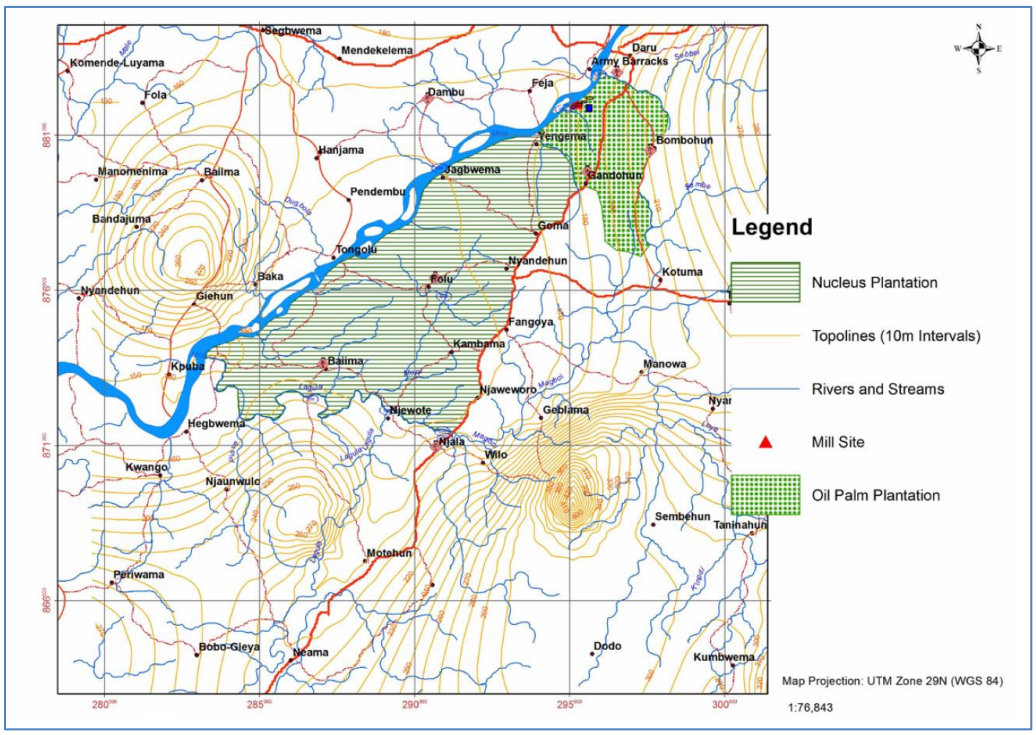
This area therefore naturally hosts large agro-industrial plantations, for example the Goldtree. The Goldtree plantation is located near the town of Daru in the Kailahun District. It includes a central area of 5,000 ha obtained in 2011 in the form of a 50-year long-term lease from the chiefdom of Jawie, customary owner of these lands. The central estate also houses a plant for the production of palm oil and by products. Almost 10,000 small oil palm off-takers are bound by purchase contracts with Goldtree (Phalisa, 2021). In 2015, Goldtree joined the global initiative called Roundtable on Sustainable Palm Oil (RSPO) and for which purpose it became an organic agriculture in its main plantations and those of it's smaller outgrowers with whom Goldtree is bound by a purchase contract (Phalisa, 2021).

An independent assessment will show whether this option is being practice on the farm and whether practices harmful to the environment and biodiversity such as the use of chemical fertilizers and pesticides have been abandoned. However, it is generally known that the lowlands of the rainy tropical regions are the preferred areas for oil palm. It turns out that these regions are home to 2/3 of the

world's biodiversity. As a result, the expansion of oil palm plantations has often come at the expense of primary forests and marsh ecosystems, leading to habitat loss, including those of the rare and endangered species.

Either way, oil palm cultivation as well as industrial seed processing uses varying amounts of water. On the Goldtree plantation and factory, the water used comes from the Moa-Makona River and its tributaries and, to a lesser extent, from boreholes drilled in the area. According to the environmental and social impact study carried out during the construction of the processing plant, Goldtree uses a total of 54.990 m3 of water per year, to be taken from the Moa-Makona River. Given that the minimum Moa-Makona flow estimated at the Daru station would be 15 m3 / s or an annual flow volume of just under 500 million m3 (CEMMATS, 2012), water withdrawals of the Moa-Makona River by Goldtree would be negligible: the annual volume withdrawn would thus be equivalent to the minimum flow volume for a period of 60 minutes (one hour). Wastewater treatment is also an issue that deserves attention.

Figure 25. Goldtree Palm Oil settlement area in Jawei Chiefdom, near Daru (Kailahum District



In the Liberian part of the basin, consisting mainly of Lofa County, shifting cultivation is the dominant farming system, with upland rice as the main crop, followed by cassava and various vegetable crops. When the fertility of rice-growing land declines, cassava and crops such as groundnuts replace rice. This is the case in the Sierra Leonean part of the basin where exhausted land is set aside for periods ranging from 5 to more than 10 years. As shown in the Table above, the role of agriculture in Lofa County has grown very rapidly over the past 25 years, representing today 24% of national rice production against 15% around ten years before. The Country provides nearly 13% of national cassava production against 7% in the 1980s and even 3% during the civil war.

Table 38. Share of the Lofa County in raive and cassava farming in Liberia

County	Rice (Tons)			Cassava (Tons)		
	1986 (before civil war)*	1996*	2019**	1986*(Before civil war)	1996*	2019**
Lofa	46.009	11.500	63.543	29.070	7.290	74.296
Total pays***	298.574	94.450	269.000	409.841	213.270	581.249
% Lofa County	15.4%	12.2%	23.6%	7.1%	3.4%	12.8%

Sources: (*) FAO. 1997; (**) FAO, 2019; (***) FAOSTAT (for data at country level for 2019)

Overall, agriculture therefore occupies a central place in the Moa-Makona Basin, both upstream and downstream. The Prefectures (Guinea) and Districts (Liberia, Sierra Leone) of the Moa-Makona Basin are part of the main areas of seasonal agricultural production (rice, maize, sorghum, peanuts) and perennial crops (peasant plantations and large agro-industrial estates. cultivation of coffee, cocoa, palm oil, etc.). These different forms of agriculture are rainfed. The level of agricultural water withdrawal from the Moa-Makona River and its tributaries is negligible. However, agriculture directly or indirectly affects the quality of water. Some of the pesticides and chemical fertilizers used in agriculture are drained into rivers and streams. Deforestation linked to agriculture and the practice of slash-and-burn agriculture leads to soil erosion and therefore gullying which results in the degradation of the banks as well as an increase in the solid load of water. These different processes thus affect the quality of the water.

3.3.2. Livestock

Animal husbandry is an important activity in the Moa-Makona Basin. However, it occupies a larger area in the upper basin, the Guinean part of the basin. In Guinea, the three regions of the basin (Faranah, Nzérékora and Kankan) receive just over 40% of the country's cattle and goats, more than a third of goats and almost all pigs (Table 38 below). On the other hand, the Districts of the Moa-Makona Basin in the Sierra Leone account for 10% of the country's cattle, around 20% of small livestock and 30% of pigs. (Table 41, below). In the Liberian part of the basin (County Lofa), livestock rearing is a rather marginal activity: only 2% of the national herd of small ruminants and large cattle (see Table 38 above). In fact, Lofa County, although one of the largest in Liberia (9% of the national territory) is mainly occupied by forests.

In the basin, the farming system is extensive. The savannah landscape in the upper basin and part of the middle valley offers favorable conditions for extensive livestock farming in general, and in particular for the rearing of large livestock. In Guinea, the rural municipalities of Soromaya, Sibiribaro (Prefecture of Kérouané), Binikala (Prefecture of Macenta) and Nongoa, in the Prefecture of Guéckédou are areas of high concentrations of livestock (especially large cattle) (TDA-RG, 2020). In the Upper Basin, there are more and more camps of herdsmen coming from the Middle, Upper Guinea and Mali. Some parts of the grassy savannah of these regions serve as corridors and transit for transhumance during the dry season period when the increase in herds leads to overgrazing and degradation of the plant cover (TDA-RG-Stakeholders, 2020)

Extensive livestock rearing can cause significant damage to the environment. This is when there is an excessive concentration of livestock in an area, leading to overgrazing, deforestation and soil erosion. It is also common for pastoralists to resort to bush fires to promote the regrowth of fresh grass, which is more palatable by livestock. These fires contribute to deforestation, the loss of plant and wildlife biodiversity, as well as soil erosion,

Table 39. The share of the Regions of the Moa-Makona Basin in the distribution of livestock in Guinea

	Cattle	Sheep	Goats	Pigs
Faranah	1140	357	313	3482
Kankan (Kerouane)	1665	483	411	229
Nzérékoré	392	314	355	124629
Eng_Regions_Moa-Mak	3197	1154	1079	128340
National	7520	2709	3196	140255
Moa-Makona Region's Portion	43%	43%	34%	92%

Source: TDA-RG Data, 2020

Table 40. The share of the Districts of the Moa-Makona Basin in the distribution of livestock in Sierra Leone

Districts	Cattle	Sheep	Goats	Pigs
Kailahun	3,289	36,173	75,090	8,645
Kenema	2,308	19,799	27,272	2,493
Kono	40,051	45,637	69,082	4,765
Pujehun	720	10,206	15,598	1,338
Total Moa	46,368	111,815	187,042	17,241
Total National	465,817	574,706	814,269	57,877
In %	10%	19%	23%	30%

Source: SSL, 2017

Table 41. Share of Lofa County in the distribution of Liberia's national livestock

	Cattle	Sheeps and goats
	2019*	2019*
Lofa	874	13 625
Total pays**	45 040	667 497
% Lofa County	2,0%	2,0%

Sources : (*) FAO, 2019, op. cit ; (**) FAOSTAT (for data at national level for 2019)

3.3.3. Fishery Resources - Fishing

Fishing activity is very poorly developed in the Moa-Makona basin, even though there are few statistics to illustrate this field observation (TDA-RG, 2020; TDA-SL, 2020). In the light of the data at the national level, we see that the countries of the MRU are lagging behind in the area of inland fisheries if we compare them, for example, to other African countries. The FAO estimates for the year 2015 the catch of freshwater fish in the MRU space at 38,300 tonnes, i.e. less than one kg of fish per person per year,

against a catch volume of over 300,000 tonnes for Sahelian countries (3.7 kg per person per year)[16]. Relative to renewable freshwater volumes, the MRU countries produce only 56 tonnes of fish per km^3 against 1,225 tonnes / km^3 for the Sahel and nearly 9,000 tonnes / km3 on the continent scale. Among the MRU countries, Sierra Leone and Liberia have the lowest volumes of fish catch per km^3 of freshwater: 14 and 9 tonnes per km^3 respectively (Funge-Smith, 2018): see details in Table 40 below). Along the same lines, an AfDB study estimates that over 90% of Sierra Leone's fish production comes from the marine fisheries sub-sector, and the rest from inland fisheries and, to a lesser extent, from aquaculture (AfDB, 2020). Inland fisheries in Sierra Leone focus on tilapia (60%) and catfish (30%), which certainly also applies to other countries in the basin (AfDB, 2020).
From the available data it is not possible to say whether the low volumes of waterfish catch in the MRU area are due to smaller fish stocks compared to those recorded in other rivers on the continent. In other words, the question remains whether the weakness of inland fishing production in the MRU area is the consequence of rivers with less fish than those in the rest of the region and of the continent or if this is the result of more low fishing effort.

Table 42. Low volumes of freshwater fish catches in the MRU countries compared to the Sahel, Africa and the world

	Inland Capture Fishery Catch (Tons) (2015)	Population (2013)	Per Capita Inland Fishery Production (kg/cap/yr)	Total Renewable Surface Water (km3 /yr)	Fish Production per unit of Renewable Surface Water (tons/km3 /yr)
Guinea	26000	11745000	2.21	226	115
Cote d'Ivoire	8000	20316000	0.39	81	98
Liberia	2200	4294000	0.51	232	9
Sierra Leone	2100	6092000	0.34	150	14
MRU countries	38300	42447000	0.90	689	**56**
Sahel States	307385	82765000	3.71	251	1225
Africa	2860131		2.56	5529	8716
World	11469460		1.64	52726	11898

Source: Funge-Smith. 2018 op.cit.

Aquaculture is indeed underdeveloped in the Moa-Makona Basin. For the Guinean part of the basin, this is what emerges from the findings of field visits and studies carried out within the framework of the TDA (TDA-RG, 2020; RG-TDA_Stakeholders, 2020). As for the Sierra Leonean part of the basin, aquaculture is a very marginal activity. Out of the 2,993 fish ponds identified in Sierra Leone in 2009, the Districts of the Moa-Makona Basin had only 61 of which 28 were functional (Sankoh et al. 2018).

3.3.4. Forest Resources

Like the Scarcies Basin, that of Moa-Makona is undergoing a process of rapid deforestation - a problem that concerns all the countries of the MRU. Most worrying is that the rate of deforestation has accelerated over the years. World Resources Institute (WRI) through the Global Forest Watch program monitors forest evolution using satellite imagery (including Google Map) (WRI, 2021). This program shows that both upstream and downstream, the level of deforestation in the Moa-Makona Basin is

[16] Sahelian countries including Chad, Niger, Mali, Burkina Faso, Mali, Senegal, Mauritania and Gambia

very high. Over the past 20 years (from 2000 to 2020), the forest area in the Guinean part of the basin (in the Prefectures of Faranah, Kissidougou, Kérouané, Guéckédou and Macenta) has declined by 13%, and by 32% in the Sierra Leonean part of the basin (Districts of Kono, Kailahun, Kenema and Pujehun)[17]. In Guinea, the most affected prefectures are those of forest Guinea (Macenta and Guéckédou) with more than 20% forest loss, while in Sierra Leone, it is the District of Pujehun, downstream of the basin, which is the most affected (40%), even if the other Districts have a very high deforestation rate, approaching or exceeding 30% (Table 43 and Table 44 below).

The rate of deforestation has accelerated in the last decade (2010 to present) compared to the previous decade, as shown in Fig. 26 below). In the Sierra Leonean part, the rate of forest decline fell from 5% between 2000 and 2020 to 28% over the following decade. During the same periods, forests in the Guinean part fell from less than 2% to around 12%, respectively.[18]

Table 43. Evolution of forest cover in the Prefectures of the Moa-Makona Basin and Guinea from 2000 to 2020

Prefecture	Total Area	Forest Cover 2000 (ha)	Losses 2001-2010 (ha)	Forest Loss 2001-2010 (%)	Forest Loss 2011-2020 (ha)	Forest Loss 2011-2020 (%)	Forest Loss 2001-2020 (ha)	Forest Loss 2001-2020 (%)
Faranah	1.286.294	858.690	15.635	1.8%	77.726	9.2%	93.361	10.9%
Kissidougou	619.643	448.807	5.630	1.3%	28.857	6.5%	34.487	7.7%
Kérouané	938.317	321.335	7.443	2.3%	20.696	6.6%	28.139	8.8%
Guéckédou	423.648	309.248	4.909	1.6%	57.044	18.7%	61.953	20.0%
Macenta	805.587	699.018	15.439	2.2%	128.839	18.8%	144.278	20.6%
TOTAL	4.073.489	2.637.098	49.056	1.9%	313.162	12.1%	362.218	13.7%

Source: WRI, 2021

Table 44. Evolution of forest cover in the Districts of the Moa-Makona Basin in Sierra Leone from 2000 to 2020

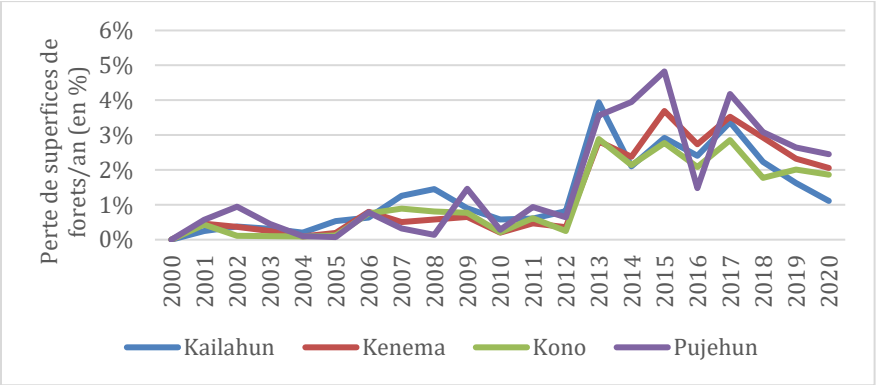
District	Total Area (ha)	Foest Cover 2000 (ha)	Losses 2001-2010 (ha)	Forest Loss 2001-2010 (%)	Forest Loss 2011-2020 (ha)	Forest Loss 2011-2020 (%)	Forest Loss 2001-2020 (ha)	Forest Loss 2001-2020 (%)
Kailahun	415.089	395.438	26.672	6.7%	100.779	27.3%	127.451	32.2%
Kenema	621.701	599.809	25.127	4.2%	166.541	29.0%	191.668	32.0%
Kono	537.660	461.974	20.361	4.4%	103.748	23.5%	124.109	26.9%
Pujehun	389.515	346.340	18.238	5.3%	119.008	36.3%	137.246	39.6%
TOTAL	1.963.965	1.803.561	90.398	5.0%	490.076	28.6%	580.474	32.2%

Source: WRI, 2021

[17] It was considered here that a unit of area (the pixel used in the monitoring) can be classified as belonging to the forest if it is at least 30% covered by the canopy

[18] The rate of deforestation over the past decade, however, may have been somewhat amplified by changes introduced in Global Forest Watch methodology in 2011-2012).

Figure 26. Evolution of the rate of deforestation in the Districts of the Sierra Leonean part of the Moa-Makona Basin from 2000 to 2020



Source: WRI, 2021

The decline of forests and, more generally, deforestation are among the main environmental challenges facing the Moa-Makona Basin today. The trends observed in recent years indicate a worsening of the problem. During the decade, the forests of the basin would have shrunk by more than 10% in the upper basin, while the forests of the middle and lower valley would have shrunk by 25% during the same period. If current trends continue, the important primary forests in the basin will have almost all disappeared within the next 20-30 years. Deforestation are due to often large-scale local natural resource use practices. These resources are of essential economic importance for the local populations and the countries of the basin in general. The expansion of agricultural land begins with clearing by burning, thus deforestation and forest recession. With demographic pressure and the adoption of cash crops, fallow periods are shortened, leading to soil impoverishment and lower yields, all resulting in an increasingly pressing need to conquer new agricultural land to the detriment of forests. Plantations, on the other hand, replace trees with other trees, but lead to a loss of biological diversity - plantations being mono-specific. The exploitation and marketing of wood (relating to species such as teak, niangon, dibetou, fraké, etc.) strongly contribute to the deforestation process in the basin, as does the collection of firewood and of charcoal. The Moa-Makona Basin is home to the main mining sites - diamonds, gold, iron, etc. Whether industrial or artisanal, intensive and large-scale mining is one of the most important causes of the process of deforestation in the Moa-Makona Basin.

3.3.5. Mineral Resources

Among the ten or so small transboundary river basins that make up the MRU area, that of Moa-Makona ranked first in terms of the importance of mining activity. Due to the richness of its diamond bed and banks, the Makona River is the object of intense industrial and artisanal exploitation, from the source in Guinea (where the basin is full of the country's most important diamond reserves), to the downstream in Sierra Leone (which includes the so-called diamond-bearing districts of the country).

In the upper basin (Guinean part), the source of Moa-Makona, the bed and the banks of the river are particularly targeted in the exploration and exploitation of diamonds. This is where the so-called “Diamond Triangle” is located, covering the Prefectures of Kérouané-Kissidougou-Macenta (USAID, 2008). Within this triangle, the intensive exploitation zones are located in the sub-prefectures of

Soromaya, Sibiribaro (Prefecture of Kérouané), Binikala (Prefecture of Macenta) and Fangamadou (Prefecture of Guéckédou) (TDA-RG, 2020).

In Sierra Leone, mineral resources are broadly distributed territorially as follows: bauxite and rutile in the west; iron especially in the north; diamond in the east (so also in the Moa-Makona Basin) and gold all over the country (TDA-SL, 2020).
The four Districts of the basin (Kono, Kailahun, Kenema and Pujehun) are part of the 7 so-called diamond districts of Sierra Leone - the others being Bo, Bombali and Kambia. Kono and Kenema are by far the two most intense diamond mining districts in the country (World Bank. 2012).

Regarding the forms of diamond mining, there are roughly three: industrial, artisanal or small-scale formal, legal; and clandestine, illegal artisanal mining.

In Guinea, diamond mining was initially industrial. It dates back to the mid-1930s in Baradou (Prefecture of Kissidougou). Subsequently four to five mines (initiated by British, Russian and French investors) embark on diamond mining. (RG-TDA-Stakeholders 2020). For about fifty years, diamond mining has been almost exclusively industrial in Guinea (USAID, 2008). Since 2004-2005, diamond mining in the Guinean part has mainly been formal or clandestine artisanal (without an exploitation permit).

Mining in Sierra Leone also began in the 1930s, with large mining companies. Today mining is mostly artisanal. This is facilitated first by the civil war, which has created a situation of insecurity everywhere, especially in the mining areas whose control was precisely at the root of the conflict. The other factor that explains the preponderant role of artisanal mining is that the deposits are secondary, often alluvial and therefore exploitable with light technical means.

Legal and illegal artisanal mining now employs hundreds of thousands of people in the basin. The World Bank estimates that while industrial mining employed around ten thousand workers (2010), artisanal mining directly employed 300,000 to 400,000 people, making Sierra Leone's second largest employer after agriculture (World Bank, 2017).

Whether in Guinea or Sierra Leone, artisanal mining uses a variety of intermediaries. The “Master” in Guinea or the “Supporter” plays a central role there, although sometimes invisible. He is either the direct holder of the operating license or buys it from the holder. Then he recruits, equips, feeds and, on the basis of the results obtained, remunerates the miners (diggers, wells, washers, etc.). Wages paid are often not insignificant and over-indebted miners are trapped in poverty. The Chiefdoms of Gorama Mende (Kenema District) and Nimiyama (Kono District) host a large number of artisanal diamond mining license holders (World Bank, 2012, op. Cit).

In addition to diamonds, gold, iron, bauxite and rutile, quarries and sands are also subject to intense exploitation, with equally significant environmental impacts. In Guinea, the sand deposits of the bed of the Makona River and its main tributaries are exploited in the dry season and used in construction. In areas where these deposits are important, mechanical shovels and trucks are deployed to accumulate stocks which are then sold during the rainy season, a period during which access to these quarries becomes difficult” (RG-TDA-Stakeholders, 2020)

Legal or clandestine, mining is carried out in the greatest anarchy in the basin and in the two riparian countries of the Moa-Makona (Guinea and Sierra Leone). With the large number of miners, especially artisanal miners, coming from all the regions of the countries concerned but also from the sub-region, the artisanal exploitation of diamonds, gold and other mining deposits is the main cause of the degradation of the environment in the Moa-Makona Basin and in most of the other small river basins of the MRU area.

Alluvial diamond mining has created a landscape of vast expanses of once forest or arable land that has become totally denuded and unusable for agriculture. Rivers have been diverted and, in some cases, destroyed. Stagnant water from open-pit mining is a breeding grounds for mosquitoes that carry malaria and water-borne diseases. Mining is itinerant. When the ore runs out or becomes scarce, mining sites are abandoned without any form of rehabilitation while new mining sites are created. (EPA-SL, 2016).

In short, as briefly described in this section and analyzed in the previous Chapter (Chapter 3), mining, and in particular that of diamonds or gold, causes significant damage to the environment. It requires the abstraction of large volumes of water, accelerates deforestation and leads to the accumulation of large amounts of soil in the exploitation sites. It changes the course and physiognomy of waterways and contaminates surface and groundwater and heavy metals with effects on ecosystems and animal and human health.

3.3.6. Exploitation of water resources

3.3.6.1. Use of water in productive sectors

Mobilization of water resources in productive sectors is weak in the Moa-Makona basin. Agriculture is mainly rain-fed, aided by the fact that it rains in abundance most of the year in the basin from the source to the mouth of the river.

The use of freshwater - which also exists in abundance - could however have made it possible to intensify agriculture (increase yields and cropping intensity) while making it less vulnerable to inter-annual variations in rainfall and to climate change in general. The amounts of freshwater used in plantations (such as Goldtree's) appear to be relatively low.

With regard to fishing, aquaculture (which retains water in ponds) is poorly developed in the upstream part of the basin and most of the ponds that exist in the middle and lower valley (Sierra Leone) are not functional.

The quantities of water withdrawn by the mining sector can be large but limited when compared to the volumes of runoff in the Moa-Makona River and its tributaries.

As we have seen above, what is of particular concern is the degradation of water quality in industrial and artisanal mining methods (pollution of water by chemicals such as cyanide and mercury, erosion of soils, increase in the solid load of water, etc.).

3.3.6.2. Access to Drinking Water

The level of access to drinking water in the Moa-Makona Basin is significantly better than the national average, also in the Guinean part of the basin than in the Sierra Leonean part. In the Guinean part, only 10% of the population does not have access to improved water sources (ie half of the national average) (Table 45 below). Similarly in the Sierra Leonean part, 15% do not have access to improved sources against a national average of 22% (Table 44). In the Sierra Leonean part, the district with the lowest level of access to drinking water (Kono District) happens to be the first diamond district in the country.

Table 45. Levels of access to drinking water in the regions of the Moa-Makona Basin in Guinea

Region	Sample Size	Access to Improved Water Source (%)	Access to Non Improved Water Source (%)
Faranah	4 714	87.1	12.9
Kankan	7 012	90.9	9.1
Nzérekoré	8 385	89.8	10.2
Region Moa-Makona	20 111	**89.6**	10.4
National	49 106	79.9	20.1

Source: INS, 2019

As can be seen from the table below (Table 46 below), in the Sierra Leonean part of the basin, the populations obtain their water mainly from groundwater (through wells and boreholes). These statistics are corroborated by the populations questioned during the field visits conducted as part of the formulation of this TDA. The river water is hardly consumed by the population, who consider it polluted[19], which however remains to be validated on the basis of rigorous water quality studies.

Table 46. Access to improved sources of drinking water by District in the Sierra Leonean part of the Moa-Makona Basin

Districts	Size of the Population in the Sample and Percentage		Total Access to Improved Sources (%)	Access to Improved Sources (By Type of Source) (%)						Unimproved Sources (%)
				Running water	Wells with Drill Pumps	Protected Wells	Protected sources	Well Collection	Other Enhanced Sources	
Kailahun	4,742	24%	67.1	8.9	42.4	14.6	1.1	0.1	0.1	16.6
Kenema	7,323	37%	87.9	24.7	23.0	39.2	0.1	0.1	0.9	5.1
Kono	5,003	25%	**66.1**	4.6	19.3	39.8	1.0	0.4	0.9	25.3
Pujehun	2,932	15%	71.0	6.3	52.4	10.5	0.7	0.6	0.4	21.5
Moa-Mak Region	20,000	100%	**75.0**	13.2	31.0	29.3	0.7	0.2	0.6	15.3
National SL	74.602		67.8	16.9	19.5	23.3	1.6	1.5	4.9	22.2

Source: SL. 2018

3.3.6.3. Planned water resources development programs

[19] Discussions with the Paramount Chief of Jawei Chiefdom in Daru, Kailahun District (Nov 2020)

The Moa-Makona River and its tributaries do not contain any significant hydraulic or hydroelectric infrastructure. Water control is therefore virtually non-existent. However, the hydroelectric potential of the river is significant.

In the Guinean part, four dam sites were inventoried: two in the Moa-Makona River (Nongoa, Kagbadou) and two in the Meli tributary (Kelibgadou and Kiligbema), for a total storage volume of nearly 37 million m^3 of water and a planned cumulative installed capacity of 48 MW (Table 47, below).

Table 47. Hydroelectric Dam Sites in the Makona Basin - Guinean Part

Basin	Makona	Makona	Makona	Makona
Watercourse	Makona	Makona	Meli	Meli
Name of Dam	**Nongoa**	**Kagbadou**	**Kelibgadou**	**Kiligbema**
Height (m)	7.80	20.30	16.40	14.00
Reservoir Volume (mln m3)	15.936	16.024	4.090	0.904
Reservoir Area (km2)	4.67	2.16	0.69	0.21
Installed Capacity (MW)	23.6	11.2	8.6	4.6
Ref Number	A-MAK-7070-1	A-MAK-9011-1	A-MAK-6505-1	A-MAK-6505-2
Locality	TOMANDOU	KAGBADOU-II	KOUNDOU	KOUNDOU
Sub-Prefecture	Nongoa	Gueckedou-Centre	Koundou	Koundou
Prefecture	Gueckedou	Gueckedou	Gueckedou	Gueckedou
Longitude	-10.300513	-10.111332	-10.474826	-10.47475
Latitude	8.490879	8.527819	8.655304	8.671865

Source: AECOM, 2018

In the Sierra Leonean part, the average flows are higher than upstream, but the hydraulic and hydroelectric potential, which is inventoried remains modest. Of the 27 dam sites identified in Sierra Leone, two are located in the Moa-Makona Basin; Baraka and Nyandehun, with a cumulative installed capacity of 46 MW, or only 5% of the installed capacity of the 27 sites of identified dams (Table 46 below).

Table 48. Potential Sites of Hydroelectric Dams in the Moa-Makona Basin (Sierra Leone)

Project	Potential installed capacity (MW)
Baraka	39.6
Nyandehun	6.4
Total Moa	46
Total Sierra Leone (27 sites)	974
Moa Part	5%

Source: EPA-SL, 2016

Conclusion of Chapter 3

Moa-Makona is a pool of contrasts. As one of the main transboundary basins of the MRU, it is well drained (high rainfall spread over the whole year, a watercourse benefiting from the inflows of a tributary and which carries billions of m^3 of water flowing into the sea every year). It houses the most important relics of the Upper Guinea Forest, one of the 333 biodiversity hotspots identified in the world. As a result, it provides unique habitats for a large number of endangered animal and plant species. The basin is also renowned for the important mineral deposits it hosts (diamond, gold, iron, rutile, etc.): the "Diamond Triangle" and the two of the districts with the richest deposits of diamonds in Sierra Leone.

The first contrast, even a paradox, is that despite the fact that the basin is well endowed by nature, the populations who live there are in an alarming state of poverty. The fishing potential of the river is almost ignored by the local populations. Mining, which attracts immigrants from all over, has so far not helped to fight poverty, while the environmental cost of mining is very high. Unsustainable agricultural practices - rice cultivation, coffee, cocoa and oil palm plantations - prevent people from taking full advantage of the very favorable context of abundant rainfall.

In terms of outlook, the most important challenges in the basin relate to the urgency of putting the conditions for mining in order. It is about slowing down or reversing the process of land degradation, forests, water pollution, loss of biodiversity, which are among the many effects of the anarchy that reigns in the artisanal and industrial exploitation of mineral resources. Extensive slash-and-burn agriculture with shorter and shorter fallows periods depletes the soil, pushing farmers to conquer new cropland to the detriment of forests.

Large agro-industrial plantations and their satellite peasant plantations lead to the conversion of forests to monocultures, with the implications of a loss of biodiversity. The use of fertilizers and pesticides is massive and contributes to water pollution. But what is most striking is the low use of the significant potential of the river and its tributaries. The people live next to the river but have limited contact with the waterway, almost mistrustful of it.

4. CHAPTER 4 – CAVALLY BASIN

Introduction

The Cavally River originates at an altitude of 600 on the northern slopes of Mount Nimba, near the village of Séringbara (Sub-Prefecture of Bossou, Prefecture of Lola) in Guinea. In its Guinean upper course, the Cavally River (also called Youn or Djougou in local languages), crosses the sub-prefectures of Bossou and then N'Zoo in the prefecture of Lola. Part of its upper course is entirely in Ivorian territory. In its middle and lower course, the main arm of the river forms the border between Cote d'Ivoire and Liberia (the country where it is known as Cavalla). The Cavally River then empties into the Atlantic Ocean at Cap des Palmes, nearly twenty kilometers from the city of Harper (Liberia) (RG-TDA-Stakeholders, 2020; TDA-RG, 2020) and, near the village of Bliero which is part of the town of Tabou (Côte d'Ivoire).

700 km long, the Cavally River has a basin shared by Guinea, Cote d'Ivoire and Liberia. This basin is unevenly distributed among the three riparian countries. Most of the basin (55%) is located in Ivorian territory, against 40% in Liberia and 5% in Guinea. Nationally, the share occupied by the basin is also highly variable: the basin occupies only 1% of Guinean territory and 5% of Ivorian territory. On the other hand, for Liberia the basin, which covers 17% of the national territory is of primary national interest (See Table 47 and Fig. 27 below).

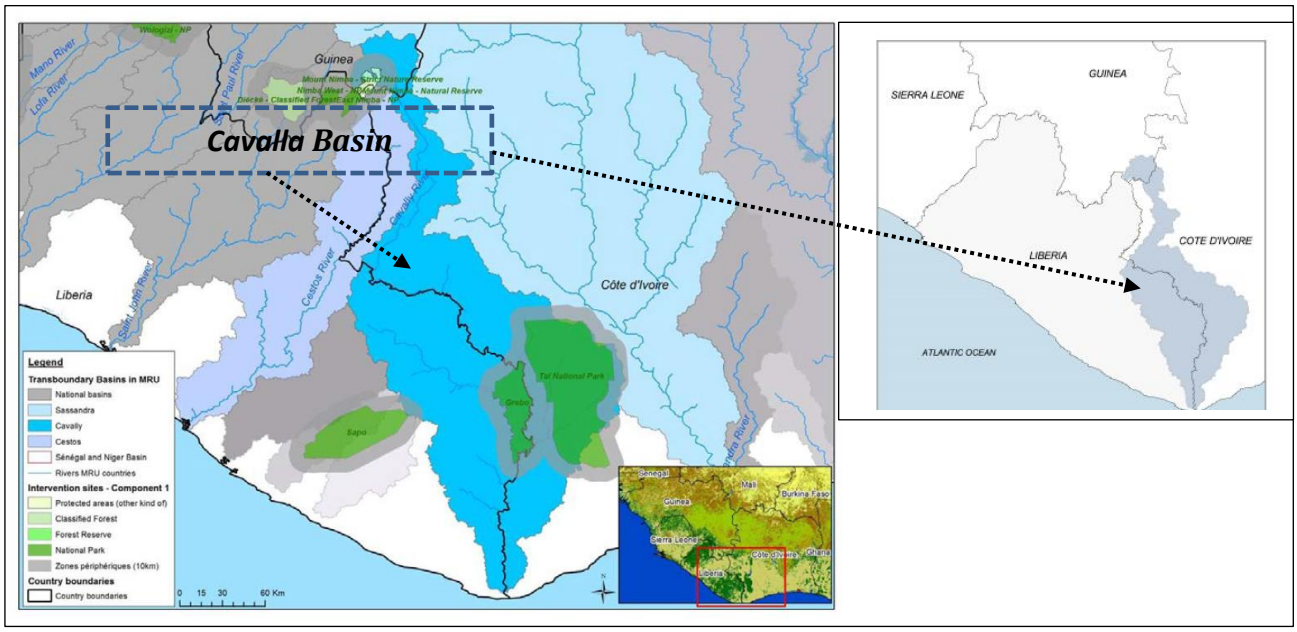
Table 49. Distribution of the area of the Cavally Basin between the riparian countries

	Guinea	Cote d'Ivoire	Liberia	Total
National Area (km2)	245 836	322 463	71 740	640 039
Area of country within the Basin (km2)	1 400	16 100	11 900	29 400
Percentage of the Basin within the country	5%	55%	40%	100%
Percentage of the country within the Basin	1%	5%	17%	5%

Source: For the areas of the basin: McCracken & Wolf, 2019.

This chapter is divided into three sections. The first is a presentation of the physical framework of the Cavally Basin. The second section describes the main demographic and socioeconomic characteristics with an emphasis on the poverty profile of the basin. The third section analyzes the main forms of use of the basin's resources, with an emphasis on agriculture, animal husbandry, fishing, exploitation of forest products; the exploitation of mineral resources as well as the forms of use of fresh water resources for the supply of drinking water and for the production of energy through hydroelectric dams.

Figure 27. Cavalla Basin



Source: IUCN, 2016

4.1. Main geophysical characteristics of the Cavally Basin

4.1.1. Geology and geomorphology

The relief of the Upper Basin of Cavally (Guinea), very rugged, is dominated by the chain of the Nimba Mountains, which culminates at 1752 meters. The steep slopes give the stream a high flow speed with very violent torrents at the falls and rapids. The lowlands around the Mountains are in the form of vast plateaus with an altitude varying between 400 and 550 meters (RG-TDA-Stakeholders, 2020). The geology of the upper basin is mainly made up of metamorphic rocks (gneiss, quartzite and graphitic schists), ferruginous armor with a high iron metal content and magmatic rocks, mainly granites (RG-TDA-Stakeholders, 2020).

In the north of the Ivorian and Liberian part of the upper basin, the relief remains very rugged, with mountains reaching over 900 m high: Mont Momi (1250 m); Tonkoui (907 m) (TDA-IC 2020). This part of the basin as well as the middle course, belong to the Precambrian Basement (SMI, 2016; TDA-LIB, 2021).

The middle Cavally Basin is marked by interior plains and transition zones with generally relatively uneven relief (100 m - 400 m) (TDA-IC, 2020).

The coastal fringe of the basin is characterized by altitudes below 20 m. It is occupied by the formations of the sedimentary basin (SMI, 20216; TDA-IC, 2020)

From a pedological point of view, there are four classes of soils in the upper basin: various skeletal and little evolved ferralitic soils, gravelly ferralitic soils, various alluvial ferralitic soils as well as hydromorphic soils (RG-TDA-Stakeholders, 2020).

In the middle Ivorian and Liberian basin, the dominant soils are acrisols or latosols, with a high iron content (TDA-IC, 2020; TDA-LIB, 2021). Yellow or red in color, these soils are characteristic of primary forest regions.

4.1.2. Hydro-Climatic Context

The Cavally Basin includes three major climatic groups: an equatorial high altitude or mountain climate in the upper basin (mainly in the Guinean part of the basin and partially in the Ivorian part); an equatorial climate of attenuated transition in the upper part of the middle course of the river (between the Cote d'Ivoire and Liberia) largely up to the height of Taï; an equatorial climate of transition in the downstream part of the middle course and in the lower valley and the coast) (RG-TDA_Stakeholders, 2020).

4.1.2.1. Rainfall

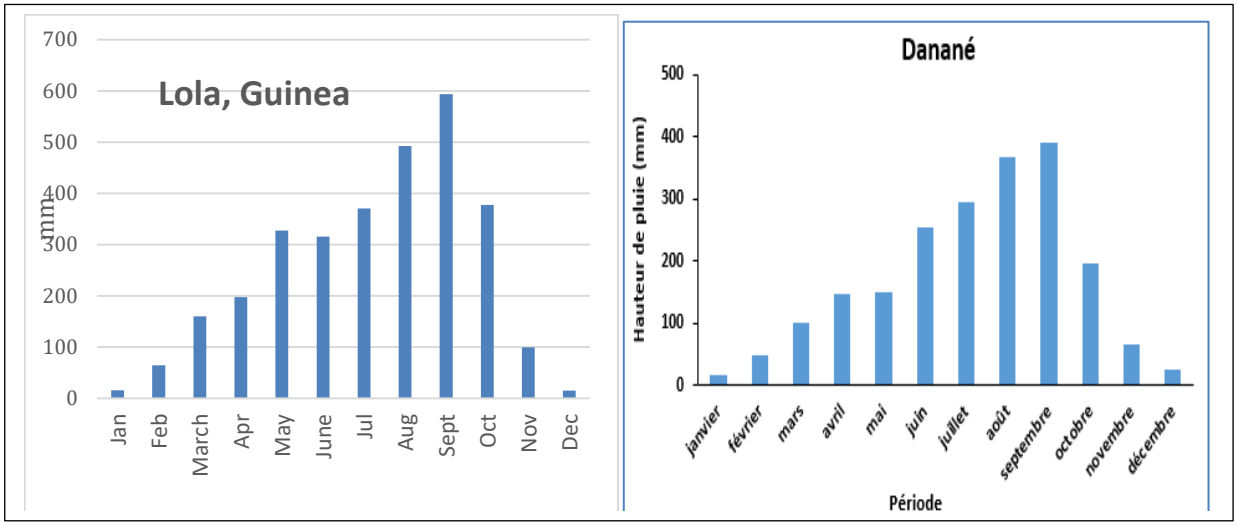
Each of the three climatic domains has its own characteristics, notably in the domain of general rainfall and the distribution of rainfall over time.

The mountain climate includes a rainy season (March-October) and a rather dry season (November-February) quite well differentiated and records an annual rainfall varying between 1400 and 2000 mm. At the Lola station (in Guinea, north face of Mount Nimba), the annual rainfall over the period 1979 to 2010 is around 1800 mm / year. The rainy season in this region lasts for 9 months (March-November), although the period from May to October (six months) records more than 75% of the annual rainfall (See Fig. 28). In the Ivorian part of the upper basin, the so-called sub-mountain rainfall regime (TDA-IC, 2020) has the same overall characteristics illustrated by the Danané station. The annual rainfall for normal before 1967 slightly exceeds 2300 mm / year, of which 70% recorded between June and October (Fig. 28 &29 below).

In the equatorial climatic domain of attenuated transition, which concerns the upper part of the middle valley (the height of the parks of Taï in Cote d'Ivoire and Grebo-Krahn in Liberia), the annual rainfall (1360 mm) is slightly higher than that of the sub-mountain climatic domain. As shown by the curve below concerning the Grabo station (Fig. 29), we note that it rains all year round, with two rainfall peaks: April-June and September-November, with 40% of the rainfall for the first peak and 30% for the second.

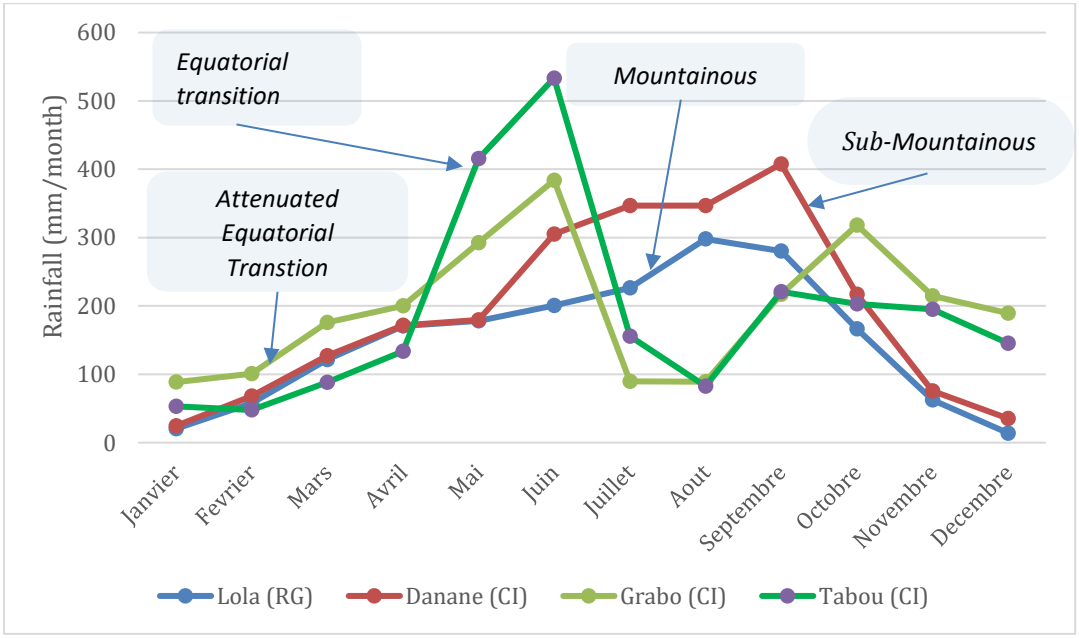
With regard to the transitional tropical climatic domain (low valley and coast, represented in the Figure below by the Tabou station, the volume of annual rainfall is very close to that of the equatorial climatic zone of attenuated transition (a slightly less than 2300 mm). The distribution over time shows two peaks, the first from April to July clearly more pronounced than the second peak which covers the period from September to November: the first records more than 50% of the annual rainfall against 30% for the second.

Figure 28. Average monthly rainfall over the period 2009-2010 in Upper Basin (mountainous climate in Lola (Guinea) and sub-mountainous in Danané (Cote d'Ivoire).



Source: Lola: TDA-RG, 2020 Data; Danané: TDA-CI, 2020

Figure 29. Average monthly rainfall in stations representative of different reaches of the Cavally Basin in Guinea and Cote d'Ivoire

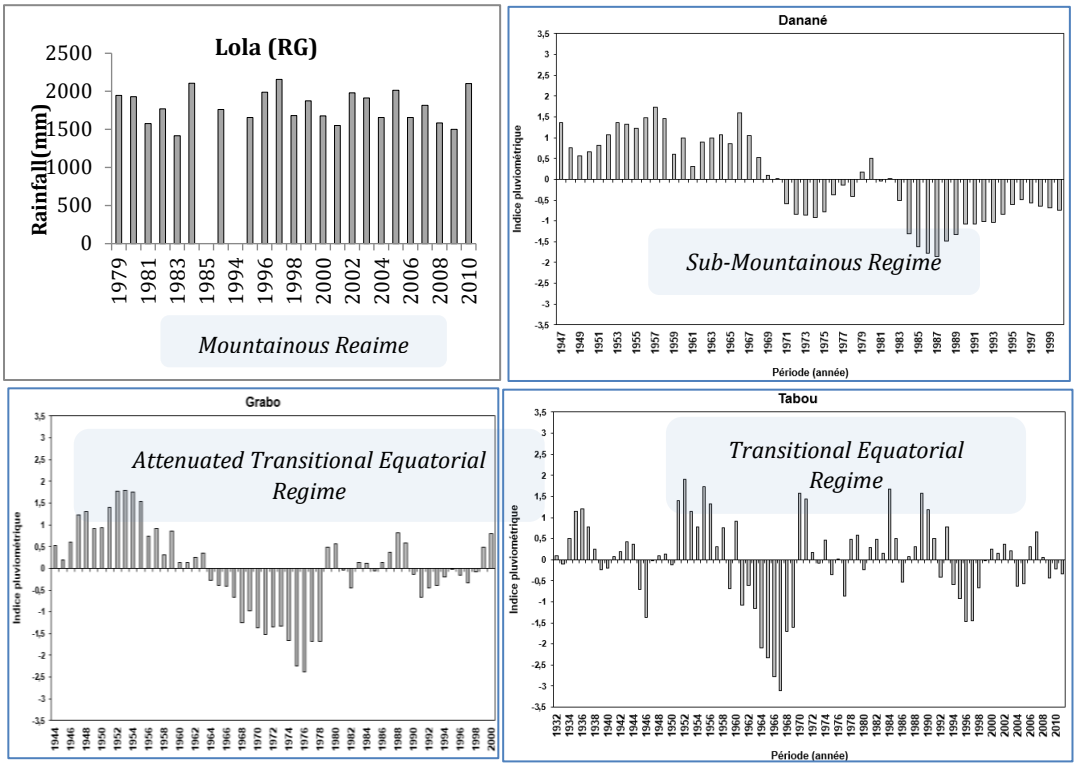


Sources: For Lola (Guinea), ref. 1979-2010, TDA-RG data, 2020; For Cote d'Ivoire stations, period ref. Up to 1967: Gerard & Toucheboeuf, sd.

The analysis of the inter-annual variability of rainfall in the basin and of long-term trends is hampered by significant gaps in the rainfall series available for the meteorological stations of the different reaches of the basin. For the Lola Station (Upper Guinean Basin, representative of the mountain climate), the available data cover the period 1979 to 2010, with missing data for two years. During this period, the recorded annual rainfall varies from 1400 to 2150 mm, which constitutes a significant difference of 750 mm. In the observation period no clear trend (towards an increase or decrease in the annual volume of rainfall) is observed. At the Danané station (sub-mountain regime), two contrasting periods

are noted: a period of high rainfall before 1970 and another between 1971 and 2000, when the rainfall is on a downward trend. With regard to the downstream stations, the annual rainfall is sawtooth, in a clear trend, especially for the period between 1980-2000 for the Grabo Station and 1970 to 2010.

Figure 30. Evolution of annual rainfall in Lola (Guinea) from 1979 to 2010 and at the stations of Danané, Grabo and Tabou (Cote d'Ivoire) from 1940 to 2000



Sources: Lola (TDA-RG, 2020); Stations of the Cote d'Ivoire (TDA-CI, 2020)

In total, rainfall in the river basin is abundant - over 1500 mm / year with a noticeable trend of increasing rainfall from the source to the mouth of the river. It rains almost all year round, with one or two seasons of high rainfall in the year, depending on whether the climatic regime is mountain or sub-mountain (a season of high rainfall) or equatorial transition (two periods of high rainfall in year). Whatever the local climatic regime, rainfall is subject to very marked inter-annual variations. However, there is no discernible general long-term unidirectional trend towards increasing or decreasing rainfall in the basin.

4.1.2.2. Hydrology

The Cavally River has its source in the flanks of Mount Nimba in Guinea and flows into the sea after having traveled 700 km. In its upper part, the Cavally flows into Guinean territory for nearly 70 km, then into Ivorian territory, between the Ivorian-Guinean border and the town of Toulepleu. In this part of its basin, the Cavally River appears as a dense network of small tributaries, including the Ma and the Diré (each about 30 km long) which are on the left bank (RG-TDA_Stakeholders, 2020).

In its middle (from Toulepleu) and lower course, the main arm of Cavally serves as the border between Cote d'Ivoire and Liberia. Before the Taï rapids area, the Cavally receives on the left bank, the Doui (48 km (, the Goin (58 km), the Doué (52 km), the Débé (42 km). At Taï, it receives the N 'sé (62 km), and a zone of rapids begins and extends to Grabo. The Hana (110 km) and the Neka

(48 km) then swell the Cavally on the left bank and, on the right bank, the Dube, Gbe and Ghee (Osman, 2019; TDA-IC, 2020; LHS, 2016).

The flow of the river increases sharply from the source to the mouth, thanks to the inflow of multiple tributaries but also because the levels of water withdrawals (for different uses) are low. Thus the average annual flow of the river varies between 4 and 8 m3 / s near the source at Nimba and 40 m3 / s at Flampleu in the Ivorian upper basin then 60 m3 and 170 m3 respectively at Toulépleu and Taï in the middle upstream and downstream basin. In the lower valley, the average flow is around 500 m^3 / s (See Table 50 below).

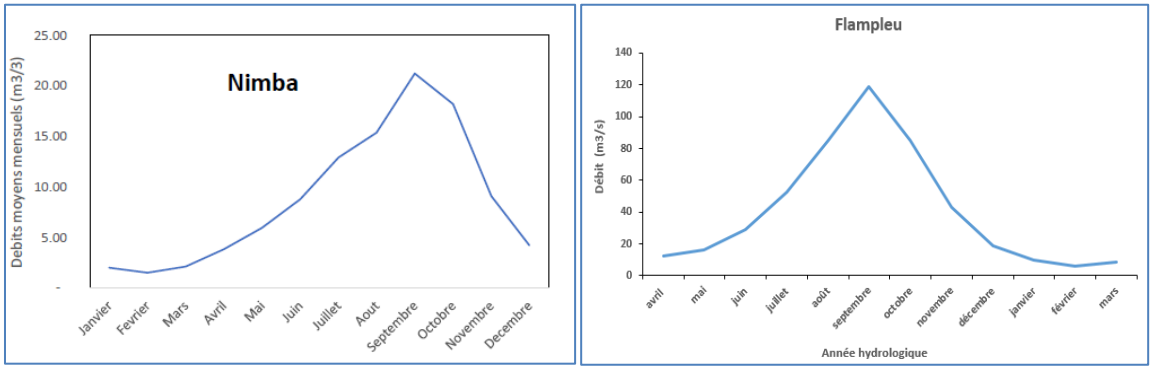
Table 50. Inter-Annual monthly mean flows of the Cavally River

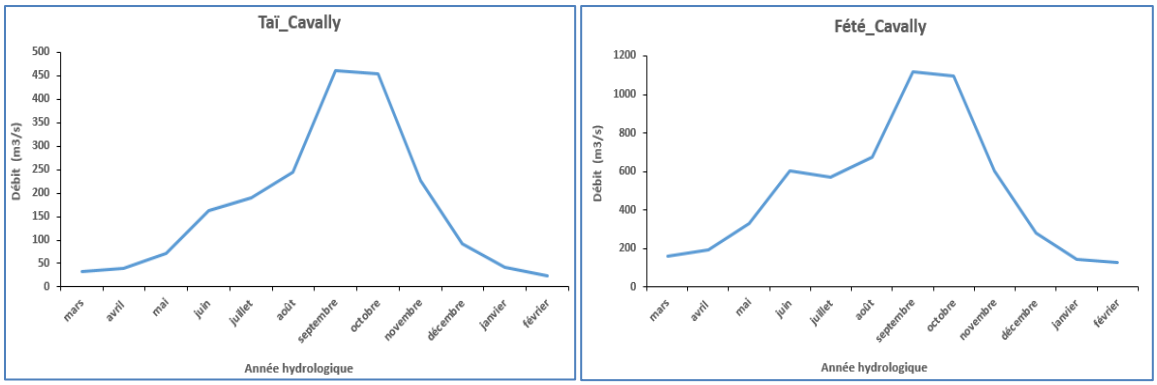
Station	Area (km^2)	Average flow (m3/s)												
		Jan.	Feb.	Mar.	April	May	June	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Flampleu (High)	648	9,6	6,2	8,7	12,5	16,0	28,8	52,5	85,4	119,0	85,1	43,2	18,5	**40,5**
Toulépleu (Average)	4 670	10,9	7,4	7,7	11,9	23,5	47,2	77,2	124,3	183,4	156,4	69,8	28,6	**62,4**
Taï (Average)	12750	41,3	24,1	31,8	43,8	74,4	157,5	185,3	256,1	462,4	439,1	220,9	92,1	**169,1**
Party (Low)	26600	146,8	127,4	158,8	193,1	331,8	605,5	570,9	677,2	1119,2	1093,5	603,6	282,3	**492,5**

Source: Ref period, see above (TDA-IC, 2020)

The hydrological regime of the Cavally River follows to a large extent the rainfall regime, especially in the upstream part of the river where the hydrograph of the watercourse is unimodal with a high-water season and a well-marked low-water season, corresponding respectively to the rainy season and in the dry season. In the middle and lower valley, the high-water period lasts for a longer period, with a flood peak in August-September preceded by a first smaller rise in May-June. In general, it is between December and March that the basin records the lowest flows in its various reaches (See Fig. 31).

Figure 31. Hydrological Regimes of the Cavally in different reaches, from upstream to downstream



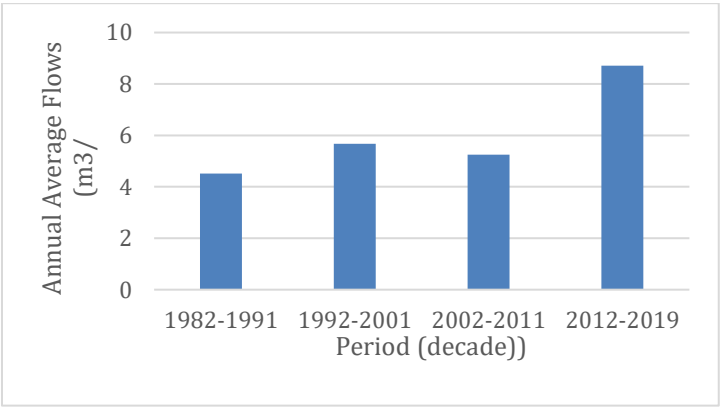


Note. Nimba stations (mountain regime): 2012-2019; Flampleu (sub-mountain regime): 1955-2000; Tai (Equatorial regime of attenuated transition): 1955-2000; Fété (equatorial transition regime): 1973-2013. Sources: TDA-RG data, 2000 for Nimba; TDA-IC, 2020 for other stations)

As with rainfall, the fact that there are no stations in the Cavally Basin with hydrological series over a long period makes it difficult to analyze the interannual variability and trends over the long term in the river regime. This situation is largely due to the politico-military and health crises that the countries of the basin have experienced at different times since the 1980s. The Nimba Station in Guinea is one of the few with hydrological data on the Cavally River covering a long period 1982 to the present day, that is to say 40 years. At this station, discharge data is available for 20 years - those years for which discharge measurements were taken for at least 345 of the 365 days of the year.

By comparing the average volumes of annual flows for the 20 years for which credible data are available, we see that the average annual flow is 4.5 m3 / s for the period 1982-1991, against 5.6 m3 / s for 1992-2001; 5.2 m3 / s for 2002-2011 and 8.7 m3 / for the period from 2012 to the present day. Thus, the average flows are subject to strong inter-annual variability, ranging from 2.6m3 / s in 2006 to 9.6 in 2017 or 2019. The average annual flow recorded during the last decade (2012-2019) is much higher than that recorded during the previous two decades (see Fig. 32). But there is no index to predict the evolution of flows in the years to come.

Figure 32. Average Annual Flows of the Cavally River near its source in Nimba (Guinea)



Source: TDA-RG Team Data, 2020[20]

4.1.2.3. Underground waters

[20] To be be noted that 4 years validated for periods 1982-91 ; 1992-2001 ; 2012-19 ; and 8 years validated for the période 2002-2011.

The information available on the groundwater resources of the basin is limited, either general or is based on ad hoc studies in areas of the basin intended to host investment projects such as mines.
In general, even if the groundwater resources available in the basin relate to substantial volumes, these are well below what one would expect in an area as humid, as rainy and well watered as the Cavally Basin. The fact that the basin is essentially located in a base country limits the groundwater potential. The aquifers of the basin are mainly made up of weathering or arena layers and those made up of fissure layers. Alterite aquifers relate to those in surface formations resulting from physico-chemical weathering and bedrock erosion processes. These aquifers are directly fed by water from precipitation. Their piezometric level drops considerably during the dry season and rises quickly in the rainy period. Basement fissure and fracture aquifers are those that develop in the crushed and / or fissured areas of the basement. They are immune to seasonal fluctuations (TDA-IC, 2020). In the Ivorian part, SMI estimates the capacity of basement aquifers - those of alterites such as cracks - at 113 billion m3 of water, of which 35.5 billion m3 is renewable (SMI, 2016).

Data on the hydrodynamics of these aquifers are approximate and sometimes contradictory from one report to another. For Liberia, the TDA Contribution Study, citing various sources, estimates that aquifers are fully recharged during the wet season, from heavy tropical rains and from the network of water bodies and are completely drained by the surface watercourse during the dry season (TDA-LIB, 2020). The Ivorian contribution to the TDA study distinguishes the case of aquifers of alterites and those of cracks. Alterite aquifers are directly fed by precipitation water and see their piezometric level drop considerably during the dry season and then rise rapidly during the rainy period. In contrast, fissure aquifers are immune to seasonal fluctuations (TDA-IC, 2020).

In all cases, aquifers, more than surface water, are the main sources of water supply for the populations of the Guinean part of the basin. The boreholes carried out and monitored by SNAPE in Guinea have a depth ranging from 52 to 85 m, for an average flow of 4m3 / hour per borehole. (RG_TDA_Stakeholders,2020). In the Ivorian part, the aquifers of alterites are exploited by traditional wells 11 to 25 m deep and boreholes from 50 to 60 m for the aquifers of cracks and fractures of the basement (See Table 51 below).

Table 51. Characteristics of Aquifers captured by Wells and Boreholes in the Cavally Watershed

Region	Departement	Total Depth Average (m)	Average Static Level (m)
Alterite Aquifers captured by Wells			
San Pedro	Tabou	11	-
Nawa	Soubré	24,83	13,11
Cavally	Guiglo	18,23	8,20
	Bloléquin	16,10	10,10
Crack and Fracture Aaquifers captured by Boreholes			
San Pedro	Tabou	48,83	7,81
	San-Pédro	67,45	12,9
Nawa	Soubré	52,20	5,10
Cavally	Guiglo	57,77	8,40
	Bloléquin	49,51	8,43
Guémon	Bangolo	53,44	7,80
Tonkpi	Zouan-Hounien	56,75	7,80
	Danané	56,90	12,30
	Man	53,05	8,50

Source: According to TDA-IC, 2020

4.1.3. Bio-geographic context

The Cavally basin belongs to the Guinean Forest of West Africa ecoregion and in particular to the Upper Guinean Forest subset. It stretches from Sierra Leone to Guinea in the west to Togo in the east, passing through Liberia, Cote d'Ivoire and Ghana. The Upper Guinea Forest ecoregion is mainly covered by landscapes comprising dense rainforests (evergreen), dense mesophilic forests, degraded forests, mangroves and highly anthropized landscapes made up of areas of perennial crops and food crops. (TDA-IC, 2020). The landscapes of the Cavally watershed include, from south to north, the dense humid evergreen forest, the dense humid semi-deciduous forest, a set of edaphic climaxes and the dense humid mountain forest (TDA-IC, 2020)

4.1.3.1. Flora and fauna

The specific characteristics of the flora and fauna vary according to these eco-geographic sub-regions. The many protected areas in the basin host the highest concentrations of animal and plant biodiversity in the basin and even in the sub-region.

a. The flora

In the Cavally watershed, there are two main types of ecosystems: terrestrial ecosystems and aquatic ecosystems.

Terrestrial ecosystems:

Dense Evergreen Humid Forests: They constitute the dominant climaxes of the ombrophile sector. In this sector, the loss of leaves from trees never affects all tree species, which moreover, constantly renew their foliage so that the forest cover remains always green. Among the characteristic species are the *Trichilia heudelotii* and *Turraeanthus africanus*, which perpetually renew their foliage; *Uapaca guineensis* and *Trichilia lanata*, which, while seasonally shedding their leaves, at the same time form young ones. (TDA-IC, 2020).

Dense Moist Semi-Deciduous Forests: They occupy the mesophilic Sector of the Guinean Domain where they constitute the dominant climax. Dense moist semi-deciduous forests are characterized by the total and alternating fall of leaves of large trees while shrubs, which depend on the internal forest microclimate remain evergreen. There are three types of semi-deciduous forest: (i) forest with *Celtis spp* and *Mansonia altissima*, (ii) forest with *Nesogordonia papaverifera* and *Khaya ivorensis* and (iii) forest with *Aubrevillea kerstingii* and *Khaya grandifolia*. (TDA-IC, 2020).

The other plant formations: In the mountain sector of the basin, the dense humid forests are characterized by the abundance of epiphytic bryophytes. There are also edaphic formations in the Cavally Watershed. They characterize certain parts of the coast but also other sectors of the basin. Usually, in the littoral zone, the vegetation is in the form of a mosaic comprising degraded forests, cleared forests, crops and fallows. (TDA-IC, 2020).

Aquatic ecosystems:

The aquatic ecosystems of the Cavally Watershed include riparian forests, periodically flooded forests, mangroves and swamp forests.

➢ The Mangrove: It is well represented at the mouth of the Cavally River near the village of Bliéron. This mangrove includes two (2) species of mangrove: *Rhizophora racemosa* (*Rhizophoraceae*) and *Avicennia germinans* (Avicenniaceae).

➢ Riparian forests: They can be observed along the banks of watercourses (the Cavally river and tributaries), ponds and other more or less permanent bodies of water. Among the characteristic species of these types of forests are *Uapaca heudelotii*, *Cathormion altissimum*, *Crudia klainei*, *Pterocarpus santalinoides*, *Carapa procera*.

➢ Periodically Flooded Forests. These are the forests that occupy areas liable to flooding on generally sandy-clay alluvium occupied by species such as *Hymenostegia afzelii*, *Sacoglottis gabonensis*, *Parkia bicolor* and *Pentaclethra macrophylla*.

➢ Swamp Forests: They occupy poorly drained soils, always hydromorphic. They characterize the lowlands of hydromorphic organic and peaty soils. The plant groups that characterize them are represented by *Hallea ledermannii*, *Symphonia globulifera* and *Raphia hookeri*, *Gilbertiodendron splendidum*, etc. (TDA-IC, 2020).

b. Wildlife

The fauna of the Cavally Basin is still rich and diverse, but due to the advanced anthropization of the area, many animal species have found refuge in the protected areas. This is the case for endemic species such as the viviparous dwarf forest toad (*Nectophrynoides occidentalis or Nimbaphrynoides occidentalis*), the Lamotte micro-potamogale (*Micropotamogale lamottei*), the African Palm Civet (*Nandinia binotata*), the Bossou chimpanzee and others such as buffalo, duikers, harnessed Gib, pangolin, hippopotamus, black-banded duiker (TDA-RG, 2020).

4.1.3.2. Areas of high biodiversity value

The Cavally Basin has a large number of key biodiversity areas (KBAs), as defined by the Critical Ecosystem Partnership Fund (CEPF), i.e. places that significantly contribute to the preservation of global biodiversity, by sheltering endangered species or with sharply reduced ranges on a global scale. CEPF identifies 12 KBAs entirely or partially located in the Cavally Basins: 1 in Guinea; 4 in Cote d'Ivoire and 7 in Liberia (see Table 52, below). In addition, the basin has several other classified forests.

Table 52. Key Biodiversity Zones in the Cavally Basin

Country	Code	Key Biodiversity Zone (KBZ)	Area (ha)	Obs
Liberia	LBR4	Gio National Forest	48.826	
	LBR18	Zwedru	64.458	
	LBR7	Grebo	282.195	Taï-Sapo-Grebo-Krahn Complex
	LBR13	Sapo - Grebo Corridor	197.421	
	LBR14	Sapo National Park	155.084	
RCI	CIV11	Taï National Park and N'Zo Wildlife Reserve	539.376	
	CIV3	Cavally and Goin - Débé Classified Forests	197.925	
	CIV14	Mount Nimba Integral Reserve	6480	Mount Nimba Complex
	CIV8	Mount Nimba (Part of the Transboundary Complex)	27.035	
Guinea	GIN9	Nimba Mountains	14.562	
Liberia	LBR12	Nimba mountains	13.254	

	LBR15	West Nimba	11.625	

Source: https://www.cepf.net/sites/default/files/fr_profil_ecosysteme_forets_guineennes.pdf

a. Key Biodiversity Areas in the upper Cavally Basin

Mount Nimba Strict Nature Reserve (RNIMN) - Guinea - Cote d'Ivoire

The Mount Nimba Strict Nature Reserve (RNIMN) was created during colonization in 1944. It covers a total area of 17,540 hectares, including 12,540 hectares in Guinea and 5,000 hectares in Cote d'Ivoire (Houéhounha & Lefebvre, 2019.). The Reserve hosts a population of chimpanzees of 229 individuals inventoried in recent studies ((Houéhounha & Lefebvre, 2019). It is also the refuge of endemic species such as the viviparous toad of Mount Nimba (*Nimbaphrynoides occidentalis*), which is to this day the only viviparous bufonid known in the world (Houéhounha & Lefebvre, 2019). This species is critically endangered due to its tiny range. The micropotamogale rodent (*Micropotamogale lamottei*) is another endemic species living in the Nimba and from Putu in Liberia. This species is classified as vulnerable on the IUCN Red List. Other specific species characteristic of this ecosystem, include the Nimba mountain buffalo (188 individuals) (Guinean part), the giant Turaco (6 individuals, Ivorian part), the longiband hornbill (Ivorian part) or the yellow-backed duiker (Houéhounha & Lefebvre, 2019). In recognition of its importance and exceptional ecological value, eventually, the Mount Nimba Strict Nature Reserve (RNIMN) was inscribed on the World Heritage List in 1981 (UNESCO, 2019).

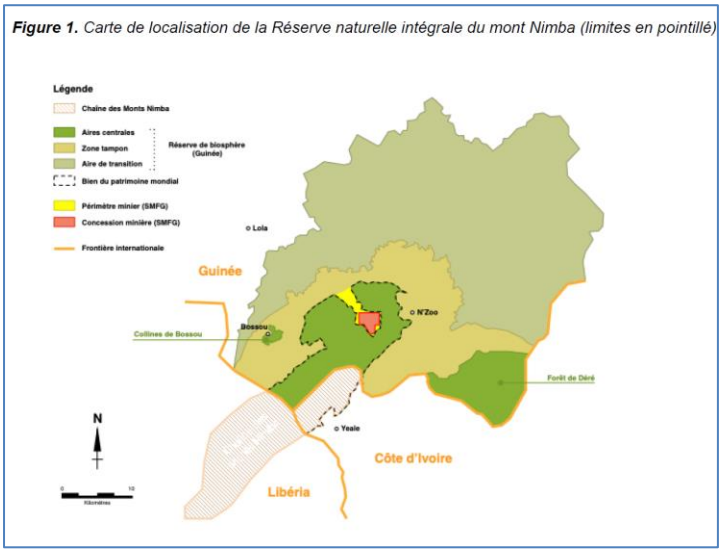
Within the World Heritage Site of Mount Nimba, there are high value ecological units such as the **Déré Listed Forest** and especially the **Wooded Hills of Bossou** (in Lola Prefecture in Guinea) (TDA-RG, 2020). The Collines de Bossou Forest Reserve (320 ha) is a rare example where the wild chimpanzee and the local populations have coexisted in harmony for generations. Bossou chimpanzees are also made famous for their special skills, particularly in the use of tools such as a hammer and a stone anvil to crack palm nuts (USAID, 2019; French Committee for IUCN, undated).

In 1992, the site of Mount Nimba was inscribed on the list of world heritage in danger, in particular because of the expansion of mining, in particular the multiplication of exploration and mining sites for iron, graphite, etc. (Houéhounha & Lefebvre, 2019). Alog with this are other threats noted in the conservation reports of the Reserve between 1984 and 2018 (Houéhounha & Lefebvre, 2019), in particular concerning:

- The advance of the agricultural front, especially rubber plantations: the designated forest of Déré is, for example, invaded by loggers and farmers from Guinea, Cote d'Ivoire and the sub-region (Guinéenews, 2019)
- Road infrastructure: asphalting of the Lola-Danané Road, which crosses the buffer zone of the World Heritage site in its Guinean part
- Commercial hunting and poaching

As a result of these threats, the natural forest islands of the Collines de Bossou are increasingly damaged. Bossou's chimpanzee habitat is fragmented and shrinking, jeopardizing their chance of survival (USAID, 2019; French Committee for IUCN. Nd).

Figure 33. Location Map of the Mount Nimba Strict Nature Reserve



Source: Houéhounha, Dodé & Thierry Lefebvre. 2019.

Mount Nimba East Nature Reserve (Liberia)

The East Nimba Nature Reserve (ENNR) was created in 2003, taking into account that the targeted area (Liberian part of Mount Nimba) was and is to a large extent still the richest forest domain in Liberia. But this zone was the object of various pressures, in particular the exploitation of iron which had intensified in the years 1960 and 1980, but with the practical quasi-generalization of slash-and-burn agriculture and the uncontrolled exploitation of timber. These practices were accentuated with the massive influx of populations during the civil war, leading to the expansion of agricultural land and advanced degradation of forests and biodiversity in the Liberian part of the Nimba Mountain Range. Thus, in 2014, the forest cover of the Liberian part of the Nimba Massif fell by half compared to the situation in 1974 (CILSS, 2016).

The Nimba-East Nature Reserve covers an area of 13,500 ha. The decision to create this Reserve is part of the dynamic to protect the Guinean and Ivorian parts of Mount Nimba with the Transfrontier Integral Reserve between these two countries, which became a Biosphere Reserve in 1980 and then included in the list of World Heritage sites in 1981. Since 2017, the Liberian State has submitted to the UNESCO World Heritage Center the candidacy of the Nimba-East Nature Reserve to constitute an extension of the heritage site that is the Ivorian-Guinean Transfrontier Integral Reserve of Mount Nimba (UNESCO-WHC, accessed August 2021).

In addition to being still one of the most important tropical forest relics in Liberia and the sub-region, the East Nimba Nature Reserve is home to endemic species considered endangered such as the Nimba's toad (*Nimbaphrynoides occidentalis liberiensis*), the Nimba River otter (*Micropotamogale lamottei*) or species of chimpanzees (*Pantroglodytes verus*) known for their skill in handling tools but which are now threatened with extinction (UNESCO-WHC, consulted August 2021)

b. Areas of high biodiversity value in the middle and lower valley - Rive Gauche – IC

The left (Ivorian part) and right (Liberian part) banks of the middle and lower Cavally Valley are home to several protected areas (parks, reserves and classified forests) very rich in flora and fauna in addition to the Taï National Park (TNP) and N'zo Fauna Reserve, the Ivorian part has the following classified forests: Upper Dodo, Cavally, Goin-Débé, Scio, Krozalié, Mt Nieton and Mt Momi (TDA-IC, 2020).

Taï National Park (TNP)

The Taï National Park (TNP) was created in 1926. Its protection status was strengthened in 1955 when it became the Taï Integral Fauna and Flora Reserve (OIPR, 2018). The TNP now covers an area of 508.186 ha[21], the TNP is 80% covered by the Cavally River Basin - the river and its tributaries (including the Hana) (OIPR, 2015). The TNP is the only large area of relatively preserved primary forest in the sub-region (TDA-IC, 2020). It is home to more than 50% of the total area of West African forest areas placed under strict protection status (OIPR, 2017).

International recognition of the value of the TNP has resulted in its inclusion on the list of the International Network of Biosphere Reserves (1978) and that of UNESCO's World Heritage (1982) (OIPR, 2017; TDA-IC, 2020). Its initial ecological condition and the projection measures taken have contributed to ensuring an exceptional state of preservation of the TNP plant cover: 97.7% of the TNP area is covered by a closed canopy - the part degraded by agriculture does not represent than 0.9% of the total park area in 2011) (OIPR, 2017).

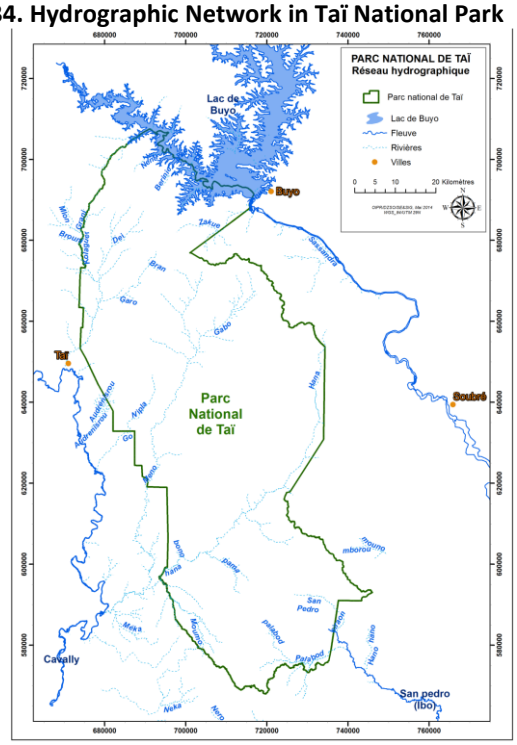
Regarding the flora, the TNP is marked by the presence of so-called Sassandrian plant species, that is to say which are found mainly to the west of the Sassandra river, and in particular in the Cavally-Sassandra interfluve. Some of these species are endemic, that is to say strictly localized in this space. Others have a discontinuous distribution and can be found in other places of the Forest of Upper Guinea, or in the forest massif of Cameroon and Congo or, again, in these two other regions at the same time. There are 162 Sassandrian species, including *Psychotria mangenotii, Ouratea duparquetiana, Polyceratocarpus parviflorus, Dracaena fragrans, Guarea leonensis, Scytopetalum tieghemii, Trichoscypha beguei*, etc. TDA-IC, 2020).

Regarding the fauna, two species of ungulates are both rarities and strict endemisms for regions close to Cavally: they are zebra duiker (*Cephalophus zebra*) and Jentink's duiker (*Cephalophus jentiki*), all two in great danger of extinction. In primates, eight species and subspecies are endemic: Procolobus verus (Olive Colobus) ; Mona Monkey (*Cercopithecus mona)*, Diana Monkey (*Cercopithecus diana*) and Spot-nosed Monkey (*Cercopithecus petaurista*), Red-capped Mangabey(*Cercocebus torquatus),* western black-and-white colobus (*Colobus polykomos)* and Western Red Colobus (*Piliocolobus badius)*.Some of the communities of this subspecies have developed skills and behaviors that have made them famous: creation and use of nut cracking tools, ant harvesting, organized hunting (with a predilection for colobus), food sharing, division of labour. These behavioral traits represent a kind of "cultural endemism" peculiar to the West African population of the species (TDA-IC, 2020).

With regard to avifauna, out of the 236 species of birds in the park, 143 are characteristic of lowland forests with 28 endemic to the Guinean Zone, eight of which are threatened with extinction or whose protection is of global interest: the owl - Rufous Fishing-owl (*Scotopelia ussher*i), White-Breasted Guinea Fowl (*Agelastes meleagrides*), Western wattled cuckooshrike (*Lobotos lobatus*), Yellow-Bearded Bulbul (*Criniger olivaceus*), Green-Tailed Bulbul (*Bleda eximius*), Black-headed rufous-warbler (*Bathmocercus cerviniventris*), Guinea Bald Pecker (*Picathartes gymnocephalus*) and Nimba Flycatcher (*Melaenornis annamarulae*) (TDA-IC, 2020).

[21] This area is the result of the integration, by Decree No. 2018-496 of May 23, 2018, of the peripheral protection zone and two-thirds of the N'zo Faunal Reserve within the limits of the Park. Within its new limits, the area of the Park is 508,186 ha.

Figure 34. Hydrographic Network in Taï National Park



Source: OIPR, 2015

N'zo Partial Fauna Reserve

The N'Zo Partial Fauna Reserve extends the Taï National Park northward to the western branch of Lake Buyo. The OIPR estimates the current area of the N'Zo Wildlife Reserve at 27,830 hectares (OIPR, nd). Unlike Taï National Park, which is an integral reserve of flora and fauna, the N'Zo Reserve has a status which authorizes, on an exceptional and transitional basis, logging.

The flora of the Reserve is essentially in the form of a dense humid evergreen forest characterized by the presence of *Antidesma membranaceum, Chrysophyllum pruniforme, Diospyros mannii, Diospyros kamerunensis, Dracanea aubryana, Warneckea guineensis, Campylospermum schoenleinianum*, etc., for the species woody erect and, for lianas, *Dichapetalum toxicarium and Eremospatha macrocarpa*. Like the Taï National Park, the N'Zo reserve is also home to Sassandrian species with, however, a less marked degree of endemism than in areas further south (TDA-IC, 2020)

With regard to fauna, the ensemble formed by the Taï National Park, its protection zones and the N'Zo Reserve, covering a total area of approximately 650,000 ha, has the potential to provide habitat, adequate for the conservation of almost all of the original fauna of the West African forest block, in particular for mammal species showing great needs in living space. If the Elephant is only exceptionally observed in this space, other species of large mammals are still relatively well represented: Western Red Colobus (*Colobus badius)*, West African black and white colobus (*Colobus polycomos polykomos)*, Chimpanzee (*Pan troglodytes verus)*, Panther (*Panthera pardus)*, Hippopotamus (Hippopotamus amphibius) around and in Lake Buyo, Harnessed bushbuck (*Tragelaphus scriptus)*, African forest Buffalo (*Syncerus caffer nanus)* and various duikers. Other species remain very inconspicuous, such as the pygmy hippopotamus (Choeropsis liberiensis), the bush pig (*Potamochoerus porcus)* or the Bongo (*Tragelaphus* eurycerus) (TDA-IC, 2020).

Threats to the TNP and the N'Zo Reserve.

While the TNP has so far been well preserved, many threats - some of which are growing - weigh on the Park and even more on the N'Zo Reserve. These are mainly the following:

- Mining and especially illegal gold mining: Between 2016 and 2018, two out of five patrols carried out by the OIPR were devoted to the fight against gold mining, which had made it possible to apprehend a total of nearly 150 gold miners (OIPR, 2018). That said, no active gold panning site is observed in the TNP but this activity continues to be carried out at the eastern edge of the park, along the Hana river, in the Soubré and Djapadji sectors ((Tiedoue et al. 2018; OIPR, 2015)
- Poaching. It constitutes the major index of human presence in the Park. It meets the demand for "bushmeat" (N'Goran Kouame, 2015). It also fuels the international wildlife trade
- Expansion of agricultural land: The expansion of agricultural land and in particular of agricultural plantations increases the degree of anthropization around the Park and the Wildlife Reserve (N'Goran Kouame, 2015). The massive use of fertilizers and pesticides in agriculture is a threat to the quality of water, including the tributaries of the Cavally which cross the Park
- Deforestation. It mainly concerns the periphery of the TNP. The OIPR (2015) cites the study by Varlet (2013) who observes that in terms of land use, the areas covered by primary forests and degraded forests have respectively fallen from 10.5% to 0.6 % and from 15.5% to 6.1% between 2003/2004 and 2011 while the areas occupied by farmland or under fallow increased from 67.1% to 79.5% during the same period (OIPR, 2015).

c. Middle and Lower Valley - Right bank - Liberia

Grebo-Krahn National Park (GKNP)

The Grebo-Krahn National Park (GKNP) was created in 2017. It covers 96,150 hectares. The Park partially covers the counties of River Gee and Grand Gedeh. To the west, the Park is bounded by the Dugbe River and to the east by the Cavally River, which borders Liberia and the Cote d'Ivoire.

The Park is home to species of West African chimpanzees that are critically endangered according to the nomenclature of the IUCN Red List. It is also home to the pygmy hippopotamus and the West African red colobus and other species in a vulnerable situation such as Cercopithecus diana (*Cercopithecus diana*), the African forest elephant, the leopard (GIZ, 2017). Other species inventoried in the Park include the buffalo, several species of primates, rodents, hippopotamus, elephants as well as a diverse birdlife (TDA-LIB, 2020).

Sapo National Park (SNP)

Created in 1983, the Sapo National Park (SNP) covers an area of 180,365 hectares. SNP is Liberia's oldest national park. On the scale of the MRU Area, it is the largest protected area of primary forest after the Taï National Park in Cote d'Ivoire. The Park was home to nearly 500 African forest elephants at the start of the 1980s, a population, which however declined sharply thereafter. Seven species of Duiker antelopes are inventoried in the Park, including Jentink's Duiker (*Cephalophus jentinki*) and the Duiker zebra (*Cephalophus zebra*), Bay Duikers (*Cephalophus dorsalis*) and Maxwell's Duikers (*Cephalophus maxwellii*), which appear in abundance in some areas of the park. Sapo Park is home to populations of pygmy hippos (*Choeropsis liberiensis*) (TDA-LIB, 2020; USAID, 2017)
Mining is the biggest threat facing protected areas - especially GKNP and SNP. Around GKNP are areas with high concentrations of traditional miners - gold panning in particular, such as Bilibo Town; the site

of Creek area (two km from Bilibo Town) and Dugbe River (4 km from Bilibo). In 2019, Bilibo Town had almost 40 small-scale mining licenses, not counting illegal miners (Osman, 2019).

4.1.3.3. Other Protected Areas and Specific Ecosystems

In addition to parks and reserves, the Cavally Basin is home to a large number of valuable ecosystems, some of which are classified forests. In the Guinean part of the Upper-Basin, the classified forest of Déré (8,920 ha) is part of the central areas of the Mount Nimba Biosphere Reserve (TDA-RG, 2020). In the Ivorian part of the basin, there are 7 classified forests which are: the classified forests of Haute Dodo, Cavally, Goin-Débé, Scio, Krozalié, Mt Nieton and Mt Momi. The flora of these classified forests includes a high number of specific plants, in particular endemic species. These classified forests have an important role to play in the conservation of biological diversity in West Africa.

These classified forests are however in varying conditions of of conservation, as illustrated by the cases of some of the classified forests of the basin in the Department of Danané (Cote d'Ivoire) (TDA-IC, 2020).

Table 53. State of conservation and threats to some of the classified forests of the department of Danané, Cavally Basin, Cote d'Ivoire

Classified Forest	State of the Forest
Tiapleu Classified Forest (28,000 ha)	- Partially degraded by clandestine peasants, - It is full of species, some of which are subject to industrial exploitation - Clandestine occupants had been evicted - It is partially hilly with an average altitude of 451 meters.
Mount Niéton (11.000 ha)	- Quite degraded by the clandestine peasants, - The illegal occupants had been evicted,
Mount Momi (10.500 ha)	- Advanced degradation, presence of isolated camps - An eviction mission in progress
Krozalié (9.300 ha)	- Partially degraded - Presence of exploited forest species subject to industrial exploitation (INDUSBOIS company) - Presence of a gold panning site cleared out by SODEFOR
Goulaleu (950 ha)	- Quite degraded - Presence of a gold panning site cleared out by SODEFOR

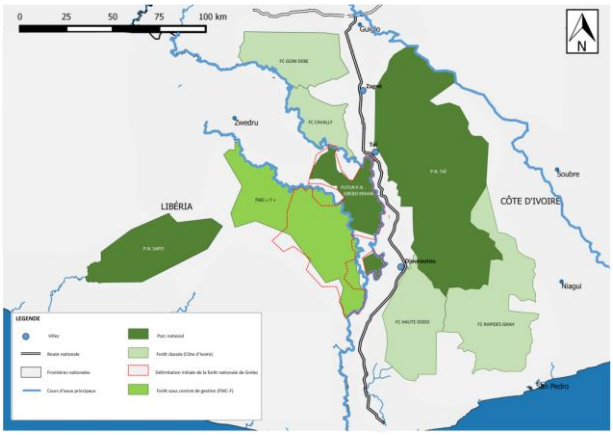
Source: TDA-CI, 2020

In the Liberian side, the Forest Management Contract (FMC) is an arrangement that seeks to reconcile the needs of forest conservation and poverty alleviation through the exploitation of available forest resources. An FMC relates to a permit signed between the State and a private investor, which gives the latter the right to carry out the commercial exploitation of a forest area over a period of 25 years, while complying with ecological protection requirements and sustainable forest management, but also taking into account considerations of equity and social justice. In the Cavally Basin, the most important management contract is the FMC "F" signed in 2015 for the benefit of the Euro Liberia Logging Company and covering an area of approximately 254,000 ha in the County Grand Gedeh, mainly the National Park of Grebo-Krahn and the Sapo National Park.

4.1.3.4. Transboundary dimension - Initiative on the Taï-Grebo-Krahn-Sapo Complex

The Taï National Park, the Grebo-Krahn National Park, the Sapo National Park as well as various classified forests (those of Cavally, Goin-Débé and Haute-Dodo in the Ivorian part and the area of the contract of forest management "F") form a transboundary complex of protected areas which constitutes the largest remaining forest block at Hotspot of the Upper Guinea Forest Ecosystem (See Fig. 35 below).

Figure 35. Tai-Grebo-Sapo complex in Cote d'Ivoire and Liberia



Source: GIZ, 2017

4.2. Demography and Incidence of Poverty in the Cavally Basin

The analysis of the demography and socioeconomic characteristics of the basin is based on national statistics disaggregated at the level of decentralized territorial units.

The data available concerning the following territorial units of the basin are the most used in the analysis:

Guinea:

- Prefecture of Lola – Urban Commune of Lola ; Rural Communes of Bossou and N'Zoo.

Cote d'Ivoire:

- San Pedro region: Tabou, San Pedro
- Region of Nawa: Department of Soubré
- Region of Cavally: Department of Guiglo, Bloléquin

Liberia:

- County of Grand Gedeh: Districts of Gbao, Cavalla, Tchien, Konobo and GlioTwarbo
- County of River Gee: Districts of Glaro, Sarbo, Tuobo and Nyenbo
- County of Maryland: Districts of Nyoken, Karluway # 1, Karluway # 2, Pleebo Sodoken and Harper

4.2.1. Demographic and Socio-economic aspects

4.2.1.1. Demographic Characteristics

The population of the Cavally Basin is estimated at 1,563,000 people in 2020, i.e. an average density of 53 inhabitants per km2. The Ivorian national portion is the most populated: 75% of the basin's population and a density of 73 people per km2. Guinea represents 5% of both the surface area and the

population of the basin. The Liberian part (318,000 people or 20% of the basin's demography) is the least densely populated: 27 inhabitants / km2, or half the average density of the basin.

The Cavally basin thus represents 4% and 3% respectively of the surface area and demography of the MRU Area.

Table 54. Demography of the national portions of Cavally

	Area (km2)	% Basin Area	Population in 2020	Density (pers/km2)	% of Basin population
Guinean Part	1400	5%	73700	53	5%
Ivorian Part	16100	55%	1172000	73	75%
Liberian Part	11900	40%	318000	27	20%
Cavally Total	29400	100%	1563700	53	10%
MRU Area	751408		52363000	70	

Sources: TDA-RG, 2020; TDA-IC, 2020; TDA-LIB, 2020

4.2.1.2. Incidence of poverty in the Cavally Basin

Despite its advantages in terms of natural resources - abundant rainfall spanning almost the entire year, multiple rivers (the Cavally and its many tributaries, lush vegetation, mining resources of all kinds (gold, iron, diamonds, etc.), the Cavally Basin faces endemic poverty, which appears in the region's poverty index. As shown in Table 55 below, the incidence of poverty in the Prefectures, Regions or Counties of the basin is as a rule higher than the national level.

Table 55. Incidence of Poverty in the Regions of the Cavally Basin (Cote d'Ivoire)

		Incidence of Poverty[22]	Food Security
Guinea	Lola Prefecture	64%	-
	Nzérékoré Region	74%	-
	National – Guinea	69%	-
Cote d'Ivoire	San Pedro	35%	12.80%
	Region Nawa	37%	7.00%
	Region Cavally	41%	17.20%
	Region de Tonkpi	60%	27.20%
	National – Cote d'Ivoire	46%	12.80%
Liberia	Grand Gedeh	72%	
	River Gee	75%	
	Maryland	64%	
	National – Liberia	61%	

Sources: For Guinea: INS.2013; For the Cote d'Ivoire: INS, 2015; For Liberia: LISGIS, 2008

The alarming level of poverty is also illustrated in statistics concerning access to basic services such as water for domestic consumption or in those concerning health. In Liberia, the three Counties of the basin (Grand Gedeh, River Gee, Maryland) are below the national level with regard to the satisfaction of primary needs (electricity and drinking water in particular). In the Ivorian part, the Cavally Region had (in 2013) an electricity coverage rate of 41%, i.e. 55 localities electrified and connected to the

[20] For Liberia, the criterion relates to "Unmet Basic Needs". This criterion concerns the proportion of households whose basic needs are not met in areas such as access to electricity, housing, running water, etc.

national grid. The Soubré hydroelectric dam on the Sassandra River, commissioned in 2013, contributes to supplying electricity to the entire Cavally Region. Despite everything, the frequency of voltage drops and outages remains a serious handicap for the development of the Cavally Region (TDA-IC, 2020).

4.2.1.3. Health - Incidence of water-related diseases

The most prevalent water-related diseases in the two main countries of the Cavally Basin (Liberia and Cote d'Ivoire) are malaria and diarrheal diseases. In the Liberian part of the basin, malaria is the main reason for consultation in primary health centers and the first cause of mortality in children under the age of five within pediatric units. During the rainy period, outbreaks of malaria but also cholera and diarrheal diseases are often noted. In the Ivorian part of the basin, the average prevalence of malaria and diarrheal diseases in the national portion of Cavally is respectively 30% and 23% higher than the national averages. Onchocerciasis and Bilharzia, although present in the Cavally basin are not at particularly worrying levels, and are presently below the average prevalence rate at the national level (see Table 56 below).

Table 56. Incidence of water-related diseases in the health districts of the Cavally Basin (Cote d'Ivoire)

Districts	Population (2018)	Incidence of Malaria (‰)	Incidence of Diaorrhea (‰)	Incidence Oncho (for 100.000)	Incidence of Urinary Reports (‰)
Danane	296 176	130,48	23,80	0,30	0,09
Zouan-Hounien	216 281	248,23	28,70	1,40	0,05
Toulepleu	60 387	281,17	27,70	0,00	0,02
Blolequin	130 682	407,88	32,20	0,00	0,02
Guiglo	296 292	403,94	24,50	0,00	0,02
Tabou	207 153	79,53	35,60	0,00	0,04
All Health Districts of Cavally Basin	1 206 971	**247,54**	**27,98**	**0,32**	**0,05**
National	25 195 540	189,86	22,70	0,80	0,13

Source: Republic of Cote D'ivoire. 2019.

In the Liberian part of the basin, malaria is the leading cause of morbidity and mortality, especially among children under 5 years old. It is estimated that malaria represents 40% of the reasons for consultations in health centers (TDA-LIB, 2020). In this part of the basin, bilharzia and Lassa fever are also among the main causes of morbidity, with prevalence levels for Lassa fever, which tend to increase during the rainy season (TDA-LIB, 2020).

4.3. Main uses of the basin's resources

The economy of the Cavally Basin is mainly based on agriculture, mining, exploitation of forest products, livestock, fishing as well as trade, especially products from these sectors of activity. This section provides an overview of the use of the natural resources of the basin in these different sectors and sub-sectors.

4.3.1. Agriculture

4.3.1.1. Upper Basin - Guinea

In the Guinean Upper Basin of Cavally, there are three types of crops: food crops, often extensive; perennial crops, mainly plantation and commercial; market gardening.
Food crops mainly consist of upland and lowland rice. Agricultural practice, especially for rain-fed crops, is extensive with slash-and-burn clearing and shorter and shorter fallows. This agricultural practice leads to deforestation and the degradation of ecosystems. Islands of forest and wooded areas are replaced by thickets and short-term fallows which are cultivated without waiting for the reconstitution of the plant cover and the natural fertility of the soil because of land pressure (RG-TDA_Stakeholders, 2020). Perennial crops primarily include coffee, cocoa, bananas, oil palm and cola.

Other crops such as rubber, cashew, avocado, pineapple and mango are not widely cultivated.
Vegetable crops include crops such as eggplant, chili, okra, cowpea, beans, tomatoes and onions. These crops are often cultivated in association with food crops or replace them in the fields during the dry off-season or when rainfall is rather low (RG-TDA_Stakeholders, 2020).

4.3.1.2. Middle and Lower Valley: Cote d'Ivoire and Liberia

The Ivorian part of the basin, mainly covering the left bank of the middle and lower reaches, is dominated by various cash crops, in particular coffee, cocoa, rubber and oil palm, but also many food crops including yam, cassava, plantain, corn and rice. Cocoa plantations occupy 64% of the agricultural area, followed by coffee with 19% of the agricultural area, rubber trees with 11% and oil palm, which represents 6%. Some industrial crops (sugar cane and cashew) are very sparsely cultivated in these regions. (TDA-IC, 2020)

The region has many processing units for agricultural products: processing corn and cassava powder, peanuts paste, or processing and packaging rubber, palm oil, coconut and cocoa. The region of San Pedro which is part of the Cavally Basin is the second economic pole of Cote d'Ivoire thanks to its port, but also because of the presence of the many factories operating in the cocoa industry, in the flour mill, the cement and wood.

PALMCI is the largest agro-industrial establishment in the Cavally Basin. It operates in four sites in the lower valley, for a total area of nearly 60,000 ha, including 12,000 ha of industrial plantations directly managed by PALMCI and nearly 47,000 ha of village plantations, operated by the communities on the basis of purchase contracts with PALMCI (see Table 57).

Table 57. PALMCI agricultural units in or near the Cavally Basin (as of 12/31/2011)

		Gross Area (ha)			Area under cultivation (ha)		
Site	Distance from Tabou	Industrial Plantations	Village Plantations	Total	Industrial Plantations	Village Plantations	Total
Blidouba	20 km	2 717	12 915	15 632	1 745	12 072	13 817
Iboke	44 km	5 438	13 626	19 064	2 343	12 523	14 866
Gbapet	80 km	1 326	8 702	10 028	1 291	5 910	7 201
Neka	110 km	2 708	11 399	14 107	1 718	9 147	10 865
TOTAL		12 189	46 642	**58 831**	7 097	39 652	**46 749**

Source: PALMCI. Sd The Oil Palm. Agriculture of the future. PALMCI. Abidjan.

In the Liberian part of the basin, the main crops are rice (rainfed and lowlands) and cassava. These two crops occupy 87% of cultivated land. The crops of bananas, plantains, pineapples, sweet potatoes, corn, etc. are mainly intended for national consumption. Cash crop farming is dominated by plantation crops of rubber, oil palm, coffee, cocoa, and sugar cane. The main agricultural export products are latex, coffee and cocoa. Large-scale agricultural enterprises are establishing in the rural landscape of the country. They sometimes hold several thousand hectares in the form of a long-term lease. Among those already operating or targeting the Cavally Basin are:

- Cavalla Rubber Corporation, awarded in 2011 an 8000ha concession in the County of Maryland, on the banks of the Cavally River;
- Golden Veroleum Inc. awarded 36,594 ha in 2010 for palm oil plantations - Palm Oil in Maryland County, west of Harper

Table 58. Large-scale Agricultural Concessions in the Liberian part of the Cavally River Basin

	Company	Intervention Zone	Object of the Concession Land	Land concession Area
1	Golden Verodium Liberia (GVL)	County de Maryland	Palm Oil	350,000 ha
2	Maryland Oil palm Plantation (MoPP)	County de Maryland	Palm Oil	15,200 ha[23]
3	Cavalla Rubber Company (CRC)	County de Maryland	Rubber Trees	

Sources: TDA-LIB, 2020; Liberia National Concession Portal: http://portals.landfolio.com/liberia/

4.3.1.3. Impacts of agriculture

The development of agriculture, along with the expansion of cultivated land, has several environmental impacts in the basin, including the following:

- The expansion of agricultural land generally comes at the cost of deforestation, deforestation and therefore savannization of areas that were previously the most wooded.
- The use of chemical fertilizers and pesticides that often accompany agriculture, especially cash crops and large agro-industrial plantations, pollutes surface and ground water as well as soil. It often also results in the loss of habitats for flora and fauna;
- The volumes of water withdrawn from rivers and streams as well as aquifers for agricultural purposes are not known, but with the predominant practice of rainfed agriculture, we can assume that these withdrawals are limited. ;

- Agriculture, which occupies large areas in a context of abundant water, does not seem to have resolved poverty, food security and malnutrition. As shown above, the national portions of the Cavally Basin have levels of poverty and food insecurity below the national averages of the countries concerned.

4.3.2. Livestock Breeding

[23] Source : www.forestpeoples.org

In the Guinean part (upper basin), Livestock rearing is practiced in two forms: sedentary and transhumant. Sedentary breeding involves small numbers of small ruminants kept in village concessions and feeding on crop or household residues but also fodder in the vicinity of the villages. The transhumance breeding of cattle consists for the breeders of moving from one place to another according to the seasons. This extensive farming system is favored by the availability of savannah lands included in the forest at the foothills of the Mount Nimba. One of the important stages in the transhumance cycle is the Divo [or Dipo] savannah, in the Siakata sector, commonly known as the "Bouviers Camp". The high concentration of livestock in the dry season also leads to overgrazing, resulting in the degradation of the plant cover (RG-TDA_Stakeholders, 2020; TDA-RG, 2020). Transhumant pastoralists also practice voluntary bush fires to promote the regrowth of tender grass, which is more palatable to the livestock (RG-TDA Stakeholders, 2020)

In the middle and lower valley, part of the Cote d'Ivoire, animal husbandry is less practiced than in the upper basin where pig farms (modern and traditional farms) and poultry farms (broilers and layers) are more common. Cattle, goats and some sheep are also raised by households. Livestock rearing is not a preoccupation activity there, with less than 4% of households taking it as their main activity. The traditional livestock sub-sector is mainly controlled by non-native populations - immigrants from other regions of the country (TDA-IC, 2020).

4.3.3. Fishery resources - Fisheries

Fishing is a fairly modest activity in the upper basin (the Cavally River and its tributaries having a low flow there). On the other hand, according to the Cote d'Ivoire Report of the UEMOA Continental Fisheries Atlas, Moyen Cavally is one of the highest concentrations of fishing vessels in Cote d'Ivoire - 1,511 canoes (or 11% of the country's canoes) being inventoried there, the other major areas of concentration of inland fishing activities include the regions of Lagunes, Bas Sassandra, Sud Comoé and Marahoué (UEMOA, 2013).

In the Ivorian part of Cavally, fishing is essentially artisanal. It is dominated by the indigenous ethnic group of the Krou followed by allochthonous Akan, Bozos, nationals of Mali and other groups made up of fishermen from Ghana (UEMOA, 2013; TDA-IC, 2020)

According to UEMOA Atlas (2013), the fish species fished in the inland waters of Cote d'Ivoire (without therefore specifying which are present in the Cavally River) include the machoiron or catfish (*Chrysichtys sp*), carp (*Hemichromis fasciatus*), catfish (*Heterobranchus sp*), claris (*Clarias anguillaris*), mormyridae or elephant fish (Mormyridae), sardines (Characidae), captain (*Lates niloticus*), crustaceans (crayfish, crabs) or species introduced as tilapia (*Oreochromis niloticus*)

The majority of fishermen (about 2/3) in the basin go fishing without any boat. When canoes are used (1/3 of the fishermen), they are generally not motorized (7.5% according to TDA-CI, 2021; 2.3% for the whole of Cote d'Ivoire according to UEMOA, 2013).

Regarding fishing techniques, the dead net is the most used gear by fishermen, followed by the trap, longline and hawk (UEMOA, 2013).

Aquaculture is poorly developed in the Cavally Basin, to a certain extent with the exception of the Liberian part of the basin where tilapia is often reared in small freshwater ponds (TDA-LIB, 2020).

4.3.4. Forest resources

4.3.4.1. Upper Basin: Guinea

The abusive cutting of timber for commercial purposes has become commonplace in the Guinean part of the upper basin. Between 1994 and 2000, the Lola prefecture (which covers most of the Guinean Upper Basin of Cavally) had the largest number of logging companies in Forest Guinea. Today these companies are no longer operational, having given way to the Chino-Guinean mixed company called Société Forêt Forte (SSF SA), which has the monopoly of logging in all the prefectures of the Nzérékoré region (RG- TDA_Stakeholders, 2020).

Logging in the Guinean part of the upper Cavally Basin is also common with unlicensed loggers who escape all control, although operating under the protection of loggers holding logging permits (RG-TDA_Stakeholders, 2020).

Logging has resulted in a profound transformation of the region's landscape, leading to the destruction of habitats, lower rainfall, higher temperatures, low crop yields, silting up of rivers, floods, erosion and gullying, savanization, increased frequency of bush fires, etc. (RG-TDA_Stakeholders, 2020)

4.3.4.2. Middle and Lower Valley: Cote d'Ivoire and Liberia

The Ivorian part of the basin, especially the middle and lower valley, has significant timber resources from the forest. The most targeted species concern samba (Triplochiton scleroxylon), which accounts for about a quarter of the wood exported in recent years, but also Aco (*Antiaris africana*), Assamela (*Afrormosia elata*), Sipo (*Entandrophragma useful*). In addition to these species are Azobé (*Lophira alat*a) and Framire (*Terminalia ivorensis*), which are relatively abundant species in the forests of the region. Species of secondary importance to this day - such as ling (*Afielia africaiia*) or Difou (*Morus mesozygia*) - find an outlet in local processing industries (SMI, 2016). But many species that were once less exploited are now targeted. These include, among others, Fromager (*Ceiba pentandra*), Forest Capoquier (*Bombax buonopozense*), etc. (SMI, 2016).

With regard to the transformation of lumber - mainly into cut or unrolled (first transformation) and a few times into furniture - the regions of San-Pedro and Nawa have most of the sawmills in the area (about twenty). The processed wood is mainly exported to the countries of the sub-region (by road) and especially to other continents (via the Port of San Pédro). (TDA-IC, 2020).

With regards to the wood for energy (charcoal and firewood), this is left mainly to artisanal carbonization. However, the war situation in Côte d'Ivoire has led to an intensification of illegal logging, causing advanced degradation of forests - including at protected forests - and endangering the sustainability of the wood resource. The problem of supplying wood industries in these regions is now a recurring problem, in particular due to the decrease in areas and natural forest resources (TDA-IC, 2020).

In the Liberian part of the basin – which is the part with most wood in the Cavally Basin - rural populations depend heavily on the exploitation of forests as a source of monetary income (sale of wood or non-wood forest products), or for food, energy, habitat and health (for medicinal plants) (TDA-LIB, 2020).

As discussed in the section on protected areas, many of the forests in the Liberian part of Cavally are subject to concessions to private companies or communities on the basis of logging and management contracts. These include the management contracts for the benefit of: Euro Liberia Logging Company

dating from 2009 and relating to logging over an area of 253,670 ha; Atlantic Resources Limited on 119,344 ha (for logging); International Consultant Capital on 266,910 ha (logging); Neezonnie Community (Grand Gedeh County) on 22,653 ha; Blouquai Community (Grand Gedeh County) on 43,794 ha; Doru Community on 35,000 ha; etc. (Liberia National Land Consession Map Portal, 2021).

With the continued increase in demand for wood and non-wood forest products, the pressure on the forests of the Cavally Basin is increasing. Alongside land concessions that try to promote sustainable management of forest resources, informal and even clandestine logging is on the rise. This results in forest degradation, destruction of wildlife habitats, including habitat for endemic and / or vulnerable species. Deforestation also leads to landscape savannization and land degradation.

4.3.5. Mining

The Cavally Basin has a variety of mineral resources, in large quantities and of high quality. This is valid at the scale of the basin as a whole but is also for each national portion of the basin. These resources include iron, gold, diamonds, graphite. Gravel and sand in the basin are increasingly being exploited intensively for the needs of housing and infrastructure in the basin and beyond. Iron and gold are by far the most targeted mineral resources in the basin. Iron is mainly the object of industrial exploitation, often by large multinational firms. Gold is mined both industrially and artisanally.

4.3.5.1. Upper Basin

Guinea

In the Guinean part of the basin, Mount Nimba has iron deposits in large quantities and also with a high metal iron content (over 65%), which explains why this area is highly coveted by mining companies. The first discoveries of iron in this region date from the colonial period. Today the Société des Mines de Fer de Guinée (SMFG) created in 2003 (by international investors including Euro-Nimba) holds a mining concession covering 195 km² including 142 km² at the level of the Lola Urban Commune and 53 km² at the level of the Municipality of Gama Béréma (RG-TDA_Stakeholders, 2020).

The other large-scale mining projects include (Houéhounha & Lefebvre, 2019; (RG-TDA_Stakeholders, 2020):

- SAMA Resource Guinea (SRG) SARL: SRG is a Canadian company in the exploration phase in search of graphite on an area covering a total area of 75.97km² including 11.46 km² in the District of Gogota and 64.51 km² to Lola. The start of operation was scheduled for the year 2021;

- Compagnie Zaly Mining SA (formerly West Africa Exploration) has a mining license (dating from 2015 and covering 23 km2 in Bourata, Sub-Prefecture of N'zoo) and an exploration license (31 km2) bearing on iron.

In total, mining permits (industrial and research mining concessions) cover (in 2019) more than 250 km2 in the Guinean part of Mount Nimba. In practice, however, these mining projects are at more or less advanced planning stages pending the actual start of mining.

In the Guinean part, mining activities also occur in some places in the form of extraction of construction materials (sand, gravel and granite). These materials are mainly the object of artisanal exploitation (RG-TDA_Stakeholders, 2020).

Liberia

The Liberian part of the Upper Basin, corresponding in large part to the County of Nimba, is rich in iron ore. Operated by LAMCO (Liberia-American-Swedish Mining Company) from the 1960s, the mine was linked to the Port of Buchanan by a 250 km long railway line. Production peaked in 1974 at 12 million tons of iron. However, the mine had to cease operations at the start of the civil war in the 1990s. Arcelor-Mittal took over the mine in 2005, but mining activities remain subdued.

4.3.5.2. Middle and lower valley

Cote d'Ivoire

The Ivorian part of the Cavally basin has enormous mining potential (gold, iron and copper deposits) and lots of cobalt, nickel and diamond. Industrial mining is represented there by the la Société des Mines d'Ity (SMI) operates large mineral deposits in the basin and in particular at the village of Ity. Artisanal gold mining is also the subject of intense activity in the basin.

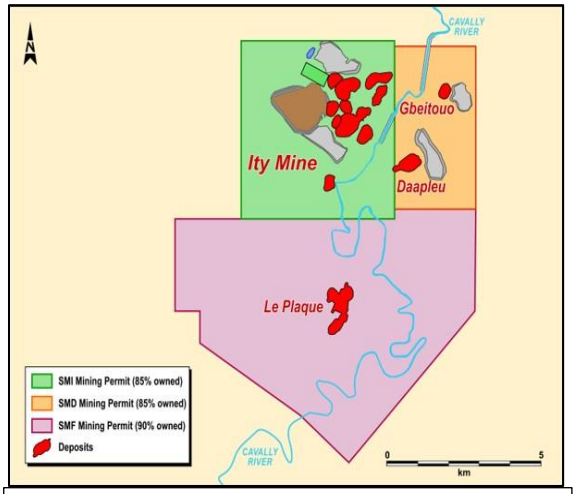
a. Industrial mining

The Société des Mines d'Ity (SMI) was created in 1983. Endeavor Mining which is the majority shareholder of La Mancha IC, which manages SMI, has benefited from several permits in and near the Cavally Basin over the past 30 years, including the following:

- Operating permit PE 26 of October 1989 - 25 km2 (permit expires in 2023; can be renewed for 10 years);
- Research permit PR 61 (1995): 153 km^2
- PE 49 operating permit for the Daapleu-Gbeitouo area (Department of Bloléquin) for an area of 13.2 km2. It dates from 2018 for 14 years, renewable for 10 years. The project includes the diversion of the Cavally River (dams, bridge, dikes).
- Operating permit PE 53 dated October 2020 for Floleu - Le Plaque site

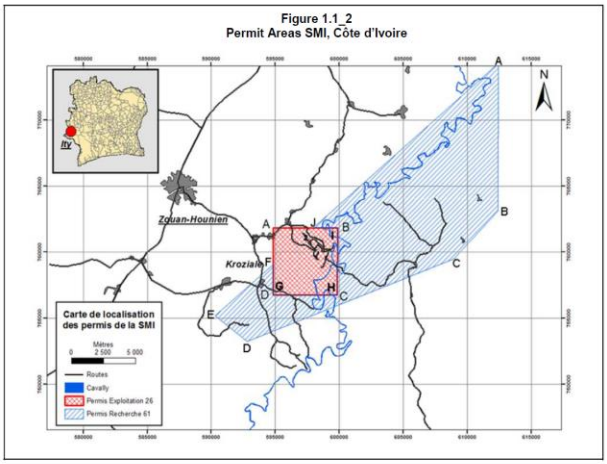
As seen in the diagram below (Fig. 36 & 37), the Cavally River is at the heart of these active industrial gold mining sites and areas covered by the mining permits mentioned above.

Figure 37. Ity Gold Mining Licence in the Cavally Basin (Ivory Coast)



Source: Endeavour Mining Corporation, 2020

Figure 36. Exploitation and Mining Exploration Licence (PE 26 and PR 61) from SMI in the Cavally Basin



Source: Body et al. 2015

b. Artisanal Gold Mining

Around the industrial gold mining areas (such as the Ity mine) there are a proliferation of sites where illegal miners operate. Clandestine artisanal gold mining thus sometimes takes place in areas subject to exploitation, exploration or research permits granted by the State to Endeavor Mining, which is a source of tension between the mining company and the artisanal operators. Artisanal mining takes two forms: (a) illegal gold panning carried out by surrounding communities; (b) illegal gold washing carried out by foreigners using barges on the Cavally River.
The areas of concentration of gold miners are: along the main arm of the Cavally in the periphery of the Ity Mine, and often within areas covered by mining or exploration permits granted by the State at Endeavor Mining as well as along some of the tributaries of the Cavally as in the upstream part of the Hana.

<u>Liberia</u>

a. Industrial mining

Due to its significant mineral resources, Liberia is in high demand by potential investors, as evidenced by the numerous mineral exploration permits issued to foreign companies. In the Cavally Basin, these permits, which mainly concern iron and gold, generally date from the last decade. However, there are few industrial mines on the ground. Few projects have made it past the exploratory phase and some, for various reasons, withdrew after a few years of exploration, leaving significant mineral deposits untapped. This is the case with iron ore from Putu (River Gee County). The reserves of this zone are estimated at 102 million tons of iron ore projected at 66% and 2.37 billion tons projected at 34.1%. An exploration agreement was signed there in 2012 for a Russian company (Severstal Resources) covering 425 km2. This company withdrew in 2016 after a few years of presence in the field (TDA-LIB, 2020; Gunn et al. 2018).

b. Artisanal mining

Artisanal and / or small-scale surface gold mining has developed in recent years in several parts of the basin such as in the Counties of Grand Gedeh, River Gee (TDA-LIB, 2020). The areas with the highest concentration of mining operators are now found around the Grebo-Krahn National Park, notably in Bilibo Town, Glio-Twabo district, Grand-Gedeh. (Osman, 2019). Artisanal mining has attracted waves of migrants from countries in the sub-region such as Burkina Faso, Cote d'Ivoire and Ghana. The number of artisanal miners is estimated at more than 100,000 people, making this activity the main provider of employment in rural Liberia (Osman, 2019).

Besides gold, sand and gravel are mined in an artisanal way throughout the Cavally Basin, particularly in the beds of rivers and tributaries. Several granite quarries are exploited to meet the growing demand for rock and concrete aggregate by the building and road construction industry (TDA-LIB, 2020).

4.3.5.3. Impacts of mining

Mobilization of large amounts of land: Industrial mining requires the mobilization of large amounts of soil: excavations and transport and accumulation of sands and various rocks. By way of illustration, it is estimated that the production of a gold ring generates 20 tons of waste and requires the displacement of 300 tons of rock ((Thierryregards, 2019). Another illustration: in the Guinean part of Mount Nimba, the iron mining site conceded to SMFG would have a total reserve of around one billion tonnes of ore, which would lead to stripping of the soil to a thickness of up to 600 m (Debonnet et al. 2013).

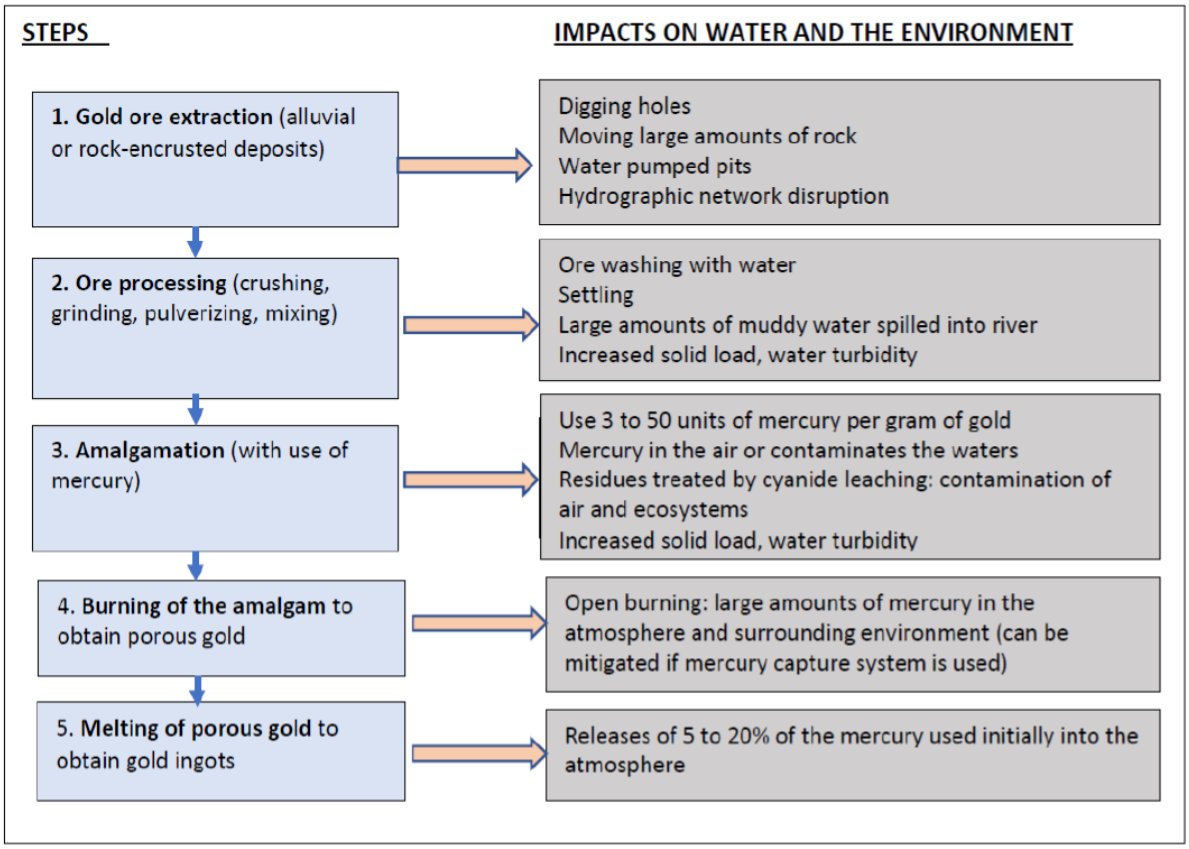
Leaching and risk of cyanide contamination: Industrial gold mining typically uses leaching to extract gold from the ore. This process involves, once the ore is finely ground, using cyanide as a solvent in order to free as much of the precious metal (gold) from the gangue of this ore as possible. It is generally estimated that it takes 0.3 to 0.5 grams of cyanide per tonne of an ore to dissolve the ore and extract the gold from it. In practice, however, cyanide consumption can reach 300 grams to more than 2 kg per tonne of ore, in order to ensure efficient extraction (Thierryregards, 2019). Between 1,700 and 11,300 tons of cyanide could have been used in the Ity Mine between 1990 and 2009, given that during this period the leaching residue storage areas accumulated a volume of 5.68 million tonnes residue (Body et al, 2015). Managing waste rock to prevent cyanide from contaminating ecosystems and water (surface and groundwater) is an important issue in industrial gold mining areas.

Water footprint of mining (example of gold): Industrial operations have a large water footprint. More or less large quantities of water (coming from the main arm of the river and its tributaries as far as the Cavally Basin is concerned) can be needed, particularly in the excavation and dust control phases (watering the access tracks to the mines for example) and leaching, etc. A heap leach operation with a processing capacity of 5 million tonnes of ore per year may require the use of 3.6 to 5 million m3 of water (Bleiwas, 2012). However, this only represents 0.2% of the annual volume of flows from the Cavally River at Toulépleu (near the SMI site). As shown above (hydrology section), this station recorded an average annual flow of 62.4 m3 (i.e. an annual flow volume of nearly 2 billion m3). However, this does not take into account the water used in other stages of mining (see Fig. 38).

Artisanal mining also affects water resources, both quantitatively and qualitatively. The digging of holes and the accumulation of sand and ore contribute to the disorganization of the hydrographic networks in the alluvial gold mining sites. From a quantitative point of view, large amounts of water (often taken from the Cavally and its tributaries) are required during the processing of gold ore, especially for washing and settling the ore. As mentioned above, industrial and artisanal mining affect water quality, due to contamination with cyanide or mercury used in leaching and amalgamation. This

degradation in water quality is also manifested by the increased turbidity of the waters of rivers and streams.

Figure 38. Main stages of traditional and small-scale gold mining (gold mining) and their effects on water and the environment

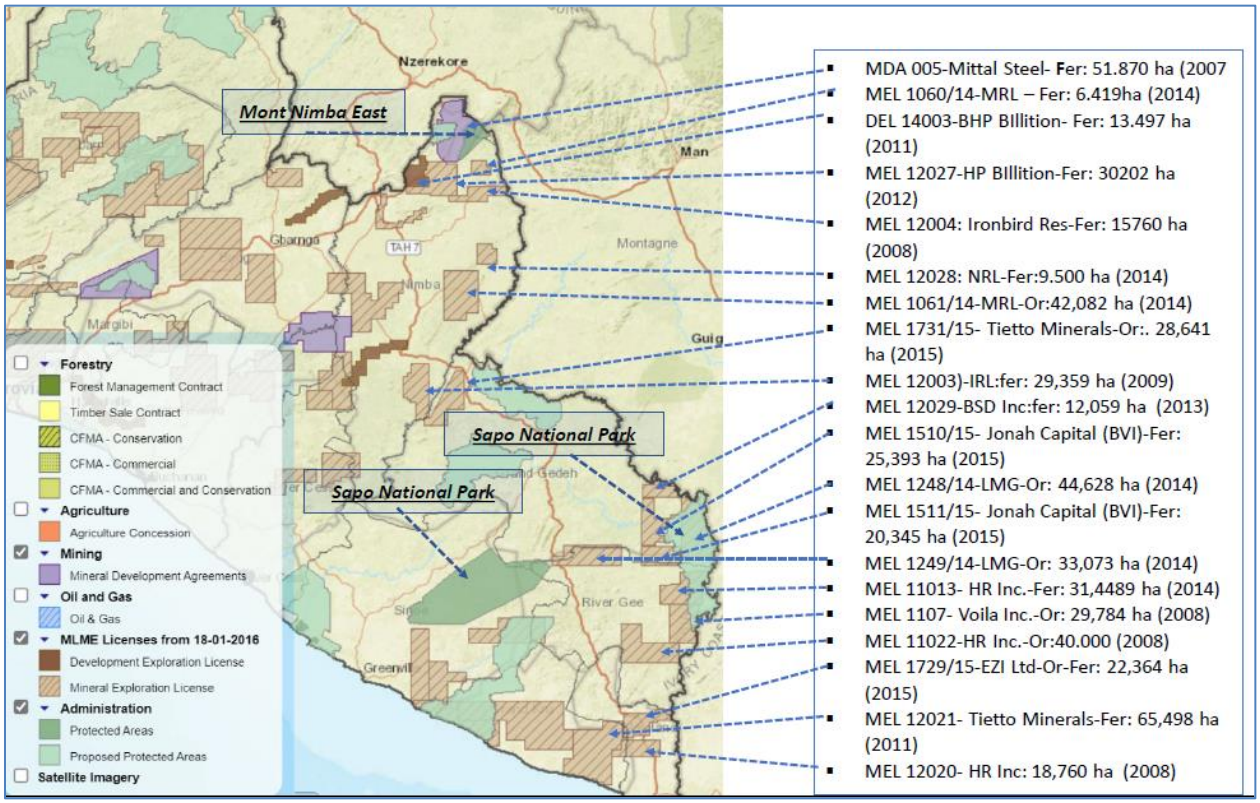


Source: Adapted from UN Environment, 2019; Osman, 2019 ; Niang, 2014

Soil degradation. (Artisanal) sand mining in lowlands and rivers in some places can lead to soil degradation. The same is true for the extraction of gravel from gravelly and lateritic soils. In the Upper Bassin of Cavally, Weyakoré is the aggregate supply district for the construction of buildings and other infrastructure. (RG-TDA_Stakeholders, 2020)

Impacts on flora and fauna and in particular on areas of high biodiversity value. The different forms of mining - industrial as well as artisanal - cause a profound disfigurement of the landscape. The ground is cleared then stripped; the land is dug over tens or even hundreds of meters. The excavated sand and ore collect on the ground. Mining thus results in a loss of flora and fauna. Mining is reaching such a scale that even areas of high biodiversity value - whether or not they are part of protected areas - are not spared. This is illustrated by the geographical distribution of mining exploitation and exploration permits in the Liberian part of the Cavally Basin (Fig 39 below). The areas of influence of some of these permits surround or overlap with the protected areas of Mount East Nimba, Grebo-Krahn National Park and Sapo National Park.

Figure 39. Exploration and mining license in the Liberian part of the Cavally Basin

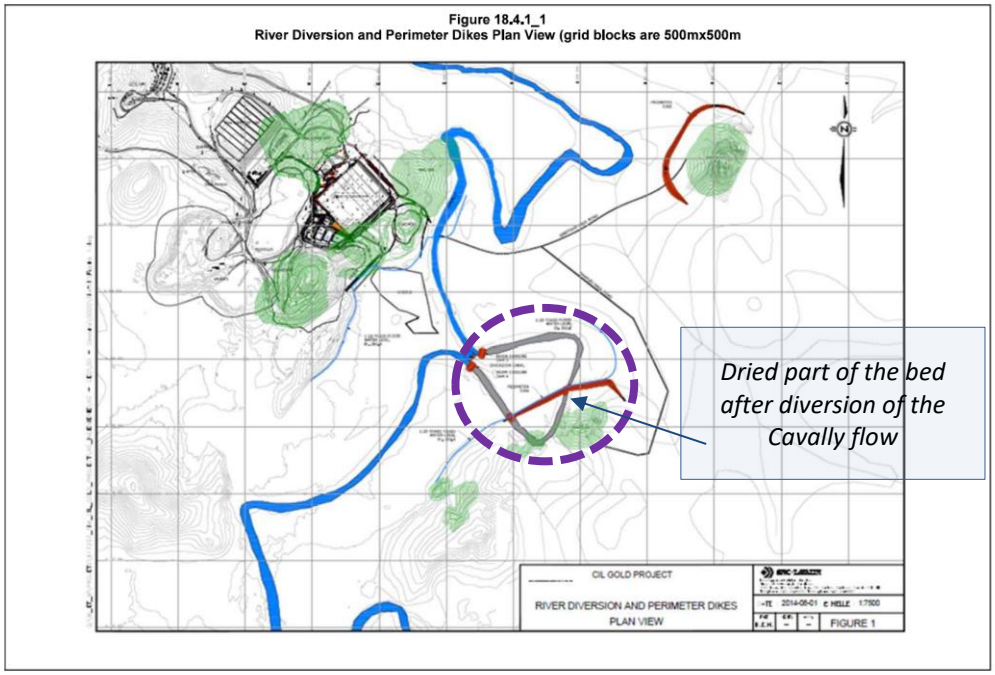


Source: Based on Liberia National Concession Portal: http://portals.landfolio.com/Liberia/ (consulted in Sept. 2021). Nota: MDA = *Mining Development Agreement*; DEL= *Mining Development License*; MEL= *Mining Exploration Licence*

Alteration of the Configuration and Hydrodynamics of Rivers: Mining often causes deforestation, soil erosion. In and along rivers, artisanal mining sometimes results in bank collapse, silting up of riverbeds and degradation of water quality (TDA-IC, 2020). A first illustrative example concerns the Nuon or Cestos River between Liberia and the Cote d'Ivoire. A monitoring report of protected areas in Cote d'Ivoire in 2018 indicates that the exploitation of iron ore in Liberia has led to the modification of the course of the Nuon River, the bed of the river having migrated slightly to the east, towards Ivorian territory. If from the point of view of Liberia the border remains the active bed of the river, therefore the new bed of the river, for the Cote d'Ivoire the old dry bed remains the border. This question has the potential to evolve into a dispute over the course of the northern border between the two countries (Houéhounha & Lefebvre, 2019). A second example of the impact of mining on the configuration of watercourses concerns the implementation of the extension of the mining area of the company SMI / La Mancha to the gold sites of Daapleu and Gbeitouo in the department of Bloléquin. The company saw fit to deviate the bed of the Cavally, in order to shorten and simplify the transport of the ore and also to address safety concerns[24] (See Fig 40).

[24] According to SMI, the fact the old riverbed was in the vicinity of the current mining pits affect the stability of the ways due the infiltration of large quantities of water in the pits.

Figure 40. Diversion of the Cavally River by SMI



Source: Body et al. 2015

4.3.6. Exploitation of Water Resources

As shown in the previous sections, the agricultural and mining sectors use water resources in different ways. Industrial mining (as is the case with the SMI gold mining site in Ity), where there is a water withdrawal station to supply the industrial process of extracting gold from the ore and water is used in the settling and washing phases. In both cases, the river system receives part of the wastewater, which is often contaminated. Irrigated agriculture is almost non-existent in the basin, but in the plantations, nurseries (like those for oil palms) are watered from the waters of the Cavally River network.

Apart from these productive uses - for which the volumes of water concerned are very limited compared to the volume of annual flows - water withdrawals are mainly intended for domestic and animal consumption. The resources requested are above all the underground zones exploited from boreholes and wells. However, in the Ivorian part of the basin there are a few SODECI water pumping and treatment stations. These stations draw water directly from the river, as is the case with the SODECI Station at Sahibly, along the Cavally River, in the Department of Toulepleu. This station has a treatment volume of just under 1000 m^3 of water per day.

Despite these initiatives, 25% to 37% of the population of the Ivorian portion of the basin (west of the southwest region) do not have access to an improved water source, against a national average of around 20%. Levels of access to improved water sources are higher in the national portions of the basin in Guinea and Liberia (see Table 59 above).

Table 59. Level of access to drinking water in the Regions and Counties of the Cavally Basin

Country	Regions/ Counties	Access to improved water sources	Access to non improved water sources
Guinea	N'zérokoré	89.8	**10.2**
	National	**79.9**	**20.1**
Cote d'Ivoire	West	74.2	25.8
	South West	63.1	36.9
	National	**80.7**	**19.3**
Liberia	Grand Gedeh	96.0	**4.0**
	River Gee	90.8	**9.2**
	Maryland	90.5	**9.5**
	National	**84.6**	**15.4**

Sources: Guinea: INS, 2019; Cote d'Ivoire: INS-CI, 2017; Liberia: LISGIS, 2021

While the levels of water withdrawals from the Cavally are still low, the region has no shortage of water resources development projects in the basin, especially in the lower and middle valley. Cote d'Ivoire has identified two large dam projects on the Cavally: the Tiboto project (planned for an installed capacity of 225 MW and that of Tahibli (19.5 MW of installed capacity). low levels of access to electricity in the sub-region, Liberia does not seem to have identified hydroelectric dam projects on the Cavally, unless it is a stakeholder in Ivorian projects. In the Guinean part of the basin, no dam site has yet been identified. It is true that the hydroelectric potential of this part of the basin is almost zero (AECOM, 2018; RG-TDA-Stakeholders, 2020).

5. GOVERNANCE ANALYSIS

The analysis of the governance framework for water and other basin resources covered in the TDA emphasizes the institutions, policies, laws, regulatory texts adopted and implemented at the national and local levels. The analysis also takes into account the relevant regional standards (treaties, conventions, agreements) to which the riparian countries of the target basins (Cote d'Ivoire, Guinea, Liberia, Sierra Leone) have subscribed. In particular, it deals with standards relating to water, the environment, mining and other sectors, which significantly affect the use and management of the resources of the target basins. This section on the framework for the governance of natural resources in the target basins of the Mano River Union (MRU) will be analyzed mainly at the following scales: (a) national scale, covering each of the four riparian countries of the target basins; (b) the MRU scale; (c) sub-regional scale (UEMOA; ECOWAS) and international scale.

The analysis of the governance framework is a very broad subject and cannot be exhaustive within the framework of the TDA. Emphasis is therefore placed on the institutional, legal and regulatory dimensions that are most relevant to the issues highlighted in chapters 1 to 4 above. This concerns in particular the general tendency to deteriorate the state of the physical environment of the basin, as well as unsustainable practices of resource use in key sectors such as: agriculture, fishing, animal husbandry, exploitation of forest products (fauna and flora), mining, development and use of water resources. Cross-cutting issues related to climate change and gender are also taken into account.

5.1. Relevant Institutional Arrangements and Frameworks for Environmental Governance of Target Basins in MRU Member States

Many of the environmental problems of the basin identified are in most cases problems common to the member countries of the MRU, they are also often confronted with challenges, concerns and problems which are specific to them and which must therefore be managed at the national level. It will therefore be a question of reviewing the legal and institutional framework of each country in the governance of water resources and environmental resources.

5.1.1. Relevant Mechanisms for Water, Environment and Resource Governance in Cote d'Ivoire

5.1.1.1. Institutional framework for water and environmental management and promotion of sustainable development in Cote d'Ivoire.

Cote d'Ivoire is distinguished by a large number of actors intervening directly or indirectly in the management of water and natural resources: (i) key ministries and their technical departments, (ii) organizations and funds attached to these ministries, (iii) decentralized public authorities and (iv) other actors made up of private companies and non-governmental organizations.
In Côte d'Ivoire, several Ministries carry out activities related to natural resources and in particular water resources. Among these Ministries we can mention the following:

- The Ministry of Water and Forests plays the role of water resources manager and all other ministries are users. This ministry ensures the implementation and monitoring of government policy on water and forest protection.

- The Ministry of Water Resources is responsible for the implementation and monitoring of the government's water policy, participation in the monitoring and protection of water resources, management of infrastructure in the water supply sector. The development of drinking water supply infrastructure in urban and rural areas and the development and monitoring of regulations in terms of studies, construction and operation of human hydraulic structures.
- The Ministry of the Environment and Sustainable Development is in charge of the implementation and monitoring of government policy in terms of environmental protection, in particular wildlife resources, which are part of biodiversity and the promotion of sustainable development.
- The Ministry of Agriculture and Rural Development is responsible for implementing and monitoring government policy on agriculture and rural development. As such, it has the initiative and responsibility, in particular for the promotion and popularization of plant material and efficient agricultural technologies, the organization and control of phytosanitary protection, the establishment and control of quality standards and packaging of agricultural products and encouragement to promote modern agriculture that respects the environment. The realization of agricultural projects requires the use and withdrawal of water resources. In addition, the use of phytosanitary products can also impact water resources.
- The Ministry of Petroleum, Energy and Renewable Energies is responsible for implementing and monitoring the Ivorian government's policy on petroleum, energy and renewable energies. Much of the energy development comes from water resources.
- The Ministry of Animal and Fishery Resources is in charge of implementing and monitoring government policy on animal and fishery resources. As such, and in conjunction with other ministerial departments, it has the initiative and responsibility for planning, promotion and development actions for livestock, aquaculture and fisheries. The production of animal and fishery resources cannot prosper without the preservation of water resources.
- The Ministry of Commerce, Industry and SME Promotion is responsible for implementing and monitoring government policy on trade, industry, and SME promotion. It is a sector that consumes water resources.
- The Ministry of Tourism and Recreation ensures the implementation and monitoring of government policy on tourism and recreation. Tourism activities are developing by relying in part on water resources.
- The Ministry of Mines and Geology is responsible for the promotion and development of the mining sector. The sustainability of this sector requires measures to protect environmental resources, especially water. Mining activities are carried out on plots falling within the rural domain. They can, if environmental conditions are not respected, be damaging to natural resources such as water, soil, subsoil and forests.
- The Ministry in charge of Women, Family and Children has, within its components, the Directorate for the Promotion of Gender and Equity which, among others, is responsible for implementing the national policy on equal opportunities, equity and gender.
- We can also add the Ministry of Transport, on which meteorology and ports depend, as well as the Ministry of Public Health which, in addition to ensuring the supervision of the National Institute of Public Hygiene, has a particular interest in the water quality, the degradation of which is one of the main causes of morbidity in developing countries.

There are multiple organizations and funds involved and intervene at different levels in the water resources and environmental resources sector:

✓ Ministry of Hydraulics :

- The National Drinking Water Office (ONEP) is under the supervision of the Ministry of Hydraulics and its mission is to provide the State and the Territorial Communities with its assistance to ensure access to drinking water for populations throughout the territory. It also ensures the management of the public and private assets of the State in the water sector.

✓ Ministry in charge of sanitation :

- The National Office for Sanitation and Drainage (ONAD) is responsible for ensuring access to sanitation and drainage facilities, in a sustainable manner and at competitive costs, to the entire national population. It ensures the delegated project management or the project management of investments in this sector.

✓ Ministry in charge of the environment :

- The Ivorian Antipollution Center (CIAPOL) is a public establishment placed under the administrative and technical supervision of the ministry responsible for the environment. It is responsible, among other things, for water analysis, the assessment of pollution and nuisances from the various receiving environments (water, air and soil), the continuous monitoring of the marine and lagoon environment through regular patrols and the application of regulations concerning dangerous, unhealthy or inconvenient activities.
- The National Environment Agency (ANDE) is responsible for implementing the environmental impact study procedure and generally environmental assessments of macroeconomic projects and ensuring that environmental concerns are taken into account in said projects.
- The Foundation of Parks and Reserves of Cote d'Ivoire (FPRCI)'s mission is to mobilize and manage funds as effectively as possible to ensure long-term sustainable financing of protected areas, in addition to the commitments of the State.
- The Ivorian Office of Parks and Reserves (OIPR) was created in 2002 with the objective of preserving and enhancing a representative sample of the biological diversity of Côte d'Ivoire and maintaining ecological processes in protected areas in a sustainable. The OIPR manages a network of sixteen (16) protected areas comprising 8 national parks (including the Taï National Park -TNP) and 8 nature reserves (including the Mount Nimba Strict Nature Reserve and the N'Zo Wildlife Reserve). The TNP, the Mont Nimba Reserve and the N'zo Reserve are located (at least partially) in the Cavally Basin.

5.1.1.2. Legal, legislative and political aspects relating to water, the environment and other uses of resources in Cote d'Ivoire

Cote d'Ivoire has developed several policy strategies and legal framework to effectively manage water and natural resources.

✓ In terms of policies, Cote d'Ivoire has:

- A development and anti-poverty policy (covering which period ??);
- An environmental protection and safeguard policy (what period ??);
- A national water policy (PNE);
- A forest policy
- A policy of prevention and fight against major risks;
- A national policy on equal opportunities, equity and gender.

✓ In terms of legal texts, there are texts taken at national level to which ratified conventions and agreements are added.

- At the national level, the legal provisions are:
- Law No. 96-766 of October 3, 1996 on the Environment Code;

- Law No. 98-755 of 23 December 1998 on the water code;
- Law n ° 2002-102 of February 11, 2002 relating to the creation, management and financing of national parks and nature reserves;
- Law n ° 2014-390 of June 20, 2014 of orientation on sustainable development;
- Law n ° 2014-138 of March 24, 2014 on the mining code;
- Law No. 2015-537 of July 20, 2015 on agricultural orientation;
- Law n ° 2019-675 of July 23, 2019 on the forestry code;
- Decree No. 96-894 of 8 November 1996 determining the rules and procedures applicable to studies relating to the environmental impact of development projects;

- Regional and International Conventions ratified by Cote d'Ivoire:

- Convention on the Law of the Non-navigational Uses of International Watercourses 1997
- Convention Concerning the Protection of the World Cultural and Natural Heritage of 23 November 1972;
- Dublin Declaration on Water and Sustainable Development was adopted in January 1992;
- United Nations Framework Convention on Climate Change adopted on May 9, 1992 in New York;
- Rio Convention on Biological Diversity of June 1992;
- Paris Agreement on Climate of December 12, 2015;
- Convention on Wetlands of International Importance, Particularly as Waterfowl Habitat of February 2, 1971.

5.1.1.3. Notable progress and challenges relating to the water, environment and resource governance framework in Côte d'Ivoire

Through the Mining Code (Law n° 2014-138 of March 24, 2014 and its implementing decree n° 2014-397 of June 25, 2014), the mining sector has an advanced governance framework, covering all types and forms of mining: industrial, semi-industrial and artisanal. For this last form of mining, the mining concessions granted are capped at 25 ha and the permits are renewable every 2 years.

The Mining Code obliges holders of mining permits (for exploration, research and exploitation) to respect the environment and restore mining sites after the mine is closed. The Code establishes a 100-meter mining protection and prohibition zones around protected areas and around water points and other environmentally, socially or culturally sensitive types of sites. An important provision of the law concerns consultation with local communities. According to Article 114, "Prospecting, research and exploitation in prohibited areas are subject to the prior consent of the owners, occupants or communities concerned, and the authorization of the Minister in charge of Mines". Another avant-garde provision concerns the requirement for mining operators to open, from the start of operations, an escrow account for the rehabilitation of the environment... This account is used to cover the costs relating to the rehabilitation of the environment at the end of operation (Art. 144).

The 2019 Forest Code punishes with heavy penalties deforestation on the edge of watercourses (25 meters on either side of the upper limit of the floods of watercourses) as well as deforestation in mangroves, areas wetlands or any other sensitive ecological area (Article 99). The same code severely penalizes clearing or cultivation in areas intended for forestry (Article 100).

5.1.2. Relevant governance arrangements for water, environment and resources in Guinea

5.1.2.1. Institutional Framework for Water and Environmental Management and Promotion of Sustainable Development in Guinea

In Guinea, the institutional framework for water and natural resource management is managed by (i) ministerial departments and (ii) technical services.

- ✓ Ministerial departments (Ministry of Hydraulics and Sanitation, Ministry of the Environment and Sustainable Development, Ministry of Agriculture, Ministry of Territorial Administration, Ministry of Livestock, Ministry responsible for Fisheries, Ministry of Mines and Geology, Ministry of Town and Regional Planning, Ministry of Energy, Ministry of Public Health.
- ✓ The Directorates and Technical Services are attached to the Ministries:
  - The National Directorate of Hydraulics (DNH), under the supervision of the Ministry of Hydraulics and Sanitation, is, among other things, responsible for drawing up the elements of the policy and action programs in terms of water supply and hydraulic resources.
  - The National Direction of Meteorology (DNM), reports to the Ministry of Transport and is responsible in particular for formulaating and applying the development policy in the sub-sectors of meteorology, installing and ensuring the maintenance and operation meteorological stations with a view to observing, collecting, processing and disseminating meteorological information to meet user needs.
  - The National Directorate of the Environment reports to the Ministry of the Environment and is responsible, among other things, for ensuring the protection of ecosystems and the biological diversity of the national territory.
  - The Guinean Agency for Environmental Evaluations (AGEE), placed within the Minister in charge of the environment, is responsible for designing, developing, promoting and ensuring the implementation of national policy in the field. of environmental assessments. He supervises the achievement of the conditions for carrying out environmental and social impact studies, approves them and supervises the implementation of Environmental and Social Management Plans (ESMP)
  - The National Directorate for the Prevention and Fight against Pollution and Nuisances reports to the Ministry of the Environment, is responsible in particular for combating all forms of pollution and nuisances and for ensuring the improvement of the quality of the environment.
  - The National Directorate of Agriculture reports to the Ministry of Agriculture and Livestock and is specifically responsible for collecting agro-meteorological data and analyzing them to better guide producers.
  - The National Directorate of Livestock comes under the Ministry of Agriculture and Livestock and is responsible, among other things, for contributing to food security, improving the monetary incomes of rural people, participating in environmental protection and the conservation of renewable resources.
  - The National Directorate of Rural Engineering (DNGR) is responsible among other things for ensuring the development and protection of water resources for agricultural purposes.
  - The National Directorate of Water and Forests (DNEF), attached to the Ministry of the Environment, is responsible for the protection of the resource with specific reforestation and development actions.
  - The National Directorate of Inland Fisheries and Aquaculture (DNPCA) is responsible for the implementation of government policy on inland fisheries and aquaculture.
  - The National Directorate of Public Health (DNSP) is responsible for the implementation of the government's health policy, in particular the prevention and treatment of water-borne diseases.

- The National Directorate of Territorial Development and Town Planning (DATU) is responsible for the implementation of government policy in terms of town and country planning, mainly in the networks sub-sector miscellaneous and sanitation.
- The National Directorate of Mines (DNM)
- The National Directorate of Energy (DNE) reports to the Ministry of Energy and is responsible, among other things, for defining and implementing the government's energy policy, implementing general planning for the development of the sector.
- The National Water Points Development Service (SNAPE), has the fundamental mission of contributing to the achievement of the government's objectives in terms of village water supply
- The Guinean Water Company (SEG), reports to the Ministry of Hydraulics and Sanitation and is, among other things, responsible for the programming of investments in the sector, the operation and maintenance of the installations as well as their renewal. .
- The Scientific Research Center of Conakry-Rogbané (CERESCOR), placed under the supervision of the Ministry of Higher Education and Scientific Research, is responsible for research and development concerning marine and estuarine waters.
- The Guinean Office of Parks and Reserves (OGPR)
- The Administrative Regions covered by the Kolenté, Kaba, Makona and Cavally Basins.
- The Kolenté, Kaba, Makona and Cavally Basin Committees, made up of representatives of all categories of users of water and related resources, operating in the national portion of the basins concerned.
- The Nzérékoré Forest Center, the Study Executing Agency.
- Centre for the environmental management of the Nimba – Simandou Mounts (Centre de Gestion de l'Environnement des Monts Nimba -Simandou -CEGENS)

5.1.2.2. Legal, legislative and policies relating to water, the environment and other uses of resources in Guinea

Guinea has adopted a range of policies and texts to sustainably manage its water and environmental resources:

✓ In terms of policies and strategies:
- Poverty Reduction Strategy Documents;
- The National Biodiversity Strategy 2010-2020 and the Aichi targets together with a 2014 action plan;
- The National Water Vision 2025;
- The National Economic and Social Development Plan for 2020;
- The Water Policy Document Adopted in April 2018,
- The New National Forest Policy;
- National Environmental Policy;
- The National Agricultural Development Policy;
- The Livestock Development Policy Letter;
- The National Fisheries and Aquaculture Policy Letter;

✓ In terms of legal framework governing the sector:
- Le nouveau Code de l'environnement adopté en 2019.
- La Code forestier révisé en 2017
- Ordinary law n ° 2018/0049 / AN on the code for the Protection of Wild Fauna and Hunting Regulations;

- Law n ° L / 95/51 / CTRN of 29 August on the pastoral code;
- Law n ° L / 99/013 / AN of 22 June 1999 on the forestry code;
- Law L / 2011/006 / CNT of September 9, 2011 on the Mining Code of the Republic of Guinea (amended by Law No. L / 2013/053 / CNT of April 8, 2013)
- Law No. L / 94/005 / CTRN on the water code;
- The Land and State Code promulgated by Ordinance n ° O / 92/019 of March 30, 1992, amended by decree D / 94/180 of December 7, 1994;
- The Inland Fisheries Code, adopted by law L / 96/007 / of 22 July 1996;
- Ordinance No. 045 / PRG / 87 of May 28, 1987 on the code for the protection and enhancement of the environment;

5.1.2.3. Notable progress and challenges relating to the governance framework for water, the environment and resources in Guinea

The 2011 Mining Code (amended in 2013) requires mining permit holders to prevent or minimize any negative effects due to their activity on health and the environment, in particular, water, air and soil pollution, degradation of ecosystems and biological diversity, prevention and treatment of any spills. The same Code requires companies holding mining permits to prepare a closure plan and fund a trust account dedicated to site rehabilitation. Shortcomings are reported with regard to the monitoring of the effective implementation of the rehabilitation plans (Dupain & Toledano, 2021).

The Water Charter/Code provides that an implementing decree to set the conditions for the discharge, flow, discharge, direct or indirect deposit of water or materials likely to alter the quality of surface and groundwater as well as the conditions for controlling the physical, chemical, biological and bacteriological characteristics of receiving waters and discharges. This Decree has apparently not yet been issued (Dupain & Toledano, 2021).

The new Environmental Code (Law L/2019/0034/AN of July 04, 2019) incorporates three major points, which are: (a) the inclusion of provisions on climate change, renewable energies and energy efficiency (Title 6); (b) the creation of the Fund for the Environment and Natural Capital (Title 7) and, (c) proposals to toughen the level of sanctions applied in the event of non-compliance with certain provisions of the Code.

The 2017 Forest Code (Ordinary law U2017/060/AN of December 12, 2017 on the forest code) sets a target rate of forest coverage of at least 30% of the surface area of the national territory (Article 2), extends the definition of forest estate (including trees outside forests) and gives new, more restrictive provisions regarding the exploitation of forests and reforestation (chapter 2, section 1). According to Article 114, "plant diversity must be preserved and the forest estate must be protected against any form of degradation or destruction caused, in particular, by overexploitation, overgrazing, fires, burning, excessive clearing, diseases, the introduction of unsuitable species and desertification. Article 125 restricts the conditions for the practice of bush fires. It provides that "controlled firings, for agricultural or pastoral purposes or for clearing brush, as well as early firings, may only be carried out within the limits and according to the procedures provided for by this code and its implementation texts".

The Wildlife Protection Code (Law No. 2018/0049/AN on the Wildlife Protection Code and hunting regulations dated Oct 18, 2018) commits the Guinean State to ensure the integral protection of all animals, especially rare or endangered species (Article 56). The species targeted concern in particular

the species taken into account in Annex I of the CITES Convention as well as the species considered to be critically endangered (CR) and endangered (EN) on the IUCN red list (Article 57). The Code specifies that it is strictly forbidden to hunt, capture, keep and sell wild animals that are included in the list of fully protected species (Art. 58).

These are two examples, which illustrate the fact that the legal framework contains elements favorable to the protection and sustainable management of natural resources. The problem therefore lies above all in the operationalization of existing laws and their effective implementation.

5.1.3. Relevant Arrangements for Water, Environment and Resource Governance in Liberia

5.1.3.1. Institutional framework for water and environmental management and promotion of sustainable development in Liberia

Like the other MRU countries, Liberia is characterized by a plurality of structures involved in the management of water and natural resources. Key Ministries and agency are involved in the field of water and natural resources management. The Ministry of Mines and Energy, the Ministry of Public Works, the Ministry of Health, and the Ministry of Agriculture have direct responsibilities in various aspects of water resources management

- The Ministry of Land mines and Energy administers all activities relative to water and energy. It has specific responsibility for ensuring that resource exploration are in line with environmental safeguards and laws of Liberia.
- The Ministry of Public Works is responsible for construction of all major bridges across Liberia ,and the provision of water for domestic use in rural areas;
- The Ministry of Agriculture is responsible for the oversight of agronomy, and research and monitoring on both surface water and grand water.

Key agencies and bodies support the ministries whose mission relates to the management of water and natural resources include:

- The Environmental Protection Agency (EPA), which is responsible for setting the standard for development interventions and for implementing the Liberia's Environmental Protection and Management Law.
- The National Fisheries and Aquaculture Authority (NAFAA) is responsible for the management of fisheries and aquatic resources
- The National Water, Sanitation and Hygiene Commission (NWASH) is responsible the formulation and implementation of water and Hygiene policies
- The Liberia Water and Sewer Corporation (LWSC) is responsible for the supply of water to all major cities in Liberia.

5.1.3.2. Legal, legislative and policy aspects relating to water, the environment and other uses of resources in Liberia

Liberia benefits from a set of governance arrangements for managing its water and natural resources.

- ✓ At the level of policy and strategy arrangements:
  - The West Africa Water Resources Policy Document (2007);
  - ECOWAS EnvironmentalP;
  - Regional Agricultural Policy for West Africa (2008);

- The IWRM Action Plan for West Africa;
- Regional Plans to Combat Desertification and Climate Change

✓ At the level of legal framework:
- Environmental Protection and Management Law of the Republic of Liberia - April 2004
- Regulations on environmental impact assessments (Regulation on Environmental Impact assessments- 2009;
- National Forestry Reform Law – 2006
- National Water, Sanitation and Hygiene Commission Act - 2012
- Wildlife and National Parks Act - - 1988
- Minerals and Mining Law – April 2000

5.1.3.3. Notable Progress and Challenges in the Water, Environment and Resource Governance Framework in Liberia

Although now rather dated, the 2000 Mining Law (Minerals and Mining Law) contains a large number of stipulations whose implementation can avoid or mitigate many of the environmental problems encountered in the Liberian parts of the Moa-Makona and Cavally basins. These provisions include the following:

Each holder of mining right (grantee of an exploration, research/reconnaissance or exploitation licence) must take reasonable, preventive, corrective and restorative measures to limit pollution or contamination or damage to watercourses, water bodies, dryland surfaces and the atmosphere as a result of exploration and mining (Section 8.1).

Each holder of mining right is responsible for restoring the land of any land disturbed by exploration and mining to its previous state or if it is not possible to do so, then to undertake the restoration which will make the land useful for economically and socially desirable purposes (Article 8.2).

Each holder of mining right must ensure that all waters polluted by exploration and mining are restored to their former state and that all watercourses that have been closed are reopened so that the area is drained. by natural flows with minimal erosion. Each holder of mining right must also engage in reforestation activities if they are responsible for the large-scale felling of trees during exploration and mining (section 8.3).

5.1.4. Relevant Arrangements for Water, Environment and Resource Governance in Sierra Leone

5.1.4.1. Institutional Framework for Water and Environmental Management and Promotion of Sustainable Development in Sierra Leone

In Sierra Leone, just like in the other countries of the Mano River Union (MRU), there is a significant number of institutions intervening in the fields of water and natural resources including Ministries, Departments, Agencies, Institutes, Research Centers, Non-Governmental Organizations.

✓ Ministries involved in the field of water and the environment:
- The Ministry of Water Resources, created to define an enabling environment to face challenges related to water and water related sanitation. This Ministry has within it the Water Directorate responsible for policy, research, planning and management of water resources.

- The Ministry of Local Government and Rural Development, delegates responsibility for water supply to local governments (local councils).
- The Ministry of Mines and Mineral Resources is responsible, among other things, for ensuring that mining activities are respectful of the environment.
- The Ministry of Environment is responsible for the management and protection of the environment.
- Ministry of Lands, Housing and Country Planning
- Ministry of Agriculture
- The Ministry of Fisheries and Marine Resources is responsible for the management and control of fisheries and other aquatic resources in Sierra Leone's fishing waters. It is responsible for the planning, development, management and conservation of all aquatic resources.
- Ministry of Health and Sanitation

✓ Other structures not less important in their support for the Ministry of Water Resources and the Environment
- The National Water Resources Management Agency is responsible for the protection, conservation, restoration and the sustainable management of the country's water resources which includes both surface and groundwater resources
- The Environmental Protection Agency SL (EPA).The National Protected Area Authority and conservation Trust Fund (NPAA).Sierra Leone Meteorological Agency
- The Sierra Leone Water Company (SALWACO) is responsible for water supply services to the provences
- National Disaster Management Agency

5.1.4.2. Legal, legislative and policy aspects relating to water, the environment and other uses of resources in Sierra Leone

Sierra Leone also has policies, strategies and legal texts in the area of water and natural resource management:

✓ In terms of policies and strategies:
- Water and Sanitation Policy (2010)
- National environmental policy adopted in 1990 and amended in 1994;
- Vision 2013 to 2035 on inclusive, green and middle-income development.
- The National Climate Change Policy (2021)

✓ Strategies and plans:

✓ - National Medium Term Development Plan 2019 - 2023
- The Nationally determined Contribution (NDC) (2017);
- The National Plan for the Development of Sustainable Agriculture;
- The National Adaptation Plan (NAP) (2022);
- The National Climate Change Strategy and Action Plans (2021-2025.
- The National Water Resources Management Strategy 2019-2023

✓ Legal texts governing the water and natural resources sector:
- National Water Resources Management Agency Act (2017)
- The Environmental Protection Agency Act 2008 as amended in 2010;

- Mines and Minerals Act 1994 and amended in 2004 and 2009;
- The Forestry Act 1988 as amended in 2022;
- The 2004 Law on Land Policy and the National Land Commission;
- The Wildlife Conservation Act of 1972 as amended in 2022.
- SALWACO Act (2017)

5.1.4.3. Progress and Notable Challenges in the Water, Environment and Resource Governance Framework in Sierra Leone

Sierra Leone Minerals and Mining Act 2009 provides for five types of licenses that can be granted to mine operators: (1) reconnaissance license; (2) exploration permit; (3) artisanal mining permit; (4) small-scale mining license; (5) large-scale mining license.
The law requires all small-scale and large-scale mining license holders to ensure that their investment projects are subject to environmental impact assessments, taking into account the need for public consultation as a means of identification. possible environmental impacts of the project. Mining license holders must provide financial security for any environmental damage caused by their interventions.

5.2. Governance framework for water resources and the environment at the MRU level

The Mano River Union (MRU) was established in 1973 with the signing of the Mano River Declaration by Liberia and Sierra Leone. The original declaration was supplemented by 16 protocols that govern institutional arrangements and expand the scope of the organization's mandate. Guinea and Cote d'Ivoire will join the Union in 1980 and 2008 respectively. The MRU is an inter-state cooperation framework aimed at promoting economic integration between member states. It aims to strengthen inter-state collaboration in the fight against insecurity. To ensure better management of the large shared water resources available to the MRU area, consultations have been initiated for the creation of an authority (a management structure) for transboundary river basins in the MRU area. The establishment of this structure was the subject of feasibility studies in 2018 with the support of the ECOWAS Water Resources Coordination Center (MRU, 2018).

5.3. Legal and institutional environment for water and environmental management of target basins at regional and international level

The member countries of the MRU are parties to most of the major conventions and agreements concluded at the sub-regional, pan-African or international level in the field of environmental protection. This section covers, by way of illustration, a limited number of these agreements and conventions, with an emphasis on those, which address the major issues in the management of water and natural resources in the MRU area.

Convention to Combat Desertification:
The member countries of the MRU are parties to the United Nations Convention to Combat Desertification (1972). The Sub-Regional Action Program (PASR) for West Africa developed as part of the implementation of this Convention is broken down into the National Action Plan (NAP) to combat desertification. In terms of achievements, the assessment of the implementation of the PASR / WA highlights: (i) the progress made in the establishment of a cooperation framework for the sustainable management of transboundary natural resources; (ii) efforts to mobilize financial resources for the implementation of LCD micro-projects; (iii) support provided to countries within the framework of the

preparation of NAPs. The poor performance of the States in the mobilization of financial resources has been one of the major constraints to the implementation of the NAPs.

Climate Change Convention:

Like the Convention to Combat Desertification, the Convention on Climate Change has also been translated in the States into national action plans for adaptation to climate change (NAPA). Some NAPAs have been translated into projects and programs and operationalized. An international conference on reducing the vulnerability of natural, economic and social systems in West Africa to climate change took place from January 24 to 27, 2007, Ouagadougou. The main recommendation of this conference is the development of a sub-regional action program to reducing the vulnerability of natural, economic and social systems in West Africa and Chad to climate change. The process of developing this program began in 2007 under the chairmanship of ECOWAS, an institution to which all the MRU countries belong. The signing of the Paris Agreement on Climate Change on December 12, 2015 during the XXIst session of the Conference of the Parties (COP 21) of the United Nations Framework Convention on Climate Change (UNFCCC) also marks the will of African countries, specifically those of the MRU, to fight against global warming. This Agreement, which reflects the commitment of the countries of the world to strengthen their adaptive capacity, entered into force on November 4, 2016. (Source: IUCN: Study on regional environmental policies in West Africa: Collection, analysis, and reflection for a real implementation / Main document - May 2012).

Convention on Biological Diversity:

The implementation of this convention requires the support of numerous legislative and regulatory texts: environmental code, forestry code, etc. This convention, which did not mobilize much actors at the level of West African countries such as those on the fight against desertification and on climate change, however saw the involvement of the MRU countries in its ratification as shown in the table below.

Ramsar Convention:

This agreement imposes a number of obligations:

- Prohibition to reduce the area of a wetland already listed (except for pressing reasons of national interest);
- Adoption and implementation of a management plan for each wetland;
- Creation of nature reserves in listed wetlands;
- Reporting to the Convention secretariat all changes in the characteristics of wetlands already produced, in progress or likely to occur.

Although little known in West Africa, three out of four countries (Cote d'Ivoire, Guinea and Sierra Leone) have ratified it.

Table 60. Some of the international conventions ratified by the member states of the MRU

	Côte d'Ivoire	Guinea	Liberia	Sierra Leone
Watercourse Convention (New York) - 1997	X			
Water Convention (Helsinki) - 1992				
Biodiversity Convention (CBD) - 1992	X	X	X	X
Climate Change Convention - 1992	X	X	X	X
Paris Agreement on climate change - 2015	X	X	X	X

Convention on Desertification - 1992	X	X	X	X
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) - 1973	X	X	X	X
Ramsar Convention (Wetlands) - 1971	X	X	X	X
World Heritage	X	X	X	X

Source: http://portal.unesco.org/la/convention.asp?KO=13055&language=F&order=alpha

Environmental and water anagement at the level of selected institutions to which MRU member States are affiliated

West Africa has the advantage of several processes of political, economic and financial integration and for the conservation, management and development of natural resources, thus of environmental protection. Natural resources are the full or partial object of many organizations including ECOWAS and the African Union.

The Economic Community of West African States (ECOWAS). ECOWAS is one of the main regional economic communities on the continent. With 15 members (including the 4 MRU member states), ECOWAS is essentially a regional instrument of political coordination and regional economic integration for the States of West Africa. It has always given pride of place to the management of natural resources, water in particular. This interest in water resources was manifested by the holding, in 1998 in Ouagadougou, of the West African Ministerial Conference on Integrated Water Resources Management. Following this, the Regional Action Plan for Integrated Water Resources Management (PARGIRE/WA) was adopted in 2000 under the aegis of ECOWAS. In 2001, ECOWAS set up the Water Resources Coordination Unit (UCRE) which became the Water Resources Coordination Center (WRCE). Over the past few years, ECOWAS has undertaken the formulation of water-related directives, starting with the one on water infrastructure development which was formally adopted in June 2017. Another ECOWAS Directive (validated in May 2017 and awaiting adoption) concerns the management of shared water resources in West Africa. The principles set out in the Water Infrastructure Directive and the Draft Shared Waters Directive are consistent with those of the 1997 United Nations Convention on the Law of the Uses of International Watercourses for Purposes other than navigation which entered into force in 2014 and also with the 1992 Helsinki Convention on the Protection and Use of Transboundary Watercourses and International Lakes. It should be noted that this last convention has not yet been ratified by any MRU member country. Given the supranational nature of the ECOWAS legal regime, these directives, once adopted (which is already the case for the one on infrastructure), are binding on all Member States (including also MRU Member States), without the need for a ratification phase at the national level (Niasse, 2019). Through WRC, ECOWAS also supports the establishment of basin organizations and the strengthening of their capacities.

The African Network of Basin Organisations (ANBO). Created in 2002, the African Network of Basin Organizations (ANBO) is a voluntary network of river, lake and aquifer basin organizations. Its objective is to help African basin organizations build their capacities to enable them to play a leading role in the sustainable regional economic development of the continent. Since 2007, ANBO has also acted as a sub-committee of AMCOW (African Ministers' Council on Water) in charge of transboundary water management. The MRU is one of the 20 basin organizations and regional economic communities that are members of ANBO.

African Ministers Council on Water (AMCOW). AMCOW was established in 2002 to promote effective management of the continent's water resources and the provision of water services. In 2008, African Union Heads of State mandated AMCOW to support Member States in their efforts to meet their water and sanitation commitments. AMCOW has been granted the status of Specialized Committee for Water and Sanitation within the African Union with the mission to "provide political leadership, policy guidance and advocacy in the provision, use and management of water resources for sustainable social and economic development and the maintenance of African ecosystems". In 2016, AMCOW launched, through the monitoring system called WASSMO (Water and Sanitation Sector Monitoring and Reporting System), an online platform (http://www.africawat-sanreports.org/IndicatorReporting/home) normally updated regularly with contributions from participating African countries (including those of MRU) (ANBO, 2020).

Conclusion on governance

In general, the MRU countries have very advanced national legislation for the prevention and management of major problems related to water resources and the environment.

Even if the basic objectives of the creation of the Union relate mainly to the promotion of regional economic integration, it is well known that the pursuit of these objectives cannot validly today be achieved to the detriment of the preservation and the rational management of natural resources on which the populations of the countries concerned mainly depend. We note an awareness of the Union in the quest to preserve this invaluable asset represented by natural resources in the area, which is reflected over the time in the implementation of various projects including the one in progress: "Conservation ecosystems and sustainable management of the international water resources of the Mano River Union". In addition, the four MRU countries are, on the one hand, part of most international conventions and treaties on water and natural resources and, on the other hand, members of other sub-regional organizations (ECOWAS, AU, etc.) which promote the sustainable management of natural resources.

The major observation that emerges from the large existing legal arsenal is that the MRU region should not apparently suffer from problems related to the management of its water and natural resources. There is, however, a gap between the existence of the texts and their application. Many constraints hamper the effective application of the texts, in particular:

- The financial and material capacity of countries to implement existing texts - that is to say, their operationalization through implementing texts (decrees, judgments, etc.) and their practical effectiveness in the field;
- The consultation structures established at both local and national level are not functional;
- Insufficient qualified technical staff;
- Lack of knowledge of legal framework by stakeholders and partners;
- Insufficient synergy between the various ministries concerned with the management of water and natural resources.

6. IDENTIFICATION AND PRIORITY CLASSIFICATION OF TRANSBOUNDARY ENVIRONMENTAL PROBLEMS

This chapter takes a quick inventory of the main environmental problems identified in the 3 basins targeted under the MRU's TDA. The approach adopted therefore deviates somewhat from the traditional approach which consists in dealing with the problems posed in each of the basins covered in the TDA - in fact a TDA for shared water concerns as a rule, address a single transboundary water system (river, lake or marine-estuarine). Adopting such an approach within the framework of the MRU's TDA would in fact consist in having three juxtaposed TDA studies - one on the basin of the Scarcies Rivers Complex, one on the Moa-Makona Basin and one on the Cavally Basin. Such an exercise would be heavy and repetitive. The target basins of the MRU are small basins quite close to each other, with climatic and biophysical conditions showing many similarities.

6.1. Main Problems and Challenges of a Transboundary Nature Identified

6.1.1. Approach for the Identification of Transboundary Problems

A transboundary problem is an environmental problem with a transboundary dimension. In other words, it is an environmental problem originating in one country and affecting another country. A shared or common environmental problem is an environmental problem that is shared between 2 or more countries in a given water system or eco-geographic space. Such a problem is not transboundary as such, but is a common type of problem, especially in a context like that of the MRU space where there are a multitude of small shared basins concentrated in a confined region.

The method of identifying and inventorying transboundary and / or common environmental problems was based on three approaches:

First, it was based on the review of the evolution of the biophysical conditions of the three basins. This review makes it possible to highlight cases of degradation, deterioration, drop in the availability or quality of physical natural resources such as water resources, soils, plant cover, etc.

Then, the review consisted of reviewing the constraints and challenges in the use of basin resources and their implications in terms of availability of said resources to sustainably meet the needs of the use sectors.

Finally, the main problems identified in the TDA national reports have been taken into account, especially if these problems are common to at least two basins studied.

6.1.2. Transboundary Issues Identified

Based on the method described earlier, a long list of issues has been identified. These are the following issues:

1) Loss of biodiversity
2) Deforestation
3) The degradation of mangroves and estuarine ecosystems
4) Degradation of water quality
5) Climate variability and change
6) Water-related diseases
7) Changes in river morphology - bank erosion
8) invasive aquatic plants

9) Erosion, degradation of soils and head sources of rivers

During the inventory of the main problems facing the target basins of the MRU, the question arose whether climate change could be considered as a transboundary environmental problem - this is a problem faced more generally at the level of GEF / transboundary water projects. The complexity of the issue arises from the fact that climate change is both one of the parameters that defines the condition of the environment and one of the factors that acts as a cause in the degradation of many other characteristics of the natural environment. As a dimension of the environmental condition, we can mention the manifestation of climate change in terms of increase in average temperatures, increase or decrease in rainfall or hydraulicity, rise in sea level, increase in the amplitude and variability of climatic conditions, frequency of extreme climatic events. From this perspective, climate change is indeed an environmental, transboundary or at least a shared problem (see above). Climate change also affects other dimensions of the condition of the natural environment. It affects the availability and quality of water, changes in plant cover, biodiversity, etc. Climate change - associated with the natural variability of the climate - was therefore retained as one of the main transboundary environmental problems of the target basins of the MRU and was thus inventoried among the nine (9) problems which were subsequently classified by priority order. But highlighted in the next section of this chapter, climate variability and change are among the factors taken into account in the causal analysis of priority transboundary environmental problems.

6.2. Prioritization of Identified Environmental Problems

6.2.1. Methodology

The prioritization methodology was made from three angles:

a. Assessment by the team of consultants responsible for the regional synthesis of TDA

The task first consisted of starting from the long list of environmental problems (see - section 6.1 above). The nine problems were reduced to 8 by combining problem 7 (Changes in river morphology and erosion of banks) and 9 (Erosion, degradation of soils and head sources of rivers).

The second step consisted of defining indicators or criteria to assess each problem. Five indicators have been defined:

(i). Impact of the problem considered on ecosystems;
(ii). Socioeconomic implications of the problem;
(iii). Level of interaction of the problem with other problems and / or its effect of amplifying impacts on other problems;
(iv). Transboundary dimension of the problem - the question being to what extent the problem is transboundary in nature, knowing that it may concern two or three countries in the case of basins targeted by TDA in the MRU area;
(v). Extent to which the problem affects (is shared with or has consequences on) other targeted basins in TDA and on MRU basins in general.

The third step was to give a score to each of the eight problems for each of the 5 criteria. The scoring is as follows: 5 = very high, very important / significant, optimal; 4 = high, substantial, important; 3 = moderate, average, fair; 2 = rather weak, below average; 1 = weak; 0 = none, irrelevant, undocumented.

Consensus was reached among consultants from the TDA Regional Team through email exchanges.

b. Rating and ranking of environmental issues in TDA national reports

The second angle used for the identification of priority problems consisted of using the scoring and ranking of the problems in question carried out by the teams of national consultants and included in the four national reports of the TDA, in this case those of the Guinea, Sierra Leone, Liberia and Cote d'Ivoire. In practice, if a problem is ranked 1st in an TDA report, it is assigned a maximum score of 5; the score of 4 if he is ranked 2nd, the score of 3 if he is ranked 3rd. Etc. From 6th rank, a score of 0 is assigned, as well as if the problem was not identified as a significant threat in a national TDA report.

c. Extent to which the issue under consideration has been identified as important to other MRU Basins

The third angle used consisted in evaluating (in the TDA national reports) whether and to what extent each of the 8 problems of the initial long list is posed in the three basins. The problem arises acutely in the three basins (X), a score of 5 is assigned, and a score of 4 if the problem arises acutely in two basins (X) and with less importance in the third basin etc.

The maximum score for a) is 25; and 20 for b) and 5 for c). This means that the highest total score is 50.

The following table 61 summarizes the scores for each problem and the final ranking - the detailed table is provided in the Appendix.

Table 61. Summary of the results of the classification of transboundary environmental problems of the target basins of the MRU area

	Rating by expert opinion	Level of importance in national TDA rankings	Level of "communality" based on national TDA content	Grand total	Ranking
1. Loss of Biodiversity	22	14	5	41	3e
2. Deforestation	23	15	5	43	2e
3. Degradation of mangrove and estuarine ecosystems	21	10	2	33	5e
4. Degradation of water quality	23	18	5	46	1er
5. Variability and climate change	21	9	2	32	6e
6. Water related diseases	18	10	2	30	7e
7. Soil erosion, land and riverbank degradation (*)	24	7	4	35	4e
8. Invasive aquatic plants	12	2	2	16	8e
(9. Erosion, degradation of soils and headwaters of rivers -- Combined with 7)					

(*) Including erosion of banks and degradation of head sources of rivers and their tributaries

6.2.2. Priority Transboundary Problems (PTB) Identified

Under the application of the selected criteria and the classification of the 8 problems examined, the following four (4) appear as priorities: (1) degradation of water quality; (2) deforestation ; ((3) loss of biodiversity; and, (4) soil erosion and changes in river hydrodynamics.

(1) *Degradation of water quality*. The degradation of water quality (surface water and part of the groundwater) can result from erosion and gullying leading to solid transport in rivers. But water degradation is mostly associated with mining and agricultural activities (massive use of fertilizers and pesticides). The degradation of water quality has a strong transboundary dimension. Upstream polluted water gradually flows into the downstream parts of the basin. The degradation of water quality has negative consequences on flora, fauna and in particular ichthyofauna as well as on human and animal health. The degradation of water quality is a general problem in the MRU area and therefore in the 3 target basins. The decline in water quality is one of the main concerns identified in the TDA national reports from Guinea, Liberia, Cote d'Ivoire and Sierra Leone – in particular the the water of the aquifers for the latter country. In Sierra Leone, the populations encountered in the downstream parts of Great and Little Scarcies have shown their concern at the severe degradation of the waters of the two rivers - degradation manifested by the ocher color of the water during periods of low water.

(2) *Deforestation*. Deforestation and loss of vegetation cover result in the degradation of ecosystems and lead to loss of biodiversity habitat. Bare soil is exposed to erosion, gullying and, as a result, soil impoverishment as well as degradation in quality. The phenomenon of deforestation and deforestation is common to the three target basins and to the entire MRU area. As shown in Chapter 1, forests declined by 28% in the MRU area between 1990 and 2020, compared to a continental average of 14%. Deforestation has a transboundary dimension because erosion and the degradation of water quality in parts of the basin highly prone to deforestation also affect other national portions of the same basin.

(3) *Loss of biodiversity*. The loss, the decline in biological diversity is manifested by the reduction of plant and animal species - by the number and by their diversity - and ecosystems in one or more defined spaces, in this case the target basins of the TDA of the MRU. Deforestation, poaching, land degradation, expansion of agricultural land, changes in water availability and quality and in some cases the proliferation of invasive species are all factors that can contribute to biodiversity loss. . The health and diversity of ecosystems play a central role in biological diversity. The decline in biodiversity has implications for socioeconomic activities such as fishing (when fish species and densities decrease in rivers) or activities linked to the exploitation of wood or non-wood forest products. The loss of biodiversity has an important transboundary dimension, especially since the ecosystems which are the shelters of the richest biodiversity in the MRU Area are in fact transboundary and are therefore places of continuous migratory movements of species in one direction and in the other. This is the case of the ecosystem of Mount Nimba (between Guinea, Cote d'Ivoire and Liberia); the Tai-Grabo-Krahn-Sapo forest complex between Cote d'Ivoire and Liberia; the Gola Forest ecosystem between Sierra Leone and Liberia. Although the loss of biodiversity has not been classified as a priority in the national TDAs of Guinea and Liberia, the said reports also stress the worrying character on the degradation and withdrawal of natural habitats for flora and fauna, including the habitats of vulnerable species. Hunting, poaching, bushfires are identified in all national reports as factors contributing to biodiversity loss in all national portions of the TDA target basins.

(4) *Soil erosion and land and riverbank degradation*. This environmental problem encompasses land degradation in general, manifested primarily in soil erosion, including gullying. In the context of

the target basins of the MRU, these processes sometimes lead to notable changes in the configuration of riverbeds and in river hydrodynamics in general, i.e., changes in the physical behavior of the waters. and their solid loads in the beds of rivers and their tributaries. Land degradation is encouraged in large part by the conversion of forests and virgin land into cultivation areas. An important aspect of soil erosion in river basins concerns the risk of degradation of the head sources of rivers. Degradation of land, spring heads and changes in river hydrodynamics are caused by factors such as deforestation, deforestation and loss of vegetation cover which strip soils and expose them to erosion and gullying. Mining - both industrial and artisanal - leads to deforestation, excavation of the earth and the accumulation on the surface of large quantities of rocks. Through these practices, portions of the river beds are reshaped - widened, narrowed, deviated or drained - and the banks are undermined. Land degradation and changes in river morphology and dynamics negatively affect the health of the basin's ecosystems as well as the quality of the water with significant socioeconomic impacts: agricultural yields, fishing productivity, and even access to river water in cases where the river bed migrates away from riparian communities. The problem of soil degradation and changes in river dynamics has an important transboundary dimension. Land degradation (at the head of springs but also at the level of the other reaches) affects the entire basin: the water retention capacity of the soils decreases, the flows are faster with higher solid loads, the biodiversity of the entire basin (both aquatic and terrestrial) is affected. Even if the degradation of soils, springs and changes in river hydrodynamics are not among the priorities identified in the national reports, this problem remains present in the various reports - degradation of springs (Guinea), effects mining and shifting cultivation on soils and vegetation cover.

These four priority problems satisfy one of the essential conditions of GEF / International Waters Projects: they are all transboundary problems. From the perspective of the GEF, a transboundary problem is an environmental problem originating in one country and affecting another country. Shared or common problems are also often put on the same footing as transboundary problems. As noted above, an environmental problem is said to be shared when it is common to at least two countries in a given water system or eco-geographic space. Such a problem is not transboundary as such, but its resolution often requires a transboundary approach.

6.3. Results of Prioritization of Identified Transboundary Issues

	SCORING BY CONSULTANT TEAM (Regional TDA) (*)						RATING IN NATIONAL TDAs (**)					IMPORTANCE IN BASINS (***)					
	Impact on Ecosystems	Socio-economic impacts	Amplification other problems	Transboundary dimension	Affects other target basins	**Sub-Total A**	Guinea	Sierra Leone	Liberia	Cote d'Ivoire	**Sous-Total B**	Scarcies Basins	Moa-Makona Basin	Cavally Basin	**Sous-Total C**	Total General	RanK
1. Loss of biodiversity	5	4	3	5	5	**22**	0	5	4	5	**14**	X	X	X	**5**	**41**	**3e**
2. Deforestation	5	5	4	4	5	**23**	5	5	4	1	**15**	X	X	X	**5**	**43**	**2er**
3. Degradation of mangrove and estuarine ecosystems	5	4	4	4	4	**21**	0	4	3	3	**10**	x		x	**2**	**33**	5e
4. Degradation of water quality	4	5	5	5	4	**23**	4	5	5	4	**18**	X	X	X	**5**	**46**	**1er**
5. Variability and climate change	4	4	4	4	5	**21**	1	4	4	0	**9**		X		**2**	**32**	6e
6. Water-related diseases	2	4	3	4	5	**18**	3	0	4	3	**10**		X		**2**	**30**	7e
7. Erosion, degradation of land, banks and spring heads	5	5	5	5	4	**24**	1	0	3	3	**7**	X	x	X	**4**	**35**	**4e**
8. Invasive aquatic plants	2	2	2	4	2	**12**	0	0	2	0	**2**			X	**2**	**16**	8e
(9. Erosion, degradation of soils and headwaters of rivers -- Combined with 7)																	

5 = Very high, very important; optimum; 4 = High, substantial, important; 3 = Moderate, medium level; 2 = Fairly weak; 1 = very low; 0 = null, irrelevant, undocumented

7. DESCRIPTION AND ANALYSIS OF PRIORITY TRANSBOUNDARY ENVIRONMENTAL PROBLEMS (PTEP)

Introduction

This chapter provides a quick description and analysis of the transboundary environmental problems a (PTEP) identified in the previous chapter. For each of the four (4) PTEPs, the approach consisted in first explaining the nature of the, its extent in the basin and, if possible, the basins or reaches in which it occurs most acutely. The analysis of each PTEP emphasizes causal links. Since each of the PTEPs as well as the main causes (mining, deforestation / deforestation, agriculture, etc.) thus the impacts of each PTEP have been analyzed in detail in Chapters 2, 3 and 4 on river basins, the analysis made in this chapter remains succinct in order to avoid redundancies. Solution options for each PTEP are briefly presented, it being understood that the relevance and feasibility of these options will have to be the subject of a more detailed analysis during the phase relating to the Strategic Action Plan of the TDA / SAP component of the IUCN / GEF-MRU Project. The last part of the chapter is devoted to the synthetic presentation of the causal links impact matrix for each of the four PTEPs.

7.1. Degradation of water quality

The degradation of water quality refers to the alteration of the chemical, physical and biological characteristics of water resulting from the uses of the resource: human or animal consumption of water, use of water in agriculture, mines, industry, etc.

Degradation of water quality can take the form of: (a) chemical pollution caused by toxic chemicals resulting from human activities such as discharges of pesticides used in agriculture or products such as cyanide and mercury used in mining; (b) microbiological pollution such as microbial pollution resulting from domestic and industrial discharges into rivers; (c) eutrophication or increased primary production due to increased availability or supply of nutrients leading to reduction of dissolved oxygen in water; (d) increased presence of suspended solids (particles suspended in water, the rate of which may increase due to human activities, erosion, etc.) (e) presence of solid wastes such as introduced solid materials in water, especially from various human activities (domestic or other) (OMVS, 2016)

7.1.1. Manifestation and Extent of Water Quality Degradation

The quality of surface or groundwater is hardly ever systematically monitored in the MRU area and in particular in the target basins of Scarcies, Moa-Makona and Cavally. There are however indications and various testimonies attesting to the degradation of the quality of water in various places of the said basins.

The rare water quality monitoring activities in the target basins, such as those carried out by the SMI-La Mancha mining company in the Cavally Basin, reveal a worrying deterioration in water quality.Microbiological and pysico-chemical analyzes were carried out by this company in the Ivorian part of the basin, based on samples taken from wells (15 to 20 meters deep) and on backwaters from which local populations obtain their domestic and drinking water. The results of these analyzes show that none of these waters meet the WHO norms for for drinking water with regards to microbiological parameters. With regards to physico-chemical norms, analyses in the sites from the same region do not show major issues of concern for the moment: (see tables 62 and 63 below). The absence of boreholes or the repeated breakdowns of the pumps pushes the populations to exploit the aquifers of alterites for human consumption, in spite of water qualities issues posed in these water bodies (TDA-IC, 2020).

Table 62. Micro-biological analysis in selected water points in RMI intervention zone – Ity, Cote d'Ivoire

Parameters	Units	Sites				WHO norms
		Tiepleu 2	Teapleu	Kouizonpleu	Daapleu	
MAG - Mesophilic aerobic germs	UFC/ml	16954.55	575	33545	5681.8	300
Coliformes totaux	Nbre/100 ml	<15	<15	<15	<15	10 ml/100ml
Escherichia coli	Nbre/100 ml	<15	0	0	<15	0/100 ml
Staphylococcus		<15	0	<15	<15	0
Streptocoques		0	0	0	0	0
Spores		<15	0	<15	<15	0
Salmonella		Absent	Absent	Absent	Absent	Absent

UFC = Unité formant colonies
Source: La Mancha. 2015.

Table 63. Physico-cheminal analysis from selected water point in SMI mining sites around Ity in Cote d'Ivoire

Parameters	Units	Daapleu (Cavalla)	Daapleu (Nuon)	Gbeitouo	WHO norm
pH		6.34	5.78	5.75	6.5 à 9.5
Turbidity	NTU/UTN	13.5	7.35	26.7	5 NTU
Conductivity	µS/cm	39.5	41.8	38.7	250 µS/cm
Chloride	mg/L	0.2	0.2	0.2	200 mg/l
Phosphorus	mg/L	0.07	0.05	0.12	
Nitrate	mg/L	25.26	70.13	68.03	50 mg/l
Calcium	mg/L	64.125	76.128	54.128	60 mg/l
Magnesium	mg/L	0.728	2.373	0.744	36 mg/l
Cyanide	mg/L	Nd	nd	nd	0.07
Mercure	mg/L	Nd	nd	nd	0.006

Nota: nd= not determined (rare or absent); NTU/UTN : Unité de turbidité néphélométrique (*nephelometric turbidity units*)
Source: La Mancha, 2015

Although scarced and now rather old, water quality information available on the Liberian part of the Cavalla and Moa-Makona, basis indicate signifant impacts of mining and other anthropogenic factors. Water testing activities carried by LHS from 1980 to 1987 showed that about 80% of the 150 wells tested on 30 water-quality parameters did not meet World Health Organization (WHO) drinking water standards (UNDTCD, 1987). The main manifestations of water quality degradation related to pollution caused by bacterial and heavy-metal contamination. Other causes of water quality degradation in Liberian rivers (including the Mano and Cavalla rivers) include pollution by iron ore mining, logging and farming activities, rubber processing as well as from improper disposal of domestic sewage. These results are largely valid for the entire MRU space, wich is confirmed by the fact that in general, in the downstream reaches of the Scarcies, Moa-Makona and Cavally Basins, local populations deplore the contamination of surface water. Sometimes it is the large amounts of chemical fertilizers, pesticides and herbicides used in rice cultivation that are to blame. Often, too, water pollution comes from mining. Drainage water from irrigated lands and mining sites contaminates surface water, soils and partly groundwater.

Some of the noted cases of deterioration in quality follow land degradation (due to deforestation, mining, etc.). The resulting soil erosion and therefore the gullying lead to the degradation of the banks as well as an increase in the solid load of the water.

7.1.2. Causes of Degradation of Water Quality

Inappropriate agricultural practices and mining activities are the main causes of the degradation of water quality in the target basins of the MRU.

Agriculture is one of the causes of water pollution. Irrigated agriculture as well as many agricultural plantations use large amounts of chemical fertilizers, pesticides and herbicides. Part of the contaminated water in the crop fields is drained to rivers and streams.

Mining is considered to be primarily responsible for the degradation of water quality. Mining activity affects quality in a number of ways, including the following:

- Exploitation of the sand in the riverbeds for housing construction works and infrastructure
- Excavation of land, soil erosion and accumulation of mineral residues which, thanks to the rain, are drained into waterways
- Use of mercury or cyanide in the ore amalgamation and leaching processes to extract gold
- Use of water for washing, settling of ore resulting in large quantities of muddy and contaminated water spilling on the ground or carried by water to rivers and streams
- Use of rivers and their tributaries as dumping grounds in industrial and artisanal mining processes and for domestic and plastic wastes. The mercury or cyanide and various heavy metals (iron, zinc, lead, manganese, etc.) contained in the waste rock and contaminated ore residues infiltrate to pollute the groundwater or migrate to the riverbed and end up affecting downstream parts, sometimes far from mining sites.

7.1.3. Impacts of Degradation of Water Quality

The degradation of water quality manifested by water pollution and soil contamination by various toxic products leads to the loss of habitats for flora and fauna.

Contamination of surface and groundwater leads to the degradation of ecosystems with implications for animal and human health. This is the case when the mercury and cyanide used in mineral exploitation pollute the waters and enter the food chain.

Women tend to be disproportionately exposed to and suffer from water quality degradation, as part of their primary responsibility for fetching water for domestic consumption, and as workers in mining sites. Water-relates diseases affecting children increase women's childcare workload. On the other hand, with adequately designed awareness-raising and capacity development activities directed primarily to women (management of domestic waste, limiting use of pollutants in agriculture and mining), water quality degradation can be reversed or attenuated.

Contamination of soils and water resources contributes to the degradation of the productivity of agricultural land, especially if adequate drainage systems are not in place.

Water pollution affects ichthyological fauna - fish populations in general - which, combined with the effects of water quality degradation on land productivity and on livestock production, has negative impacts on livelihoods of the populations of the MRU Area.

7.1.4. Solution options for water quality degradation

Among the possible options to fight against the degradation of water quality in the target basins of the TDA and in the MRU area in general, we can mention the following:

- In the mining sector:
  - Ensure better supervision of small-scale and / or artisanal mining activities by providing them with a legal framework for intervention that would bring them out of the informal and underground.
  - Consider information and awareness-raising activities targeting stakeholders (both men and women) in artisanal and small-scale mining and focusing, for example, on good practices to minimize the damage of mining on the environment, ecosystems and resources in water (e.g. alternatives to amalgamation which usually uses large quantities of mercury: pan washing, gravity separation, etc.).
  - In artisanal and industrial mining, ensure better management of waste rock to prevent mercury or cyanide from contaminating ecosystems and water (surface and groundwater)
  - Monitor the quality of surface and groundwater in and around mining sites.
- In the agricultural sector:
  - Ensure functional drainage systems for irrigated land and agricultural plantations
  - Promote agroforestry and the use of organic fertilizers and pesticides
- In the area of standards and governance:
  - Encourage large agro-industrial plantations to align with international standards for their intervention sectors, such as Goldtree (in the Moa-Makona Basin in Sierra Leone) which joined the Round Table on sustainable palm oil (RSPO = Roundtable on Sustainable Palm Oil) and which, as a result, undertakes to produce organic palm oil.

- Strengthen efforts aimed at the operationalization and practical implementation of the relevant international conventions and treaties, such as:The Stockholm Convention on Persistent Organic Pollutants (2001), ratified by the 4 member countries of the MRU. This Convention identifies and prohibits the use of the most harmful POPs.
- Adopted Minamata Convention on Mercury (2013) which, among other things, calls for the reduction of the amounts of mercury used in small-scale mining. Signed by all the states of the MRU and ratified by three of them: Cote d'Ivoire, Guinea, Sierra Leone;

Encourage and support efforts by local communities (including decentralized collectivities) and civil society organisations to monitor bad practices and to raise awareness for the need for attitudes that prevent water quality degradation

7.2. Deforestation

Deforestation concerns the loss of forest areas and / or the degradation of existing forests - degradation that occurs when said forests lose part of their ecological functions and services. Tree cutting leads to deforestation if it is not accompanied by compensatory reforestation actions.

7.2.1. Manifestation and Scale

The MRU space is subject to an intense process of deforestation. In the MRU space, the areas occupied by forests have regressed twice as fast as on the continental scale in the period from 1990 to 2020: - 28% for the MRU against -14% on the continental scale. The MRU area loses 200,000 ha of forests per year, or nearly 1% of forests per year (Table 64).

Table 64. Evolution of forest cover in the MRU area and in Africa 1990-2020

	Forest Area (x1000 ha)		Net Annual Change (ha /Yr in %)	
	1990	2020	2010-2020	
MRU	26,779	19,178	-200.9	-0.95%
Africa	743,000	637,000	-3.900.0	-0.58%

Source: FAO, 2020

Within the MRU area, the rate of deforestation is very variable. Cote d'Ivoire loses 3 to 3.5% of its forest cover per year, i.e. a decline of 64% of forest cover in 30 years (1990-2020), while forests are shrinking on average by 0.4% per year in the past. Liberia (10% forest loss over a period of three decades). During the same period Guinea and Liberia respectively lost 15% and 20% of their forests.

As has been observed in other basins, plantation forests have sometimes replaced primary forests or occupied land previously deforested. [In the middle and lower Scarcies valley, the area of plantation forests has tripled since 1990 - from 6,680 ha in 1990 to 21,310 ha today. Even so, the expansion of plantation forests in the MRU area is far behind the rate of deforestation.

The deforestation process is not limited to the retreat of forest space. Where the plant cover is preserved, we sometimes observe the more or less advanced degradation of the state of the targeted forests. For example, it is estimated that primary forests (57,000 ha) represent only a quarter (1/4) of the total forest area in Sierra Leone (2.5 million ha).

The mangrove - mangrove forests - also undergo a significant deforestation process. In the Scarcies estuary, mangroves declined by more than 40% between 1990 and 2020 - from 145,000 ha to 85,000 ha - while across Sierra Leone mangrove swamped by 25% during the same period.

In addition to the fact that forests have declined sharply in recent decades, these are the trends that are of most concern. In the Sierra Leonean part of the Scarcies basins, forest cover fell by 1.5% in the decade 2000 to 2010 and then by 24% in the following decade (2010 to 2020). In the Moa-Makona Basin, forests declined from 5% between 2000 and 2010 to 28% over the following decade. During the same periods, forests in the Guinean part of the basin fell from less than 2% to around 12%, respectively. If current trends continue, the important primary forests of the Moa-Makona Basin and to a large extent in other TDA target basins will have almost all disappeared within the next 20-30 years.

Even if deforestation is a problem that arises everywhere in the MRU space and in particular in the target basins of the TDA, some localities suffer from it more than others. While the Districts of the middle and lower Scarcies Valley in Sierra Leone have lost 25% of their forest cover over the past 20 years, those of Port Loko District (36% of forest loss) and Kambia District (30% of loss) were the most affected. In the Moa-Makona Basin, the Prefectures most affected by deforestation in the Guinean part of the basin are those of Macenta and Guéckédou (20% forest loss since 2000). In the Sierra Leonean part, the district most affected by deforestation is that of Pujehun (40% loss of forest area in two decades.

7.2.2. Causes of Deforestation

Deforestation in the MRU area and in particular in the Scarcies, Moa-Makona and Cavally Basins has three main types of direct causes: logging, agriculture, mining and bush fires - these causes being in some cases closely interrelated. All of these causes have a strong anthropogenic dimension.

a. Logging

Logging is a booming activity in the MRU area. Timber is cut for commercial purposes in all regions of the MRU area. In the Guinean part of the Cavally Basin (Lola Prefecture), there were a large number of logging and timber marketing companies in the 1990s. In the lower Cavally - Ivorian and Liberian parts - many companies are engaged in the cutting of treated wood in industrial and semi-industrial sawmills such as those present in the outskirts of San Pédro and Tabou (Cote d'Ivoire). While much of the treated lumber in sawmills is exported, the lumber is also cut to meet the ongoing demand for charcoal and lumber in domestic housing construction.

b. Expansion of Agricultural Land

Deforestation in the MRU area has accelerated in recent years thanks to the expansion of agriculture, which appears to be one of the direct causes of the decline in forest areas. Agriculture, especially rainfed and extensive, has a great need for agricultural land. The land becomes exhausted after a few years of cultivation and must therefore be set aside to restore its fertility. As the population increases, land reserves decrease and, as a result, fallow times are reduced. The land is losing its fertility, which requires clearing, and therefore deforestation, more and more land. In the lower valleys (as in the Scarcies estuary), the rice-growing lands are increasingly nibbling on the mangroves. Womn who are using wood from mangrove trees are also used by women for smoking fish and for processing crabs, molluscs and crustaceans, etc., contribute to deforestation processes,

c. Mining

Intensive mining - industrial as well as artisanal - is one of the main causes of deforestation in the MRU area. In each of the many mining sites, the soils are cleared, stripped, dug, and large amounts of excavated soil are accumulated on the surface. The process of burning amalgam to extract gold uses large amounts of wood. The influx of mining immigrants also leads to the creation of new homes requiring the clearing of part of the forest and the use of wood for the construction of new homes for immigrants.

d. Bush fires

Deforestation is largely caused by the practice of bush fires. These fires can be linked to extensive agriculture, animal husbandry (early fires), hunting, poaching, etc.

7.2.3. Impacts of Deforestation

The consequences of deforestation are numerous. They include:

The loss of habitats for flora and fauna and therefore the disappearance or shrinkage of ecosystems constituting the refuge of rare, threatened and endangered species

Deforestation and degradation of existing forests lead to the acceleration of erosion, gullying with therefore the decrease in the capacity of forests to retain rainwater and slow down flows, with direct effects on river flows and water quality.

The decline of forests, the decrease in forest density and the decline in the floristic diversity of forests affect the availability of non-timber forest products, which play an important role in the diet of local populations and their sources of income as well as in the pharmacopoeia. As they play a premoninent in the exploitation of forest product (charcoal, firewood for non-timer forest products for domestic consumption or sale in local and national markets), women suffer heavily from deforestation trends being observed in MRU space.

Forest destruction contributes to climate change. Forests are carbon sinks. Deforestation releases CO_2 into the atmosphere and reduces the capacity to absorb greenhouse gases. Deforestation thus contributes to global warming.

7.2.4. Response Options to Deforestation

Several types of interventions are possible to slow down, or even reverse deforestation. Among these intervention options, we can mention the following:

- Identify and classify as protected areas (classified forests, national parks, nature reserves) the residual primary forests and those which play functions and provide first-class ecological services such as constituting a habitat for endemic species, or rare or threatened species. However, classification as a protected area is only a step. It is also necessary to ensure respect for the protection status and, better still, to develop and implement viable management plans for said protected areas.
- Carry out reforestation, reforestation of deforested areas or, in the case of conversion of forests to other uses (mines, agricultural plantations, various infrastructures), ensure the implementation of a compensatory reforestation / reforestation program for lost forests
- Scale-up community-based forest management initiatives
- Restore degraded forests, through reforestation or natural regeneration
- Ensure rigorous regulation of forest harvesting and rigorous supervision to ensure compliance with the conditions for granting timber harvesting permits
- Limit the need to convert forests into cropland by promoting intensive agriculture (irrigation, agroforestry, use of fertilizers, etc.);
- Ensure involvement of local populations in the management of natural resources in order to achieve sustainability of local governance systems ;
- Supervise mining activities while preserving protected areas, primary forests and forest ecosystems of particular interest. Promote mining practices that minimize deforestation and ensure the rehabilitation of mining sites, including by restoring vegetation cover and reforestation
- Promote employment and income-generating activities that can be viable alternatives to unsustainable logging and informal and clandestine mining

7.3. Loss of Biodiversity

Biological diversity relates to the diversity and variability of living organisms, terrestrial, marine and aquatic ecosystems. Diversity also concerns the genetic attributes of species as well as their abundance and distribution in time and space (Otero et al. 2020). The analysis of biodiversity loss here focuses on the diversity and abundance of flora and fauna as well as on the health of areas of high biodiversity value, in particular areas of concentration of rare or threatened wildlife species such as protected areas. Due to a lack of data, the biodiversity of ichthyological fauna is poorly covered.

7.3.1. Manifestation and Extent of Biodiversity Loss

In the field of ichthyofauna, no study has been carried out on the inventory and numbers of aquatic fauna in the target basins of the TDA. However, various reports indicate a drop in fish catches, probably resulting from the decline in fish stocks.

With regard to avifauna, the MRU basins and especially some of the protected areas such as national parks offer habitats or seasonal transit zones to a wide variety of bird species, some of which are threatened with extinction.

The threats to biological diversity in the MRU Area and the target basins are best illustrated by the threats facing protected areas. In the Cavally Basin, the Mount Nimba Reserve (Guinea and Cote d'Ivoire) was inscribed in 1992 on the list of world heritage in danger. Today the gallery forests of the Collines de Bossou are increasingly damaged, compromising the chances of survival of the Bossou chimpanzees. On the other side of the border, the forests of the Mount Nimba East Nature Reserve (Liberia) have shrunk by half since the 1970s. Further downstream, the Taï National Park (Cote d'Ivoire) and those of Grebo -Krahn and Sapo (Liberia) face many threats, such as mining, deforestation and expansion of agricultural land.

In the Scarcies River Estuary, the mangrove swamp of the Scarcies River Estuary is in decline due to the expansion of irrigated agriculture and the exploitation of salt.

In the Moa-Makona Basin, the Gola Rainforest National Park (Sierra Leone) and the Gola National Forest (Liberia), we are witnessing in places a deep disfigurement of the landscape and degradation of natural habitats for these rare or endangered species. '' a conjunction of factors such as mining, expansion of extensive and plantation agriculture, bush fires, etc.

7.3.2. Causes of Biodiversity Loss

The causes of loss of biological diversity in MRU Area are numerous. Some of the main causes and threats include:

Deforestation. Deforestation is one of the manifestations and the main cause of biodiversity loss. The deforestation which affects all space is accelerating from year to year. River basins and protected areas are not spared.

Agriculture. The expansion of agricultural land affects biodiversity in the target basins of the MRU in various ways. In the upstream parts and the middle valleys of the target basins, agriculture is generally of the extensive type. It requires continuous clearing (often by means of bush fires) of virgin land (often natural habitats for flora and fauna) to compensate for low yields and rapid soil depletion. The expansion of rice cultivation in the middle and lower valleys (eg Scarcies) has come at the expense of mangroves. The same can be said of plantation agriculture. The MRU area is home to a large number of large palm oil, rubber, coffee and cocoa plantations, in particular the Moa-Makona (Sierra Leonean part) and Cavally (Ivorian and Liberian parts) Basins. Sometimes extending over thousands of hectares, plantations often convert primary forest into monoculture land, helping to reduce biological diversity.

Mining. The MRU Area is rich in mineral resources (diamonds, gold, iron, etc.). In the absence of rigorous supervision, mining activity often takes place in anarchy. The proliferation of mining sites (most of which are clandestine) contributing - through the mobilization of large quantities of land and the pollution of soil and water - to profoundly alter the landscapes, leading to the destruction of ecosystems of high

biodiversity value. Even protected areas (nature reserves, national parks, classified forests) are not spared.

Exploitation of sand quarries in the beds of rivers. Intense sand and gravel extraction activities for the construction of housing and infrastructure are observed in several places on the beds of the Cavally, Moa-Makona, Kaba and Kolente rivers and their main tributaries.

Poaching. The practice of illegal hunting is widespread in the MRU Area. Targeting primary forests and normally protected areas, poaching responds to the strong demand for "bushmeat" at the regional level and in the sub-region. It also fuels the international trade in wildlife products

Logging. Large-scale logging by private concessionaires leads to rapid deforestation and the loss of natural habitats, despite the obligation of sustainable logging often attached to concession contracts. Added to this is the exploitation of firewood and timber for domestic consumption.

Bush fires. The practice of bush fires - associated with shifting cultivation, animal husbandry or hunting is a formidable factor in the destruction of natural habitat and the decimation of wildlife.

Road infrastructure. The development of road infrastructure helps to open up the most remote areas and, as a result, makes the best-preserved ecosystems more accessible and which then become the target of poachers, loggers and even farmers in search of new land.

The use of unsustainable fishing practices and techniques. The decline in fish stocks is largely linked to overfishing, and the use of unsuitable fishing techniques: small mesh nets; boats using unauthorized fishing equipment and sometimes illegally practicing this activity

Urbanization and population growth. The expansion of housing and urbanization in a context of galloping demography, sometimes reinforced by the massive influx of populations (as was the case during civil war situations in Liberia, Sierra Leone and more recently in Cote d'Ivoire), has contributed to increasing the pressure on the natural environment: eg expansion of agricultural land; logging.

7.3.3. Impacts of biodiversity loss

The loss of biodiversity is reflected in the general degradation of the conservation status of flora and fauna in the Guinean Forests Hotspot of West Africa, with heightened risks for endemic and / or threatened species in the area. .

A decrease in biodiversity also results in a lower resilience of ecosystems, which could consequently have a reduced capacity for reconstitution, regeneration after crises such as drought, devastating floods, global warming, etc.

Biodiversity loss manifests itself in the disappearance or scarcity of plant and animal species, some of which are exploited (hunting or gathering or harvesting non-timber forest products) for local consumption by the populations. The loss of biodiversity therefore affects food security.

The MRU space, and the three target basins of the Scarcies, Moa-Makona and Cavally are home to many plant and animal species that are threatened with extinction (See Annex). This testifies to the extent of biodiversity loss but also highlights the important role of the ecosystems of the river basins of the MRU space in the preservation of global biodiversity.

The decline in biodiversity can have negative impacts on the health of populations, firstly because the diversity of species harvested and consumed contributes to strengthening the nutritional status of the population. Secondly, because the decline in biodiversity can also be manifested by the disappearance of species used in the local pharmacopoeia and the pharmaceutical industry.

7.3.4. Response options to biodiversity loss

Among the options for combating biodiversity loss, we can consider the following:
The identification and classification as protected areas of ecosystems sheltering a rich biodiversity or forming part of the last refuges for rare or threatened species. The next step is to ensure that existing and newly created protected areas have credible management plans and are effectively implemented;

Identify wetlands and study their ecological functions, including for avian fauna. Encourage and support the Member States of the MRU (which are all parties to the Ramsar Convention on Wetlands), to ensure the inclusion on the list of Ramsar sites of wetlands which have or may be of international importance from the point of view of ecological, economic, cultural and scientific. It should be noted that there is not a single Ramsar site in the three target basins of TDA. For each of the wetlands that will be included in the list of Ramsar sites, it will also be a question of foMRUlating and implementing a management plan.

Support Member States to reflect at the national level the relevant provisions of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora). All MRU member countries are parties to CITES, which is a Convention whose purpose is to ensure that international trade does not harm biological diversity. To this end, CITES recommends regulations targeting around 5,000 animal species and 30,000 plant species with different levels of protection. The Convention prohibits international trade in endangered species and products thereof (ivory, rhino horn).

Carry out a comprehensive inventory of threatened species found in the MRU space and in particular in the target river basins and strengthen, at the transboundary and MRU level, the protection measures for species in critical danger of extinction.

Encourage companies involved in the cultivation and value chain of palm oil to join the Roundtable on Sustainable Palm Oil. RSPO is a platform, a membership association aimed at minimizing the negative impacts of palm oil cultivation on the environment and communities. RSPO is based on a series of principles broken down into criteria to be met by members to meet the requirements for "Sustainable Oil Palm Certification". One of the 7 principles concerns the protection, conservation and improvement of ecosystems and the environment. This principle includes a series of criteria aimed at the protection of biological diversity such as the use of pesticides, the fight against erosion, the preservation of the quality

of groundwater, etc. The Goldtree Company in the Moa-Makona Basin in Sierra Leone has been a member since 2018 and has certification on part of the land it operates in the outskirts of Daru.

Establish an early warning system against the introduction and proliferation of invasive species. The water hyacinth is, for example, present in the Buyo reservoir, upstream of the Sassandra river - a river whose basin partly covers the Tai National Park (TNP). Since most of the TNP is located in the Cavally Basin and is crossed by tributaries of the same basin such as the Hana, the risk of colonization of the river network and of the Cavally and the Park by this invasive species is not to be ruled out.

Encourage and support community-based and civil society initiatives aimed at exercising a more effective citizen watchdog role to ensure more responsible company practices.

7.4. Erosion, Degradation of Land, Banks and Springsheads

According to the United Nations Convention on Desertification, land degradation refers to the reduction or disappearance of biological or economic productivity and of agricultural land, cattle ranges, forests or woodlands in general. The degradation process can be linked to these natural or anthropogenic causes. Land degradation can be the result of soil erosion, i.e. the degradation of the earth's surface followed by the removal and transport of organic material and mineral particles from the soil by wind or the water. Erosion occurs in several forms: (a) water-rill erosion; (b) water erosion by gullying; (c) river erosion manifested by the undermining of the banks of rivers and, in some cases, the retreat of the river bed; (d) water sheet erosion resulting in the removal of the top soil layer over large areas; (e) wind erosion mainly affecting bare and dry surface conditions. The process of land degradation results in a situation of persistent decline or loss of biodiversity and ecosystem functions and services to the point where the possibility of medium-term natural recovery and regeneration of ecosystems is precluded (IPBES, 2018).

7.4.1. Manifestation and Scale

The entire MRU area and in particular the target basins of the MRU are facing land degradation. The level of degradation is more severe in active or old mining sites. Areas devoted to extensive rain-fed slash-and-burn agriculture are also exposed to an intense erosion process. The sources of the rivers - such as the sources of Cavally in Mount Nimba - undergo a process of degradation: deforestation of the sources, gullying, silting, etc.

7.4.2. Causes of Land Degradation

Agriculture, as practiced in the MRU area, and the target basins, is one of the main causes of land degradation (erosion, soil depletion). Extensive agriculture consumes a lot of land - yields per hectare are low and the soils need to be set aside, ideally for a long period, after a few years of exploitation. With the increase in population, densities increase, including in rural areas, arable land per capita decreases. As a result, the fallow times are shorter, the soils are exhausted. New land must then be cleared, which also becomes depleted after a few years. Bare soils are then exposed to gullying or wind erosion.

With the increase in livestock numbers, extensive raering of livestock leads to overgrazing, especially in areas of high concentration of livestock, in the upper and middle reaches of the Moa-Makona River and upstream of the Cavally Basin. Overgrazing results in deforestation, loss of plant cover, trampling of soils which become vulnerable to erosion.

As has been severely noted in the Moa-Makona Basin, deforestation - linked to the exploitation of timber or fuelwood - combined with bush fires leads to a decrease in the capacity of soils to retain the water. The runoff water with a high solid load flows towards the rivers causing rapid degradation of the banks.

Artisanal mining in alluvial deposits sometimes leads to the modification of the route and configuration of the river beds, following interventions such as the construction of dams and gutters of variable length, the deposit of large quantities of waste water. Rock and ore residues on the banks or in the rivers, which causes the narrowing of the bed or the deviation of the flows (example of the Cestos / Nuon River between Cote d'Ivoire and Liberia). In and along rivers, artisanal mining sometimes results in bank collapse, river beds silting up and water quality degradation.

Likewise in the multitude of mining sites in the MRU area, soils are stripped and large amounts of rock excavated and deposited on the surface. The geography of degraded lands therefore largely matches that of mining sites.

7.4.3. Impacts of Land Degradation

With land degradation comes the destruction of habitats for flora and fauna, ecosystems of high value.
Land degradation, resulting in lower primary and agricultural productivity of land negatively affects the food security of populations.
Land degradation and erosion is often the cause of water pollution, increasing their solid load.

7.4.4. Response Options to Land Degradation

Among the possible measures to slow down or reverse the process of land degradation, we can mention the following:

- Promote agroforestry as an alternative to extensive slash-and-burn agriculture: this can be envisaged as government initiatives or as initiatives by local farmers and communities with support from NGOs;
- Carry out the mapping and study of the inventory of the source heads of transboundary rivers (Kaba, Kolenté, Moa-Makono and Cavally) as well as their main tributaries. Then develop plans for the restoration and rehabilitation of the most degraded heads of sources;
- Identify and map the banks most exposed to erosion and put in place a bank restoration and stabilization plan;
- Carry out reforestation and regeneration activities on soils most exposed to erosion. Promote soil and water management techniques (bunds, stone bunds, hill dams) on degraded land on the sides of mountains and hills and plateaus.

7.5. Cross-cutting issues of critical relevance

This section identifies and briefly addresses some of the cross-cutting issues of great relevance in the analysis and treatment of priority transboundary problems that arise in the target basins of the TDA. This relates in particular to: (a) climate change challenges; (b) risks of conflicts for access to and control of shared watercourses and related resources; and (c) the gender dimension.

7.5.1. Climate change vulnerability in focus basin and MRU space

Introduction

There is no climate change study – climate change scenarios based on the downscaling of general and regional climate or circulation models (GCMs) – at the scale of the MRU space, nor at the scale of any of the three priority basins (Scarcies complex, Moa-Makona and Cavalla). There is however a high level of convergence results of studies about recent trends of climate variability and in projected changes in climate conditions at national level. This is illustrated in Nationally Determined Contributions (NDCs) and National Adaptation Plans of Action (NAPAs) prepared as part of the United Nations Framework-Convention on Climate Change (UNFCCC). The few available regional syntheses on climate change and variability –such as the ones on the Upper Guinean Forest of West Africa—are also generally consistent with climate projections found in national reports. This section briefly synthesizes key features of recent trends and anticipated long changes in MRU space's climate, especially with a focus on changes in temperature, precipitation and their environmental and socioeconomic impacts. This section also lists a series of response options to the climate change challenges – options to be further examined during the formulation of MRU's strategic action plan (SAP).

7.5.1.1. Key features of climate change at the level of MRU space

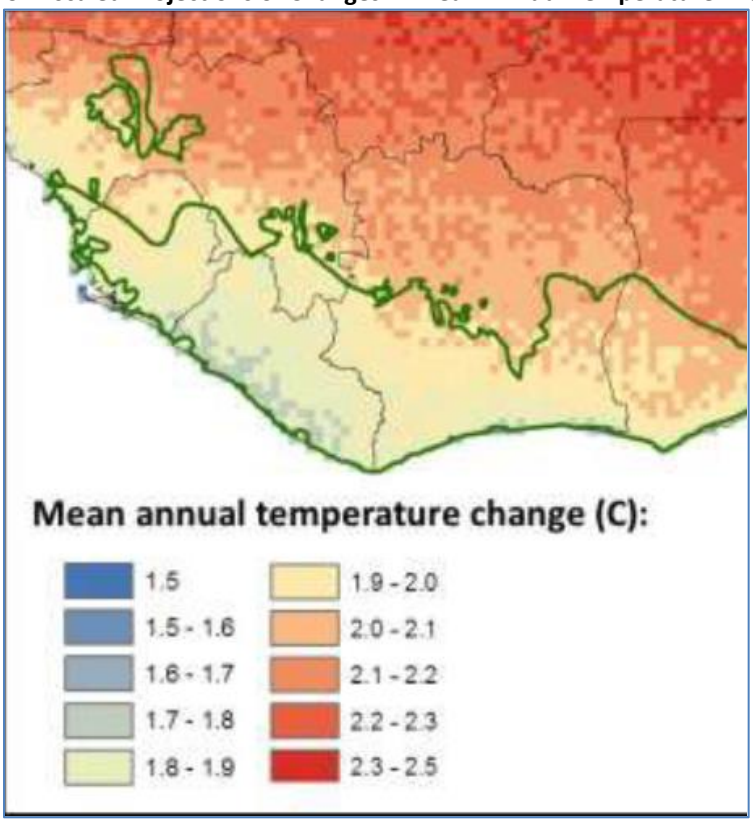
Temperature changes

At regional level, a 2015 CEPF report gives preview of emerging climate context in the West Africa region, covering the MRU space. This report sums the climate realities in the region as follows: "Regarding future climate changes, regionally downscaled projections of temperature changes in West Africa show a clear pattern of overall warming in both mean and maximum temperatures, and a trend of increasing change from coastal to interior regions" (CEPF,2015). Analyses of these forecasted trends show that, on average, mean annual temperatures are projected to increase by 1.9°C by 2055 in the West Africa region (from 25.6°C to 27.5°C), and approximately 35% of the Upper Guinean Forest area has a projected mean annual temperature increase of greater than 2°C.

Intra-annual variability in monthly mean temperatures is predicted to remain relatively constant (1.5°C). Mean maximum monthly temperatures are expected to rise by a similar amount on average by 2055 (30.5°C to 32.3°C) (CEPF,2015). For the West Africa region, it is projected that the change in mean annual temperature could increase up to 3.2°C by 2100, while more optimistic scenarios limit this increase to about 1°C (CEPF, 2015) (see Fig. 41 below)

The already observed and the projected increase in temperature in the MRU space will translate in significant impacts on water resources and ecosystems and on related socioeconomic activities: increase in evaporation of surface waters and of evapotranspiration of the vegetation, changes in weather patterns, reduction in soil moisture with incidence on land cover and on agricultural water needs, etc.

Figure 41. Regionally Downscaled Projections of Changes in Mean Annual Temperature in the MRU space



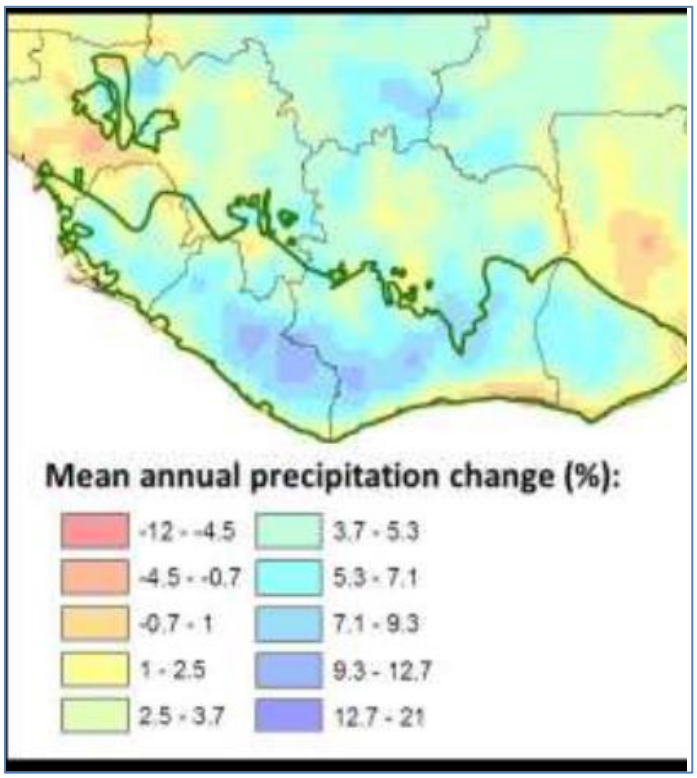
Source: CEPF, 2015.
Nota: Temperature change compares 1975 (based on a mean of 1961 to 1990) and 2055 (based on a mean of 2041-2070), based on the RCP 4.5 scenario.

Precipitation changes

The recently released 6th assessment report of the Intergovernmental Panel on Climate Change (IPCC) confirms to a large extent rainfall and temperature dimensions of climate projections made at national level and reflected in national climate adaptation plans of actions (NAPAs) and Nationally Determined Contributions to climate mitigation and adaptation efforts. According to IPCC's 6th Assessment Report, West Africa Monsoon Region – coinciding broadly to ECOWAS space plus Mauritania) -- experienced the wettest decade of the 20th century during the 1950s and early 1960s. This period was followed by the critically dry years during 1970-1989. The average annual rainfall declined by 60% (in the Sahel sub-region) and 25-30% in the Guinean costal sub-region (including the MRU space) during 1970-1989 period, relative to the long-term mean. Wetter conditions prevail in the West Africa region since the mid-to-late 1990s. While recalling the uncertainties that are inherent in climate projections, the 6th Assessment report, on

the basis of the outputs of CMIP6 models[25], projects a general increase of summer precipitation in the West Africa region during the 21st century. The report also anticipates a decrease in the frequency but an increase in the intensity of very wet events, meaning higher frequency of extreme events of floods and droughts (Douville et al. 2021). In the MRU space, a general trend of increasing mean annual precipitation is projected with an increase of 8.1mm (4.9 percent) in mean monthly precipitation (CEPF 2022).

Figure 42. Regionally Downscaled Projections of Changes in Mean Annual Precipitations in the MRU space



Source: CEPF, 2015.

Sea level rise

West Africa and the Guinean Forest hotspot are among the world's most vulnerable regions to sea-level rise –one of the manifestations of global warming. The coastal zones of the MRU space, including the estuaries of major rivers – estuaries of the Scarcies, Moa-Makona and Rockel rivers in Sierra Leone and of Cavalla river between Liberia and Cote d'Ivoire-- are typically located in low-lying and are therefore highly vulnerable to the projected climate-related sea level rise of 1 to 2 meters.

Extreme events

Climate change in West Africa and in particular in the MRU space is projected to translate into an increase in the frequency and/or duration of heat waves. Similarly, precipitation extremes are expected

[25] . CMIP6 is phase 6 of the Coupled Model Intercomparison Project. CMIP6 coordinates rather independent model intercomparison activities and their experiments. These experiments adopt a common infrastructure for collecting, organizing, and distributing output from models.

to increase in Africa as a whole and the MRU space, while the increase in the risk of floods in tropical Africa will likely translate into higher risks of slope instabilities and landslides (CEPF, 2015).

7.5.1.2 Observed and projected changes in the MRU countries

Unlike in the West Africa Sahel region, the observed climate change situation in the Guinean forest of West Africa comes with varied outcomes mainly across different ecozones like forest and the coastal areas and as recorded at different locations across the Mano River Union region. Though yet to be visibly confirmed unlike in the Sahel, climate change is already being experienced in Liberia, Sierra Leone, Guinea and Cote d'Ivoire.

Liberia

The sensitivity of Liberia's biophysical features to climate change and the level of vulnerability of each sector is currently being felt and observed according to the report by Environmental Protection Agency (EPA, 2018). The same EPA report provided an overview of changes that have been observed starting in the second half of the 20th century. Indeed, in overall, there is an observed average increase in temperatures of 0.18˚C per decade.

According to the Liberia INC report, the mean annual precipitation over Liberia has decreased since 1960, for by about 5.4 mm per decade according to CEPF report. Still, it is unclear as to whether this represents a long-term decline attributable to anthropogenic climate change or if it is instead part of an existing pattern of interannual and interdecadal variability.

Projections of future trends for temperature and precipitation show that Liberia will continue to be affected by changing climatic conditions. Global climate modeling data indicates that the mean annual temperature is projected to increase by 1.8^{o}C between 2040 and 2059.

The general trends are for a warmer climate in most of the country. The Nimba region is estimated to warm by an average temperature of 1.50°C by 2050 and 2.13°C by 2080 during the dry season. The southeastern region, especially the Sapo National Park projected to warm slightly with an estimated average of 1.44°C by 2050 and 1.95°C by 2080 during the dry season (1.29°C by 2050 and 1.73°C by 2080 for the wet season).

Cote d'Ivoire

In Cote d'Ivoire, historical changes in annual rainfall in the Nuon and Cavally watersheds in Cote D'Ivoire were observed at the meteorological stations of Man (1936-2010), Danané (1947-2000), Toulépleu (1940-2000), Taï (1940-2000), Grabo (1944-2000) and Tabou (1920-2010). The Nuon and Cavally watersheds experienced excess rainfall during the 1940s, 1950s and 1960s as indicated by the positive precipitation indices for the period, however from the 1970s, rainfall decreased throughout the extent of the Nuon and Cavally watersheds despite some wet sequences of 2 to 8 years at some stations. This general decline in rainfall due to climate variability has had consequences for water resources and biodiversity. Looking to the future, climate model projections anticipate that by 2031-2040 most of the Nuon and Cavally watersheds could experience an annual rainfall deficit of between 1 and 10%. However, the middle Cavally river could experience an increase in rainfall of nearly 10%. According to the regional RegCM model, by 2091-2100, rainfall could experience a decline with deficits of up to 10% to 20% except in the north of Cavally and Nuon (ADT-CI, 2020). Changes in temperature are also anticipated to be significant. By 2031-

2040, the Nuon and Cavally watersheds could experience an average temperature increase of 0.66 to 0.76°C compared to the reference period of 1991-2000. These temperature increases become more significant towards the end of the 21st century, i.e. around 2091-2100. Indeed, at this horizon, the average annual increase in temperature could reach 3.6°C over most of the Cavally watershed (ADT-CI. 2020).

Guinea

According to Guinea's 2007 National Adaptation Programme of Action (PANA) and the country's 2021 NDC, climate change in Guinea, including in the Guinean portion of Scarcies, Moa-Makona and Cavalla manifests itself in the form of increased temperature levels and decreased mean annual rainfall, although the 2021 NDC projects an increase in rainfall during the wettest period of the year (Republic of Guinea, 2021). The same report anticipates that delays in the onset of rainy season. Average river discharge for the main watercourses is projected to be reduced. Sea level rise is anticipated to be reach 80 cm by 2100. Dourghts and floods are anticipated to be more frequent. These projected changes will translate into decreased terrestrial and aquatic biodiversity, decreased soil fertility and crop yields, higher intensity in migrations, resource use conflicts, and higher poverty incidence.

Sierra Leone

In Sierra Leone in particular, rural migration to Freetown, during and since the civil conflict has increased pressure on urban water resources. Reliable and clean access water is essential for these multiple uses and populations with implications for social vulnerability and poverty. Shifting rainfall patterns has created water and energy supply problems. This has led to decreasing access to water and reduced stream flow of rivers and streams, as well as lower supply of energy to meet cooling, lighting, and heating needs. Stream flow has decreased as there has been a decrease in rainfall since the 1970s. For example, the stream flow to the Mano River fell by 30% between 1971 and 1989. This has large impacts on access to water since about 80% of the rural population receives water from surface sources, including many streams and ponds. These streams also dry up during severe droughts which are likely to become more common. There is also seasonal variation where 40% of the protected water points suffer water shortages in the dry season (USAID 2016), demonstrating that existing vulnerability is already acute.

Sea level rise threatens low-lying coastal Sierra Leone; particularly vulnerable are the communities of Kroo Bay and Moa Wharf. Increased coastal flood events, coastal erosion, reduction in fresh water quality, population displacement, loss of property, reduction in groundwater resources, and reduced agricultural potential for coastal areas (e.g. mangroves) are expected impacts. Changes in flooding, rainfall patterns, and drought will also adversely affect human health by increasing the likelihood of particular diseases (e.g. cholera, diarrheas). Floods regularly affect Sierra Leone during the rainy season due to heavy precipitation and from storm surges along the coast.

Table 65. Observed trends in temperature and rainfall Averages for the MRU countries

	Temperature (°C)		Precipitation (mm/month)	
Country	Mean 1970-1999	Trends 1960-2006 (Changes per decade) : in °C	Mean 1970-1999	Trends 1960-2006 (Changes per decade)
Guinea	25,6	0,18	134,7	-4,7
Liberia	25,0	0,18	186,4	-5,4
Sierra Leone	25,7	0,18	197,8	-6,4

Cote d'Ivoire.Ref. trends from 1961 to 1998	26,5	0,2	122,9	-5,1

Sources : For Guinea, Liberia and Sierra Leone : CEPF, 2015 ; For Cote d'Ivoire, calculations done based on République de Côte d'Ivoire, 2010.

7.5.1.3. Climate Change Impacts and Implications for TDA

The baseline and projected climate change in Cote Ivoire, Liberia and Sierra Leone indicate that countries have experienced some physical processes relating to changes in climate. Some physical processes include variations in rainfall patterns and weather conditions, rising sea levels, increased frequency of extreme weather events, and variation in the country's temperature. These physical processes can either have a direct or indirect impact. For example, in Liberia, the impact of climate change includes deforestation, an increase in agricultural pests, decline quality of water resources in some regions, displacement, and migration of populations.

Risk of Drought:
The impact of climate change can induce drought-associated effects on forest ecosystems, thereby decreasing the sector's economic and social benefits. This could exacerbate the incidence of poverty.

Forecasts from climate models suggest an increased risk of droughts in tropical forests, including Guinea and Liberia's forest, over the next few decades, potentially threatening the large existing carbon sink due to the impact of climate change.

Coastal Areas Disruption:
The limited supporting infrastructures available across the MRU countries also increase the vulnerability of the population. Coastal areas in Sierra Leone and Liberia are the most populated and economically vibrant areas. Sea erosion continues to pose increasing threats to coastal cities' shorelines, including major infrastructures and investments. It can also lead to displacement, loss of lives and properties and can severely undermine national security. The climate vulnerability and variability assessment followed the International Panel on Climate Change (IPCC) climate change vulnerability and risked conceptual framework as defined in its fifth assessment report (IPCC, 2013).

Water Resources Sector:
Concerning the Water Resources Sector. the Initial National Communication report of the MRU countries showed that alterations in temperature and rainfall patterns brought on by climate change are likely to cause significant impacts on water availability (volumes and distribution), affecting the multiple uses of water and the general population.

Even though the overall water resources dependence of the communities is limited especially at the transboundary water areas across the countries, extreme water-related climate events (flooding and drought) are likely to become more intense. Given the indispensability of water, water-related issues are likely to be among the first global climate change impacts felt by these populations.

However, the impacts of extreme events attributed to climate change may also be exacerbated by other pressures on water resources, including inappropriate land use and settlement in river basins, increasing

demand for urban water supply, agriculture, and power generation; the intensification of processes that impair water quality, higher exposure of populations, and increased anthropogenic intervention.

More downstream, the Mano River region's water resources, which serve as the transboundary link between countries, are increasingly under pressure and overcommitted for agriculture, even as these resources are dwindling. This is leading to conflict situations in few instances (MRU, 2013; Liberia, 2015). Table 66 gives a summarized inventory of the kay types of manifestations and impacts of climate change that are identified in NAPA and NDC documents prepared by MRU countries in recent years.

Table 66. Overview of vulnerabilities identified by MRU Countries in their NAPAs and NDCs

Types of climate change manifestations & impacts	Specific types of climate change manifestations and vulnerabilities	Cote d'Ivoire	Guinea	Liberia	Sierra Leone
Direct manifestations	High temperatures/heat waves		X		
	Flooding		X		X
	Biodiversity	X		X	
	Changes in catchments/water resources	X	X		X
	Changes in coastal zone/ mangroves	X	X		X
	Drought/drying of soils		X		X
	Delayed/changed timing of rains				X
Consequences on the conditions of ecosystems	Land degradation	X			
	Landslides/erosion				X
	Loss of vegetation		X		
	Marine impacts	X			
Impacts on the economy, livelihoods, living conditions	Agricultural and livestock impacts, farmers	X	X	X	X
	Food security	X			X
	Fishers/fisheries	X	X		X
	Forests, savannah and NTFPS		X	X	X
	Coastal municipalities			X	X
	Industry/infrastructure		X		
	Disease/health		X		X
Sources		NDC 2022	NAPA 2007	NAPA 2007	NAPA 2011

Source of table: Adapted from CEPF, 2015

7.5.1.4. Enabling governance environment for addressing climate change-related challenges

MRU member countries have a long tradition of involvement and engagement in climate change dialogues and negotiations at African and global levels. They have all ratified the three key international agreements related the climate change challenge: the 1992 United Nations Framework Convention on Climate Change (UNFCCC).; the 1997 Kyoto Protocol; the 2015 Paris Agreement. In addition to nationally

determined contributions (NDC) –which articulates how each country intend to organize itself to contribute to global climate change mitigation efforts --. MRU members have developed and submitted national adaptation action plans to improve resilience and strengthen capacities to cope with climate change effects (See table 67 below).

Table 67. International and National Agreements and Strategies Relating to Climate Change in MRU countries

Country	Year of UNFCCC Ratification	Year of Kyoto Protocol Ratification	Paris Agreement Ratification	Years of national communications	National Adaptation Programme or Plan of Action (NAPAs)
Côte d'Ivoire	1994	2007	2016	2001; 2010; 2022 (May)	No NAPA submitted to UNFCC.
Guinea	1993	2000	2016	2002; 2021 (July)	Plan d'action national d'adaptation aux changements climatiques (PANA), 2007 ;
Liberia	2002	2002	2016	2013 ; 2021 (August)	National adaptation programme of action (NAPA), 2008. Currently developing NAP.
Sierra Leone	1995	2006	2016	2007; 2012; 2021 (July)	National Adaptation Programme of Action of Sierra Leone, 2007.

Source: Adapted from CEPF, 2015 updated with data from: unfcccc.net (accessed June 2022)

7.5.1.5. Response options to the challenges of water-related climate change

Response options to climate are in two main categories: (a) responses aimed at contributing to global efforts to mitigate climate change, for example by avoiding or minimizing greenhouse gas emissions; (b) responses aimed at improving resilience and adaptation capacities to climate change impacts. As part of latter responses, a series of adaptation mechanisms are being planned or implemented at country level as reflected in National Adaptation Programmes of Action (NAPAs) and/or of adaptation components of National Determined Communications (NDCs) prepared in the framework of the Paris Agreement on climate change. Table 68 below summarizes the main types of adaptation responses to climate proposed in NAPAs and NDCs by MRU member states. These responses are highly relevant for river basins targeted in this TDA study. They can help build adaptation capabilities across sectors and ensured that appropriate adaptation mechanisms are put in place for the communities living close to the targeted transboundary watercourses of the basin. The faisability and relevance of these measures for addressing the priority transboundary problems identified in this TDA will be assessed during the development of the Strategic Action Plan (SAP).

Table 68. Overview of main climate change adaptation measures identified by MRU countries in their NAPAs and Nationally Determined Communications

Adaptation measures	Cote d'Ivoire	Guinea	Liberia	Sierra Leone
Agroforestry	X	X		
Agriculture/livestock rearing/food security	X	X	X	X

Anti-disease/health measures	X		X	X
Coastal zone protection/sea-level rise mitigation	X	X	X	X
Ecosystem management/restoration		X		X
Education/awareness raising	X	X	X	X
Efficient stoves/fuel wood				X
Fire management/prevention		X		
Fisheries management/enhancement		X	X	X
Forestry/protected areas/corridors	X		X	X
Indigenous/traditional knowledge		X		
Income diversification/microfinance		X		
Infrastructure (including road/transport)			X	
Renewable energy/energy efficiency			X	X
Rapid alert/early warning system			X	X
Water utilization/irrigation/dams	X			X
Water conservation/management/wetlands	X	X	X	X
Water and sanitation		X	X	X
Mainstreaming gender, youth and social inclusion				X
Sources	NDC (2022)	NAPA 2007	NAPA, 2008; NDC, 2021	NAPA 2007 NDC, 2021

Source table: CEPF, 2015 updated with information from www.unfccc.net

7.5.2. Inter-state dispute and conflict risks around shared water resources

The existence of shared watercourses creates opportunities and sometimes an imperative for cooperation between border states. But transboundary watercourses are also often sources of disputes (for example around the location of the borderline the borderline) and of tension (e.g., regarding modalities of water allocation and use between riparian countries, or water pollution by upstream States, etc.). These characteristics also apply to transboundary rivers in the MRU space, including the 10 small transboundary basins mentioned chapter 1 of this report. A few examples of interstate tensions or disputes around the target basins of the TDA are briefly described here for illustrative purposes. The objective is to show the importance of having credible mechanisms for promoting cooperation and preventing the risk of conflicts around shared waters, but also for mitigating and resolving such conflicts when they arise.

7.5.2.1. Case of the Yenga disputed territory- Border between Guinea and Sierra Leone on the Moa-Makona River

From the perspective of the government of Sierra Leone, the locality of Yenga is officially part of the Chiefdom of Kissi Teng, in the Kailahun District of Sierra Leone. Yenga is located on the left bank of the Moa-Makona River, on the border with Guinea. Its belonging to Sierra Leonean territory was not, until the end of the 1990s, a subject of open disputes on the part of Guinea.

Things changed later, with the generalization of insecurity in the sub-region. With the civil war in Liberia, which soon spread to Sierra Leone, incursions by armed gangs into Guinean territory multiplied (Gberie, 2009). In response, the Guinean armed forces crossed the border (Moa-Makona) in 1998 to set up their camps in the Yenga area of Sierra Leone. With the return of peace in 2001, Sierra Leoneans expected a rapid withdrawal of Guinean troops from the area, which was slow to happen. On the contrary, the incidents between the Guinean army and the local populations have become more frequent in the following years during which Guinea began to evoke its rights on the part of the occupied territory, rights which are allegedly based on colonial agreements between the France and the United Kingdom (Silberfein & Conteh, 2006).

A joint Guinea-Sierra Leone Border Committee was set up in May 2003 to try to find a consensual solution, relying among other things on colonial agreements including the 1912 Protocol of Agreement between France and the United Kingdom (Sandouno. 2014)..).

The border dispute between Guinea and Sierra Leone was also high on the agenda of the MRU Heads of State Summit in July 2005. The Heads of State reaffirmed their commitment to a "brotherly and peaceful" solution to the dispute, recalling an earlier consensus between the two countries concerned, consensus that the village of Yenga belongs to the Republic of Sierra Leone. The three leaders taking part in the Summit (Guinea, Liberia, Sierra Leone) agreed on the urgency of the demarcation of borders in the disputed area (UN Security Council, 2005).

Almost two decades after the MRU Summit mentioned above, the problem remains unresolved.

7.5.2.2. Diverging perspectives on the limits of the border between Guinea and Côte d'Ivoire in the Cavally Basin

The 610 km long border between Guinea and Côte d'Ivoire is often a source of tension between the two countries. This is particularly the case for the part of the border located in the upper basin of the Cavally river. There many perspectives regarding to the course of the border between the Sub-Prefecture of N'Zoo (Prefecture of Lola in Guinea) and the Departments of Danané and Zouan-Hounien in Côte d'Ivoire. Some locate the border along the Labayah River (it seems that markers were installed along this river before independence to mark the limits of the two colonies). For others, the Goué River is the border, supporting their point of view by the fact that a bridge over this river called the "friendship bridge" would have been the meeting place between Sékou Touré and Houphouët in 1962 and that on the occasion, the two leaders had declared that it was Goué which be the limit between the two countries. Finally, a third perspective consists in saying that the border is between the two rivers of Labayah and Goué (Sandouno. 2014). This confusing situation favored misunderstandings and tensions between Guinea and Côte d'Ivoire in the 1980s when the Guinean government decided to strengthen the protection of the Mount Nimba Integral Reserve, and therefore to redefine the limits of its central area (including the Déré forest) and the buffer zone. This had required the eviction of Guinean populations from certain parts of the Reserve, leading to the influx of populations from Côte d'Ivoire to the liberated lands. It seems that the Ivorian side had interpreted the eviction measures taken by the Guinean authorities as an act of recognition of the sovereignty of the Ivorian State on the Déré forest. Thanks to the rebellion that broke out in Côte d'Ivoire from the beginning of the 2000s, clashes and bloody clashes multiplied all along the border between the two countries, particularly in the disputed area of the forest of Déré, against the backdrop of competition for agricultural land and forest resources in the region. (Sandouno. 2014.

7.5.2.3. The alleged instability of the riverbed of Nuon (Cestos), a transboudary river between Cete d'Ivoire and Liberia

An Arrangement was concluded between Liberia and France in 1907 fixing the limits between the French possessions and the territories of Liberia: "The Franco-Liberian border would be constituted by the right bank of the Nuon river up to its confluence with the Cavally… If if appears that the Nuon river is not a tributary of the Cavally, then the right bank of the Nuon would be the border only up to the vicinity of Toulépleu…" (Schwartz, 1966). Subsequently, the French colonial authorities as well as the now independent Ivorian State suspected Liberia of coveting the interfluve zone between the Nuon and the Cavally. In recent years, the local populations, whose voice was relayed by part of the Ivorian opinion, have started to alert on the fact that the Nuon would have, in part of its reach, left its original bed to migrate towards the east, following factors such as climate change and sand and waste rock deposits from mining (Kader, 2020). Because of this rather confused situation, access to the resources of this part of the basin and their use are greatly hampered for the riparian populations of the two countries.

To these different examples, we can add the case of the border between Guinea and Sierra Leone along the Kolenté (Great Scarcies) where the populations of the Sierra Leonean shore say that the Guinean State controls the river and is reluctant to facilitate grant them access to the fish resources of the river. Within the framework of this TDA, it was not possible to study in detail each of the cases of risk of border conflicts. We know, however, that water is at the center of these disputes – vagueness in the language of colonial treaties on the exact route in relation to the bed of the river; changing nature of the configuration of rivers following climate change or other anthropogenic practices; etc. On each dispute, the points of view of

the countries are often contradictory. Each point of view having its own logic and coherence, an expert opinion is required to reconcile views or arbitrate disputes.

Apart from the current border disputes and the risks of conflict, it is also necessary to underline the porosity of the borders, the cross-border movements of populations not always controlled as well as the large-scale practice of smuggling. All of this creates a significant security challenge for all MRU member countries.In response to this security challenge, MRU and its member countries need to strengthen their capacities in water conflict prevention and resolution, through dialogues, negotiations and water diplomacy. Special emphasis must also be placed on the ratification of international conventions regarding the cooperation around water resources. These include in particular the Watercourses Convention (New York, 1997) and the Water Convention (Helsinki, 1992). These conventions contain a large number of provisions relating to the promotion of cooperation and the prevention of conflicts around shared waters. While Cote d'Ivoire is the only MRU country to have ratified the New York Convention, no state in the Union has yet ratified the Helsinki Convention (see Chapter 5).

7.5.3. Gender dimension of the use and management of the resources of MRU target basins

Men and women play different yet complementary roles in the exploitation of the resources of the MRU space. Their responsibilities in family management are generally different. The improvement or degradation of the environment has gender-differentiated impacts. Levels of vulnerability to the deterioration of hydro-climatic conditions vary according to gender. For all these reasons, the diagnosis of the state of the environment, the identification of the most urgent problems to be addressed and the solution options to be considered to address the said problems cannot ignore the gender dimension.

But taking gender into account in the cross-border diagnostic analysis is a challenge in the African context, and in that of the MRU space in particular. Data disaggregated by gender is rare and where it is available, its quality remains questionable. Where there are reliable data, they are in different formats or refer to different dates from one country to another, which makes it difficult to integrate them at the regional level. Consequently, the analysis of the gender dimension is less detailed than desirable and is based on anecdotal examples and illustrations rather than on quantitative data of regional scope.
Gender analysis in the African context typically highlights the fact that women are more dependent on resources than men and are more exposed to the impacts of changes in the condition of said resources (availability, accessibility, quality). This is true with regard to water for human and animal consumption, forest resources, fisheries, etc. In the field of productive activities (agriculture, livestock, fishing, mining, etc.), apart from a few exceptions, women intervene more as suppliers of labor than as managers and main beneficiaries of the products generated by these activities.

7.5.3.1. Access to water and sanitation

In the target basins of the ADT (the Scarcies, Moa-Makona and Cavally) as in the MRU space in general, there is still a lot to be done in the field of access to drinking water. Although significant progress in the construction of drinking water supply infrastructure has been made in recent years (wells, boreholes, development of springs, etc.), between 15% (Liberia) and 22% (Sierra Leone) of the populations from MRU space still do not have improved access to water. This means that for many women in the basin, fetching water continues to occupy a large part of the daily work schedule, even though the MRU space is one of the best watered regions in Africa.

The degradation of water quality affects women and children more directly. The surface water available in the numerous national and cross-border rivers is generally of such poor quality that the local populations do not consume it. The causes of the degradation of the quality of these waters are pollution linked to the erosion of river banks, mining and discharges from agricultural drainage water and domestic wastewater. The decline in water quality also affects groundwater. According to Liberia's national contribution to the MRU's TDA process, analyses carried out in the late 1980s on 150 wells showed that 80% of these wells had water that did not meet the quality standards for water intended for human consumption (TDA-LIB, 2021).

7.5.3.2. Access to forest resources

Women are highly active in the exploitation of forest products, forest flora (wood, fruits, leaves, etc.) and fauna for the needs of domestic consumption and as a source of monetary income. Women are therefore the first victims of the decline of forests (when converted to savannah or crops), the degradation of plant cover and the decline in the diversity of forest species and fauna. But women do not always remain inactive in the face of the regression of forests: in the Cavally basin, women are very involved in the development of community forests and thus participate in efforts to plant trees and promote agroforestry (TDA -LIB, 2021).
It should also be noted, however, that women sometimes engage in productive practices that contribute to forest degradation. This is the case in the Scarcies estuary where women use mangrove wood to smoke fish. This practice added to the conversion of estuarine land into rice fields has strongly contributed to the degradation of mangrove forests in the lower valley and the delta of the Scarcies (TDA-SL, 2000).

7.5.3.3. Women’s increased rôle in agricultire – processing of continuing feminisation of the farming sector

While the countryside is becoming increasingly depopulated of the young male population who tend to emigrate to the cities and to mining areas, agriculture (all forms combined) and animal husbandry rely more on women than men. The role of women in agriculture in the MRU space is even more visible in rice cultivation and market gardening. In the Moa-Makona basin, rice cultivation in the lowlands and floodplains, which occupies large areas, is mainly practiced by women. This is for example the case in Lofa County (Foya and Kolahun Districts) in the Liberian part of the basin. Family farmers have increasingly diversified their production systems there by engaging in the cultivation of coffee and cocoa since the 1980s (TDA-LIB, 2021). Women are also increasingly involved in other segments of the agricultural value chain. In the Sierra Leonean part, Kailahun District, the majority of women are active in the trade of agricultural products but also of non-agricultural products (World Bank, 1982).
With regard to livestock, women play a central role in the processing of dairy products and their marketing. For this reason, the decline in vegetation cover and the degradation of pastures directly affect women's incomes.

7.5.3.4. Women’s prominent roles in all segments of the fishing value chain

Women play a leading role in fishing activities. They generally have primary responsibility for freshwater fishing. For example in the Scarcies basins, they target streams, marshes and floodplains during the high

water period, using hollow nets or dip nets or even fish traps. In the dry season, inland fishing activity is reduced, consisting of women extracting fish from the lowlands that have not dried up. Young boys are also involved in freshwater fishing often during the rainy season, mainly angling with hooks (Sanko et al. 2018). As is the case in the Cavally basin (Ivorian part), they are also heavily involved in post-harvest activities (smoking, fish marketing, etc. (UEMOA, 2013).
In Sierra Leone, women are at the center of all stages of fish production in the fisheries sector, providing loans to fishermen. They also own pirogues and fishing boats, and run formal and informal fish processing enterprises. They also often dominate fish marketing (as wholesalers and retailers). They support fishing communities by providing them with the necessary logistics to catch fish. They therefore deserve their nickname of "Fish Mammies of Sierra Leone" (Thorpe et al. 2014).
Although they do not entirely control it, women in MRU basins are very active in aquaculture. Of the 2,087 ponds identified by USAID in 2018 in the Bombali Districts (middle basin of Little Scarcies), nearly 20% of these ponds were operated by women (Sankoh et al. 2018).

7.5.3.5. Gender dimension in mining activities

At the continental scale, Yoboué citing other sources, estimates that there would be between 4.5 and 6 million workers (including 30 to 40% women) engaged in artisanal mining (Yoboué, 2017) . There is a fairly clear gendered division of labor in gold mining. Men are typically in charge of digging and removing the ore from the pit and crushing the ore. Women and children are responsible for collecting water and washing the crushed powder to remove the gold. Gold panning is a labor-intensive activity involving all age groups and genders (UN-Environment, 2019; TDA-SL, 2020).

7.5.3.6. Implications

Due to their strong involvement in the exploitation of basin resources, women are most affected, often disproportionately, by the degradation of these resources. To improve consideration to the gender dimension of the challenges of managing environmental problems in MRU basins, it is or primary importance to fill the information gap. The unavailability of quality gender-disaggregated data prevents a rigorous diagnosis of the gender-differentiated impacts of changes in the environment of the MRU space and makes it difficult to formulate relevant targeted responses.

With a view to empowering women and improving their access to basin resources and greater participation in the governance of these resources, the MRU, within the framework of the SAP but also in its other programs, could rely on the emerging international standards in the field. Among others, we can mention the ECOWAS's Supplementary Act on equal rights between women and men for sustainable development. Under this Act, adopted in 2015, ECOWAS Member States undertake to adopt measures aimed at the equitable participation of women and men in environmental and natural resource management bodies and to take necessary actions to ensure women's equitable access to land ownership rights and better control of land resources. They are also committed to facilitating the presence of women in the value chains of the mining sector.

7.6. Causality and Impact Matrix

7.6.1. Degradation of Water Quality

Manifestations	Direct/intermediate causes	Root Causes	Consequences/impacts	Solutions Options
• Absence/scarcity of data • Indications/testimonials attesting to degradation of surface water quality in different locations in the target basins • Surface water turbidity • Results of microbiological analyzes (La Mancha): worrying deterioration in the quality of surface and ground waters of Cavally • Cavally water quality below WHO standards (La Mancha) • Local populations (Moa-Makona, Cavally) deplore the contamination of surface water (pesticides, chemical fertilizers) • Deterioration of water quality in various places, following land degradation	• Disposal of domestic wastes on water bodies; • Lack of proper sanitation systems • Agriculture: drainage to the river of contaminated drainage water from irrigated agriculture and plantations (chemical fertilizers, pesticides) • Mines: earth excavation, soil erosion and accumulation of ore residues • Mines: use of mercury or cyanide in the amalgamation and leaching process; • Mines: water for washing, ore settling ⇒ large quantities of muddy and contaminated water • Mines: Mercury, cyanide, etc. in waste rock and ore tailings contaminate ground and surface water • Sand and stone mining : increase in water sediment laod and turbidity • Forest: deforestation, soil erosion	• Low level of knowledge of water quality • Lack of education and awareness • Deficiencies in national legal and institutional frameworks or in their practical effectiveness • Low level of harmonization of water quality standards and governance frameworks • Low level of transboundary cooperation • Poverty, lack of alternative to unsustainable practices (minières, agricoles, etc.)	• Decrease of level of access to potable drinking water • Loss of fauna and flora habitats; • Degradation of ecosystems with impacts on animal and human health • Degradation of agricultural land productivity • Impacts on fish fauna; declining land productivity; degradation of animal health ⇒ negative impacts on people's livelihoods • Negative impacts on livelihoods (agriculture, fishing, forestery) • Disproportionate negaive impacts on women	• Mines: better supervision of small-scale and/or artisanal mining activities • Mines: Information and awareness-raising activities targeting stakeholders in artisanal and small-scale mining • Mines: Better management of waste rock to prevent contamination of water and ecosystems by mercury or cyanide • Mines: Better water quality monitoring in and around mining sites • Agriculture: Promote agroforestry • Agriculture Adopt and ensure alignment with agricultural drainage norms that are hamonised at MRU scale • Governance framework: Encourage agro-business membership (oil palm) in RSPO • Governance framework: support to States to operationalize: Stockholm Convention on Persistent Organic Pollutants; Minamata Convention on Mercury; relevant provisions in in the New York Watercourse Convention (1997) and Helsinki the Water Convention (1992) • Education and sensitisation campaigns in collaboration with cil soeciety organisations Apply the polluter-pays principle at national and transboundary levels

7.6.2 . Deforestation

Manifestations	Direct/Intermediate Causes	Root Causes	Consequences/Impacts	Solution Options
• Intense process of deforestation (loss of 64% forest cover in 30 years • Decline of primary forests in favor of agriculture • Degradation of the state of existing forests: primary forests only ¼ of Sierra Leone's forests • 40% decline in mangrove forests in Scarcies estuaries • Increasingly rapid rate of deforestation	• Logging (industrial exploitation) • Wood cutting (timber, firewood, charcoal) • Expansion of agricultural frontier (coffee-cocoa plantations) • Expansion of agro-industrial land • Large-scale practices of extensive agricultura (with extensive slash-and-burn agriculture) • Industrial and artisanal mining • Bushfires (linked to agriculture, livestock, hunting, etc.) • Expansion of land used for infrastructures (roads, transmission lines, etc.) • Fish, seafood smoking poissons (using wood from mangrove trees)	• Population increases • Increase in rural population densities • Declining fertility of agricultural land • Influx of immigrants in search of livelihoods • Poverty • Lack of jobs for young people • Weaknesses in the implementation of codes and regulations related forest exploitation and management • Expansion of urban areas and human settlements in rural areas • Loss of biodiversity • Weaknesses in the governance of forests	• Loss of fauna and flora habitats • Disappearance/shrinkage of ecosystems constituting the refuge of threatened species • Acceleration of erosion, gullying • Alteration of the water cycle • Soil erosion and accelerated siltation of rivers • Modification of hydrological regimes of rivers • Declining soil fertility • Declining/loss of species used for pharmacopoeiaReduced capacity of forests to retain water • Decline in water quality • Decreased availability of non-timber forest products • Negative impacts on pharmacopoeia, health • Negative impacts on the food and nutritional security of populations • Negative impacts on people's incomes • Contribution to global warming	• Identification / classification in protected areas of primary forests and valuable ecosystems • Reforestation of deforested areas • Implementation of reforestation/compensatory reforestation programs for lost forests • Restoration of degraded forests, through reforestation or natural regeneration • Rigorous regulation of forest exploitation • Rigorous supervision to ensure compliance with the conditions for granting logging permits • Promotion of intensive agriculture (irrigation, agroforestry, use of fertilizers, etc.) • Supervision of mining activities by preserving protected areas, primary forests and forest ecosystems of special interest • Promotion of mining practices that minimize deforestation and ensure the rehabilitation of mining sites • Promotion of employment and income generating activities as alternatives to unsustainable exploitation of forests and informal and clandestine mining • Organisation of joint inter-state patrols in the framework of existing transboundary cooperation • Involvement of local communities in decision-making

7.6.3. Loss of Biodiversity

Manifestations	Direct Causes/Intermediaires	Root Causes	Consequences/Impacts	Solutions Options
• Gaps in knowledge on ichthyology • Decline in fish catches, which may result from the decline in fish stocks in the waterways • Mount Nimba Reserve (Cavally between Guinea and Cote d'Ivoire) inscribed in 1992 on the List of World Heritage in Danger • Bossou Hills (Upper Cavally) damaged: risk to Bossou chimpanzee survival • Loss of ½ of the primary forest of Nimba East Nature Reserve (Cavally, Liberia) • Limited knowledge of avifauna • Protected areas and wetlands, often degraded, habitats and seasonal transit points for migratory birds	• Declining water quality (surface water in particular) • Acceleration of deforestation, including in protected areas • Modification of aquatic ecosystem habitats • Modification of forest ecosystem habitats • Soil erosion • Unsuitable agricultural practices: use of chemical fertilizers and pesticides without adequate drainage; • Acceleration of deforestation, including in protected areas • Agricultural land expansion (extensive agriculture) leading to forest conversion • Rice cultivation expansion leading to mangrove conversion • Expansion of plantations ➔ conversion of primary forests • Mines: land degradation, deforestation, pollution ➔ loss of biodiversity • Poaching and illegal trade in species and fauna and flora products • Logging (industrial; timber, fuelwood) • Bush fires • Roads, opening up	• Population growth • Urbanization • Political instability, civil wars, insecurity • Failures in environmental governance framework • Low level of transboundary cooperation in environmental management, biodiversity • Deficiencies in the environmental protection provision • Non-enforcement of the legal and regulatory framework • Low level of operationalization and implementation of international conventions related to biodiversity • Climate change and variability	• General deterioration of the conservation status of fauna and flora in the Guinean Forests Hotspot of West Africa • Low resilience of ecosystems resulting in reduced capacity for reconstitution, regeneration in the face of shocks including climate change • Degradation of food and nutritional security, following the disappearance, depletion of biodiversity • Loss of income (of women) linked to the exploitation of animal plant species), contributing to poverty and emigration • Negative impact on the health of human and animal populations (impacts on pharmacopoeia, pharmaceutical industry, nutritional status of populations)	• Identification and classification in protected areas of ecosystems sheltering rich biodiversity or forming part of the last refuges for rare or threatened species • Formulate and implement credible management plans for existing and newly created protected areas • Identification of wetlands and study of their ecological functions, including for avian fauna • Listing of Ramsar sites of wetlands which have or may have international importance from an ecological, economic, cultural and scientific point of view • Update the list of threatened species (that are part of the IUCN Red List) • Domesticate and implement the provisions of the CITES Convention at the national and MRU levels • Carry out study on ichthyology in target transboundary river basins • Harmonize inland fishing regulations in the MRU area • Encourage private stakeholders to join a network promoting good resource management practices (eg RSPO for oil palm cultivation promoters) • Set up an early warning system against the introduction and proliferation of invasive species • Identify and classify some of the transboundary basins as "intact rivers" from an ecological point of view (basins to be spared from major projects that could modify their ecosystems (e.g. dam projects)

7.6.4. Erosion / Degradation of Land, rive vanks and head sources

Manifestations	Direct Causes/intermediaires	Root Cause	Consequences/impacts	Solution Options
• Any MRU space and in particular MRU target basins facing land degradation • High level of land degradation in active or former mining sites • areas of extensive rainfed slash-and-burn agriculture highly exposed to erosion • Loss of plant/tree cover • Acceleration accumulation of sediment load and water turidity • Erosion of river banaks • Headwaters of rivers and tributaries sometimes severely degraded	• Extensive agriculture: shortening of fallow periods • Agriculture: widespread practices of slash-and-burn • Advance of the agricultural front (clearing of new land) • Extensive farming, overgrazing • Timber logging (industrial exploitation, timber and wood energy for local consumption • Deforestation and reduction in soil water retention capacity ➔increased water runoff • Mines: erosion, degradation of banks • Bush fires	• Rapid increase in urban and rural population, leading to increase in population densities and hence to an increase in agricultural land area requirements • Increase in livestock numbers • Low level of supervision, use and management of resources (agriculture) • Low level of supervision and governance of mining activity • Land tenure insecurity • Weaknesses in the governance framework for natural resources (water, forests, mines, fishing, etc.) • Climate change	• Destruction of habitats for fauna and flora, of high value ecosystems. • Decline in primary and agricultural land productivity negatively affecting people's food security. • Water pollution, increase in their solid load. • Increased flood risk • Decreased soil water retention capacity, resulting in lower land productivity • Increased risk of conflicts between riparian states; between communities	• Promotion of agroforestry as an alternative to extensive slash-and-burn agriculture • Mapping and study inventory of transboundary river springs • Development and implementation of restoration and rehabilitation plans for the most degraded source heads • Identification and mapping of the banks most exposed to erosion and implementation of a bank restoration and stabilization plan • Activities of reforestation, reforestation and regeneration of the soils most exposed to erosion • Promotion of soil and water management techniques (bunds, stone barriers, hillside dams) on degraded land on the sides of mountains and hills and plateaus • Encourage and support land reform processes aimed at improving the tenure of land and natural resources • Improve the governance of the mining sector at the level of the MRU and of each member country • Promote renewable energies, as alternative to the use of firewood and charcoal

7.6.5. Cross-cutting themes

	CLIMATE CHANGE					RESOURCE USE CONFLICTS			GENDER DIMENSIONS					GOVERNANCE FRAMEWORK	
Manifestation	Projected temperature increase Sea-level rise projection Uncertainties in climate predictions Highest frequency/amplitude extreme events Uncertainties in climate predictions, especially regarding rainfall and river discharge					Uncertainties regarding inter-state border lines Tensions/disputes between States Tensions between neighboring communities Sub-optimal use of resources in hot spots (zones of tension)			Gaps on gender-disaggregated information Leading role of women in the management and use of resources: water, forests, agriculture, mines Disproportionate impacts of resource degradation on women					Anarchy (impression of absence of regulation) in several sectors (mining in particular). The ten transboundary rivers of the MRU space have no river basin organizations National legal and institutional framework relating to the governance of resources often very extensive Ratification by MRU States of most major international and regional conventions on the environment and on water Low level of operationalization and effectiveness of national laws and ratified conventions	
Effects on/interactions with PTEP	Gaps to fill on climate projections	Rise in temperature=> loss of biodiversity, water quality	Climate change ➔ Deforestation	Climate change ➔ erosion, land degradation	Extreme events ➔ vulnerability of production systems	Risks of conflicts over borders are also conflicts over the use of resources in coveted areas	Absence of dialogue and consultation around shared waters	Coveted areas not or little exploited (fishing, forests, mines)	Women disproportionately affected by degraded water quality	Women severely affected by deforestation (firewood, exploitation of non-timber products, etc.)	Impacts of the decline in biodiversity unequally distributed according to	Impacts of erosion and land degradation highly differentiated according to	Low availability of gender-disaggregated data for the different PTEPs	National natural resource management laws, institutions often below emerging international and regional standards	Lack of harmonization of the legal frameworks of the UFN countries in areas such as: water quality, biodiversity, deforestation, land degradation, climate change, change, transboundary waters

	CLIMATE CHANGE	RESOURCE USE CONFLICTS	GENDER DIMENSIONS	GOVERNANCE FRAMEWORK
Options de réponses	• Undertake study of climate change scenarios in MRU space or target basins • Carry out vulnerability analysis studies to climate change in target basins • Invest in basic water control infrastructure works • Promote irrigated agriculture • Develop and implement resilience building program • Ensure the effective implementation of NAPAs at the national level	• Undertake a study on the identification of areas at risk of transboundary conflicts • Strengthen the capacities of the MRU in the prevention and resolution of transboundary conflicts relating to the use of resources • Promote hydro-diplomacy on the scale of the MRU space • Promote common (jointly owned) major inter-state hydraulic and hydroelectric projects • Promote benefit sharing approach across the MRU and future inter-state investment projects • Organization of information, awareness-raising and capacity development activities on international conventions relating to water: Stockholm 1992, New York 1997, ECOWAS-2014 on hydraulic structures, etc.	• Ensure consideration of the need for disaggregated data collection in MRU and member country programs • Initiate development programs targeting women and the youth: income-generating activities; aquaculture; small-scale irrigation/market gardening; sustainable use of non-timber forest products • Initiate non-renewable energy projects (substitution for firewood) • Information and sensitization activities targeting women in sectors such as: small-scale/artisanal mining; prevention and management of waterborne diseases.	• Support for upgrading of national frameworks with emerging international and regional standards • Support for the ratification of international and regional conventions (Stockholm 1992; New York 1997) • Assistance in the harmonization of key legal provisions such as: water quality, deforestation, loss of biodiversity, land degradation, transboundary waters • Information/sensitization capacity building on emerging natural resource governance frameworks • Establishment of a basin organization at MRU scale • Establishment of an observation of the environmental at MRU scale

GENERAL CONCLUSIONS

The TDA of three MRU target basins - namely the Scaarcies complex (Kaba and Kolente), Moa-Makona and Cavally - showed that these basins have great similarities, both from the point of view of general physiognomy only from the point of view of the major challenges with which these basins are confronted. Given the geographic layout of the target basins in MRU space – one basin in the extreme west (Scarcies complex), one in the center (Moa-Makona) and one in the extreme east (Cavally) – it can be assumed that the six other small and medium-sized transboundary basins in the MRU space [26] have common biogeographical characteristics and face the same issues of use, management, protection and governance of natural resources. This is important because the target basins can then be assimilated to a broadly representative sample of the MRU transboundary basins. Consequently, the diagnosis made in the present TDA, the problems identified, their causes and the options for remedies can be considered as being relevant for the other basins of the MRU space.

The MRU has identified the following priority environmental issues: (1) Degradation of water quality; (2) Deforestation and deforestation; (3) Loss of biodiversity; (4) Erosion / degradation of land, banks and spring heads. In addition to these problems, there are four cross-cutting issues of great importance: (a) the risk of conflicts over the use of resource(of shared waters in particular); (b) climate change and its consequences on resources; (c) ignorance or insufficient consideration of the gender dimension in efforts to conserve and sustainably use the resources of the MRU space; (d) weaknesses related to the resource governance framework at the level of Member States and the MRU space.

The causal chain analysis highlighted that unsustainable industrial and artisanal mining practices are by far the most devastating factor for the water resources and environment of the MRU space, while the economic fallout of the mining sector are well below expectations. The dominant forms of agricultural practices also contribute greatly to the degradation of the environment of the basins of the MRU space, with in particular extensive slash-and-burn agriculture, the conversion of vast areas of primary forest into plantations, the use of large quantities chemical fertilizers and pesticides, poor agricultural land drainage systems, etc. To these factors are added the large-scale exploitation of wood, unsuitable fishing techniques, etc.

Faced with these challenges, the TDA recommends options for solutions which must be the subject of more in-depth examination during the formulation phase of the Strategic Action Plan (SAP). Among these response options, we can mention: the urgency of a common initiative to improve and guide mining practices in the MRU space; the identification and protection of residual primary forests and sensitive ecosystems for biodiversity in the MRU space; the promotion of sustainable agricultural practices concerned with the preservation of land productivity, water quality and the health of ecosystems in and around cultivation areas.

Cross-cutting measures are also important to consider. Among these measures, we can mention the need for working for the improvement of the framework of governance of natural resources at the level of the MRU and the member countries by taking into account the relevant international and sub-regional (ECOWAS) standards. To fight against the unsustainable practices of exploitation of the resources of the basin (agriculture, mines), substantial efforts must be made to offer alternative sources of income to the populations of the MRU space. In this context, particular attention must be paid to the gender dimension

[26] These are the following transboundary basins: St. John, St. Paul, Loffa, Mano-Morro, Cestos/Nuon, Sassandra

and in particular to the empowerment of women in the decision-making bodies that concern them and the sectors in which they are involved. There is also a need to strengthen resilience in the face of climate risks, in particular through the diversification of livelihoods and the construction of structuring infrastructure for water control. The MRU must also take seriously the need to anticipate and prevent the risk of conflicts around common resources, and in particular the border parts of shared waterways.

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ANNEX . LIST OF ENDANGERED SPECIES IN THE MRU TDA FOCUS BASINS (NOT EXCHAUSTIVE)

Annex a. Animal species

Common name ENG/FR/Local	Latin name	Category of threat (*)	Basin found	Type of ecosystem
ENG: African Forest Elephant	*Loxodonta cyclotis*	CE	Scarcies Cavalla	Sierra-Leonian part GKNP (LIB)
ENG/FR: Leopard	*Panthera pardus*	VU	Scarcies, Cavally	Sierra-Leonian part; N'zo wildlife reserve (RCI) GKNP (LIB)
ENG/FR: Lion	*Panthera leo*	VU	Scarcies	Sierra-Leonian part
ENG: African Buffalo	*Syncerus caffer*	NT (Near Threatened_	Scarcies	Sierra-Leonian part
ENG: Chimpanzee	*Pan troglodytes*	EN	Scarcies	Sierra-Leonian part" Outamba Kilimi Park
ENG: Pygmy Hippopotamus	*Choeropsis liberiensis*	EN	Scarcies Cavalla	Watercourses/Sierra-Leonian part N;Zo Wildlife Reserve (RCI) SNP (LIB)
ENG: African Manatee FR: Lamantin	*Trichechus senegalensis*	VU	Scarcies	Watercourses / Sierra-Leonian part
ENG: Western Red Colobus (Monkey_	*Piliocolobus badius*	EN	Scarcies	Sierra-Leonian part / Outamba Kilimi Park
ENG : Lesser African Threadfin [fish]	*Galeoides decadactylus*	NT	Scarcies	
ENG: Sea turtle FR: Tortue de mer Caouanne	*Caretta caretta*	VU	Scarcies	
FR: Tortue verte	*Chelonia mydas*	EN	Scarcies	
	Eretmochelys imbricata	CE	Scarcies	
Defassa Waterbuck	Kobus ellipsiprymnus ssp. defassa	NT	Scarcies	
Gola Malimbe FR : Malimbe de Gola	*Malimbus ballmanni*	NT	Moa-Makona	Gola National Park (SL)
White-necked Rockfowl	*Picathartes gymnocephalus*	VU	Moa-Makona	Gola National Park (SL)
White-breasted Guineafowl	*Agelastes meleagrides*	VU	Moa-Makona	Gola National Park (SL)

Common name ENG/FR/Local	Latin name	Category of threat (*)	Basin found	Type of ecosystem
Forest elephant	*Loxodonta cyclotis*	CE	Moa-Makona	Gola National Park (SL)
Pygmy Hippopotamus	*Choeropsis liberiensis*	EN	Moa-Makona Cavalla	Gola National Park (SL) GKNP
West African chimpanzee	*Pan troglodytes verus*	EN	Moa-Makona	Gola National Park (SL)
Jentink's duiker	*Cephalophus jentinki*	EN	Moa-Makona Cavalla	Gola National Park (SL) SzNP (LIB)
Zebra duiker	*Cephalophus zebra*	VU	Moa-Makona, Cavalla	Gola National Park (SL) SNP (LIB)
Liberian mongoose	*Liberiictis kuhni*	VU	Moa-Makona	Gola National Park (SL)
Diana or Captain monkey	*Cercopithecus diana*	EN	Moa-Makona Cavally	Gola National Park (SL)
Sooty Mangabey FR: Singe vert Mangabe	*Cercocebus atys*	VU	Moa-Makona	Gola National Park (SL) GKNP (LIB)
African forest Buffalo ; Buffle nain	*Syncerus caffer nanus*	NT	Moa-Makona Cavalla	Gola National Park (SL) N'Zo Wildlife reserve (RCI)
Mount Nimba Viviparous Toad	*Nectophrynoides occidentalis or Nimbaphrynoides occidentalis*	CE	Cavalla	Mount Nimba Strict Nature Reserve (Guinea, Cote d'Ivoire); Nimba-East Nature Reserve (Liberia)
ENG: Nimba otter shrew FR: Micropotamogale de Lamotte	*Micropotamogale lamottei*	VU	Cavalla	Mount Nimba strict Nature Reserve (Guinea/CI); Nimba-East Nature Reserve (Liberia)
ENG: Chimpanzee of Bossou FR: Chimpanze de Bossou (Nimba	*Pan troglodytes verus*	CE	Cavalla	Collines de Bossou Forest Reserve (Guinea)
White-bellied Pangolin	*Phataginus tricuspis*	EN	Cavalla	
FR: Buffle nain	*Syncerus caffer nanus*	CE	Cavalla	Mount Nimba strict Nature Reserve
ENG: Chimpanzee FR: Chimpanzé	*Pan troglodytes verus*	EN	Cavalla	Nimba-East Nature Reserve (Liberia), Réserve de faune du N'zo
ENG: Zebra duiker FR: Céphalophe zébré	*Cephalophus zebra*	VU	Cavalla	PNT (Parc National Tai), RCI
ENG: Jentink's duiker FR : Céphalophe de Jentink	*Cephalophus jentiki*	EN	Cavalla	PNT (Parc National Tai), RCI
ENG: Olive Colobus	*Procolobus verus*	VU	Cavalla	PNT (Parc National Tai), RCI

Common name ENG/FR/Local	Latin name	Category of threat (*)	Basin found	Type of ecosystem
FR: Colobe de Van Beneden				
ENG: Mona Monkey FR: Cercopithèques Mone	*Cercopithecus mona*	NT	Cavalla	PNT (Parc National Tai), RCI
Diana Monkey	*Cercopithecus diana*	EN	Cavalla	PNT (Parc National Tai), RCI
ENG: Spot-nosed Monkey FR: Pétauriste	*Cercopithecus petaurista buettikoferi*	NT	Cavalla	PNT (Parc National Tai), RCI
ENG: Red-capped Mangabey FR: Cercocèbe fuligineux / Mangabey fuligineux	*Cercocebus torquatus*	EN	Cavalla	PNT (Parc National Tai), RCI
Western black-and-white colobus; FR : Colobe noir et blanc d'Afrique occidentale	*Colobus polykomos*	EN	Cavalla	
Western Red Colobus FR: Colobe bai	*Piliocolobus badius*	EN	Cavalla, GKNP	PNT, Réserve de faune du N'zo, RCI
Rufous Fishing-owl FR: Chouette-pêcheuse rousse	Scotopelia ussheri	VU	Cavalla	PNT (Parc National Tai), RCI
White-breasted Guineafowl FR: Pintade à poitrine blanche	*Agelastes meleagrides*	VU	Cavalla	PNT (Parc National Tai), RCI
ENG: Western Wattled Cuckooshrike FR: Echenilleur à barbillons	*Lobotos lobatus*	VU	Cavalla	PNT (Parc National Tai), RCI
Yellow-bearded Greenbul FR: Bulbul à barbe jaune	*Criniger olivaceus*	VU	Cavalla	PNT (Parc National Tai), RCI
Green-tailed Bristlebill FR: Bulbul à queue verte	*Bleda eximius*	NT	Cavalla	PNT (Parc National Tai), RCI
White-necked Rockfowl FR : Picatharte chauve de Guinée	*Picathartes gymnocephalus*	VU	Cavalla	PNT (Parc National Tai), RCI
Nimba Flycatcher FR : Gobemouche du Nimba	*Melaenornis annamarulae*	VU	Cavalla	PNT (Parc National Tai), RCI
ENG : Hippopotamus FR : Hippopotame amphibie	*Hippopotamus amphibius*	VU		N'zo Partial Fauna Reserve, RCI
Bay Duiker FR: Céphalophe à bande dorsale	Cephalophus dorsalis	NT	Cavalla	SNP (LIB)

Source: IUCN List of threatened species: https://www.iucnredlist.org/

Nora: (*) = Critically Endangered (**CE**), Endangered (**EN**), and Vulnerable (**VU**); **NT**=Near Threatened; **NL**=Not Listed

Annex b. Plant Species

Common name ENG/FR/Local	Latin name	Category of threat(*)	Basin found	Location/Type of ecosystem
Veen	*Pterocarpus erinaceus*	EN	Scarcies	
	Afzelia africana	VU	Scarcies	
Iroko	*Milicia regia*	VU	Scarcies	
	Mitragyna stipulosa	NT	Scarcies	
Local/Common: Iroko	*Milicia excelsa*	NT	Moa-Makona	
Local/Common: Kosso	*Pterocarpus erinaceus*	EN	Moa-Makona	
ENG: African mahogany Local: afzelia; doussi	*Afzelia africana*	VU	Moa-Makona	
FR/ENG: Etimoe Local: Salikunda; Koumara	*Copaifera salikounda*	VU	Moa-Makona	
Local/Common: Avodiré Autre: Apeya	*Turraeanthus africana*	VU	Cavalla	Dense Evergreen Humid Forests
Local: Kotibé [Attié]	*Nesogordonia papaverifera*	VU	Cavalla	
African mahogany [Acajou d'Afrique]	*Khaya ivorensis*	VU	Cavalla	
Local: Bahia [Agni]	*Mitragyna ledermannii*	NT	Cavalla	Swamp Forests
	Gilbertiodendron splendidum	VU	Cavalla	Swamp Forests