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Proposed Strategies for Optimizing the Environmental and Social Management of OMVS Hydropower Facilities during the Operational Phase through Results-Based Management (RBM)

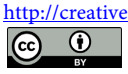
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Abstract

This study aims to propose environmental and social management strategies for the operational phase of the OMVS's hydroelectric structures and facilities. Thus, based on the mitigation and mitigation measures proposed during the analysis of significant environmental aspects and impacts, nine (9) environmental management programs (EMPs) have been proposed which are directly linked to the Sustainable Development Goals (SDGs) and the aspirations, objectives and priority areas of the African Union's Agenda 2063. The methodology applied to each program is the results-based management (RBM) approach. However, as the study is conceptual and forward-looking in nature, it does not report on implementation results, nor does it demonstrate that the proposed EMPs have already produced organizational, environmental or social effects. For each EMP, a logical framework is determined, considering the activities, the immediate results called "outputs," the change noted as "effect," and the final results called "objectives," which are correlated with the EMPs.

Keywords

Environmental Management Program, Results-Based Management (RBM), Objectives, Effects, Outputs, Activities

1. Introduction

The construction and operation of hydroelectric facilities along rivers have several advantages, but also disadvantages for the physical, natural, and human environ-

ments. As part of the management of the Senegal River by the Organization for the Development of the Senegal River (OMVS), several dams have been built, and others are in the planning stage (Faye, 2024).

Since 1968, the climate has been marked by repeated droughts, which worsened in the 1970s and 1980s. The flow rates of rivers crossing the Sahelian zone were then greatly reduced. Lakes also reached their lowest levels, with some even drying up. Naturally, infrastructure development remains undoubtedly the best human response to variations in flow (abundance or scarcity of water resources) (Dione, 1996). In response to the drought of the 1970s, Mali, Mauritania, and Senegal created the Organization for the Development of the Senegal River (OMVS) in Nouakchott in March 1972, which launched an ambitious program of investment in infrastructure to control the waters of the Senegal River. This led to the construction of the Manantali and Diama dams, respectively, to regulate the river's level (flood control and low water support) and prevent the rise of saltwater (Severino & Naudet, 2009). The construction of the Manantali hydroelectric power plant (1998) also helped develop the hydroelectric potential of member states, complemented by the Gouina (2022) and Félou (2013) hydroelectric developments.

All dam projects have been subject to numerous impact studies, particularly the Manantali project, whose impact and pre-investment studies between 1960 and 1970 were funded by the United Nations Development Program (UNDP) and carried out by the Senegal-Consult group (Cisse, 2016).

The impact studies for the construction of the Manantali dam were carried out in accordance with the National Environmental Protection Act (NEPA), following the basic approaches defined in paragraph 1500.8 of the 1973 Guidelines, Preparation of Environmental Impact Statements (CEQ, 1973).

Based on the data collected in the literature review, the environmental impacts during the pre-construction and construction phases were identified and assessed using a matrix of interrelationships between the project's impact sources and the valued components of the environment (physical, biological, and human). Most of the mitigation measures were implemented, but those relating to the operational phase should be better planned to ensure proper control of environmental impact aspects (Leopold, Clarke, Hanshaw, & Balsley, 1971; Leduc & Raymond, 2000).

With the absence of real environmental management strategies in the operational phase of hydroelectric facilities, the analysis of data collected as part of the management of significant environmental aspects and impacts according to ISO 14001:2015 (AFNOR, 2015), during the operational phase, maintenance of facilities and OMVS hydroelectric installations (Faye, Ndao, & Sambou, 2024b), highlights the urgent need to develop and implement environmental management strategies to minimize the environmental impacts of activities related to the operation of hydroelectric facilities.

The aim of this study is to develop and document a proposed environmental and social management framework for the operational phase of the OMVS's hy-

droelectric schemes. This framework is based on the significant environmental aspects identified in the Manantali operational assessment (Faye, Ndao, & Sambou, 2024b), the analysis of changes in the physico-chemical quality of the water since the dam was filled (Faye, Ndao, & Sambou, 2023), the analysis of trends in biological water quality (Faye, Ndao, & Sambou, 2024c) and the comparative study of water quality upstream and downstream of the dam (Faye, Ndao, & Sambou, 2024a), and translates the associated mitigation and management needs into nine proposed Environmental Management Programs (EMPs) directly linked to the Sustainable Development Goals (SDGs) and the objectives of the African Union's Agenda 2063, in line with a Results-Based Management (RBM) approach. The study should be viewed as an exercise in proposal and design rather than as an evaluation of programmes that have already been implemented: no causal claims are made to the effect that the proposed SMEs have already produced organisational, environmental or social impacts.

2. Materials and Methods

2.1. Study Area

Located on the Bafing River 90 km southeast of Bafoulabé, in the Kayes region of Mali, the Manantali Dam was designed to control flooding while providing a water reserve to ensure the stability of various economic activities, such as water supply, irrigation, flood recession agriculture, hydroelectric power generation, and river navigation. Controlling approximately 50% of the upstream watershed of the Senegal River, the dam has a storage capacity of nearly 12 billion cubic meters. The dam is equipped with a hydroelectric power plant comprising five units and was commissioned between 2001 and 2002. The dam has a total crest length of 1,495 m and consists of a concrete structure that houses the hydraulic structures (spillway, bottom outlets, surge basin, and water intakes), as well as two side dikes. The plant is equipped with five units of 40 MW each, giving an installed capacity of 200 MW, with an expected average annual production of around 807 GWh, corresponding to a load factor of 46% (Faye, Ndao, & Sambou, 2024b).

The high-voltage (HV) transmission network, known as the "Manantali Interconnected Network" (RIMA), connects Mali, Mauritania, and Senegal. It is powered by the Manantali, Gouïna, and Félou hydroelectric power plants and comprises (CIMA, 2017): High-voltage lines: a total of 2312 km distributed as follows: 2055 km of 225 kV lines; 22 km of 150 kV lines; 235 km of 90 kV lines. There are 18 transformer stations distributed as follows: 6 stations in Mauritania (Rosso, Nouakchott, Boghé, Kaédi, Sélibaby, and Gouraye); 6 substations in Senegal (Tobène, Sakal, Dagana, Matam, Bakel, and Tambacounda); 6 substations in Mali (Manantali, Kita, Kodialani, Félou, Kayes Médine, and Gouina). In addition, there are fiber optic backup cables and a dispatching center in Manantali. The RIMA and the electricity networks of the National Electricity Companies of Mali, Mauritania, and Senegal constitute the OMVS Interconnected Network (RIO) (Faye, Ndao, & Sambou, 2024b).

2.2. Methods

The operation of hydroelectric facilities has an impact on the local and regional environment, raising important ecological, social, and economic issues. These issues translate into positive and negative impacts (Treabaol & Chabal, 2003).

The environmental analysis carried out during the operational phase of the Manantali hydroelectric facilities and structures identified 16 significant environmental aspects (SEAs), both positive and negative and for controlling all the SEAs, mitigation and/or mitigation measures are proposed. These SEAs were identified on the basis of environmental monitoring data (electromagnetic fields, noise levels, light levels, PM10, PM2.5, 1, etc.), a waste inventory, and the physico-chemical and biological analysis of water quality (Faye, Ndao, & Sambou, 2024b), and following an assessment of environmental impacts based on a three-level rating grid taking into account legal, environmental, economic and influence aspects (Faye, 2024). The grouping into nine environmental management categories (EMCs) is based on thematic similarity and management coherence: EAS relating to energy use and efficiency are grouped under EMC 1; waste under EMC 2; pollution/nuisances and living conditions under EMC 3; water resources and water quality under EMC 4; biodiversity under SME 5; soil and subsoil contamination under SME 6; health and safety under SME 7; climate-related risks and adaptation under SME 8; and cross-cutting compliance, monitoring and performance evaluation under SME 9.

These measures are inspired by the Sustainable Development Goals (SDGs) and the aspirations and goals of the African Union's Agenda 2063 and are formulated in Environmental Management Programs (EMPs). For the applicability of EMPs in all other hydroelectric facilities and structures to be built in the OMVS area and around the world for the operational phases, an RBM approach is applied.

RBM is based on a chronological intervention logic: activities are carried out using available resources and produce immediate results called "outputs (EX)" which enable the change noted as "effect (EF)" to be achieved using these "outputs (EX)". If the "effect (EF)" is achieved, it means that the intermediate results have been achieved. This, in turn, contributes to the achievement of the final results called "objectives," which are correlated with the EMPs. For each objective, objectively verifiable indicators (OVIs) are determined, and for each effect and output, OVIs, means of verification, and assumptions/risks have been determined (COTA, 2007).

3. Results and Discussions

3.1. Results

The operational assessment identified 16 significant environmental aspects (SEAs). Based on the mitigation and management measures associated with these SEAs, nine SMEs are proposed as a management framework. The selection of these nine

SMEs results from the grouping of management needs that are thematically similar and operationally consistent; it should not be interpreted as evidence that nine programs have already been implemented or that measurable results have already been achieved. Thus, the ranking of mitigation and/or management measures resulting from the SEA analysis has identified nine (9) EMPs, which are presented in Table 1. For each program, the corresponding SDGs and the aspirations, goals and priority areas of the African Union's Agenda 23 have been determined (Table 1).

The percentages defined at the IOV level in this study are target values, not outcomes; prior to implementation, each target must be associated with a baseline value.

Table 1. Environmental management programs (EMPs).

N°	Environmental Management Program (EMP)	SDG	Agenda 2063	
			Aspirations	Goals
EMP 1	Optimization of energy resources	7	1	7
EMP 2	Waste management	12	1	7
EMP 3	Pollution management and improvement of the living environment	1, 2, 4, 5, 7, 8	1, 6	1, 4, 5, 7, 17, 18
EMP 4	Water management	6	1	7
EMP 5	Biodiversity management	15	1	7
EMP 6	Combating soil pollution	15	1	5, 7
EMP 7	Health and safety management for stakeholders	3,8	1	1, 3
EMP 8	Adaptation to climate change	13	1	7
EMP 9	Monitoring environmental performance			

- **Optimization of Energy Resources**

Table 2 summarizes the relationships between the EMP, the SDGs, and the aspirations, goals, and priority areas of the African Union's Agenda 2063. For EMP 1, this is SDG 7; aspiration 1, goal 7, and the priority area associated with goal 7 of the African Union's Agenda 2063.

Table 2. Relationship between EMP 1, the SDGs, and the African Union's Agenda 2063.

		No	Title
Agenda 2030	**SDG**	7	Affordable and clean energy
Agenda 2063	**Aspiration**	1	A prosperous Africa, based on inclusive growth and sustainable development
	Goal	7	Economies and communities that are environmentally sustainable and resilient to climate change
	Priority area		Renewable energy

This EMP, which focuses on optimising energy resources, has the overall objective of optimising energy resources. To achieve this objective, two main outcomes have been identified:

1) EF 1.1: Electricity and fuel consumption are managed efficiently;

2) EF 1.2: The carbon footprint and CO_2 emissions are reduced.

To implement the desired changes (outcomes), three outputs are required:

1) EX 1.1.1: Local communities have access to energy and are made aware of the need for its rational management;

2) EX-1.1.2: The performance of equipment is periodically monitored and analysed through energy audits;

3) EX-1.2.1: Carbon offset programs and their monitoring mechanisms are implemented and evaluated.

To achieve these outputs, several activities have been identified, the implementation of which will ultimately optimise energy resources (Table 3).

Table 3. EMP: Optimization of energy resources.

	Intervention Logic	Objectively Verifiable Indicators	Verification Methods	Assumptions/ Risks
Objective 1	OBJ-1: Energy resources are optimized	80% of local communities have access to energy		
Outcomes (Effect)	EF-1.1: Electricity and fuel consumption is managed efficiently	Energy consumption has stabilized at 30%	Monitoring energy consumption Source: Environmental performance monitoring table	Energy data is reliable
	EF-1.2: The carbon footprint and CO_2 emissions have been reduced	CO_2 emissions have been reduced by 15%	Monitoring energy consumption Source: Environmental performance monitoring table	Emissions data is reliable
Outputs	EX-1.1.1: Local communities have access to energy and are made aware of the need for its rational management	Percentage of target groups with access to energy who are aware of the need for rational energy management	Monitoring of the awareness-raising schedule Source: Awareness-raising plan	The awareness-raising plan has been drawn up
	EX-1.1.2: The performance of equipment is periodically monitored and analyzed through energy audits	Percentage of the audit program completed	Monitoring of the audit program Source: Audit program	The equipment audit program is available
	EX-1.2.1: Carbon offset programs and their monitoring mechanisms are implemented and evaluated	Percentage of carbon offset program actions completed	Monitoring of the offset program Source: Awareness program	The carbon offset program is available
Activities	A1.1.1.1 Improve access for local communities to the hydroelectric power generated			
	A1.1.1.2 Raise awareness amongst local communities about the rational use of electricity			
	A1.1.2.1 Carry out energy audits			

Continued

A1.1.2.2 Monitor the performance of hydroelectric generation equipment
A1.2.1.1 Implement a carbon offset program by investing in reforestation projects and supporting initiatives to reduce CO_2 emissions
A1.2.1.2 Assess greenhouse gas emissions
A1.2.1.3 Set up monitoring systems to track CO_2 emissions in real time and identify sources of pollution
A1.2.1.4 Optimize the use of diesel vehicles and fuel consumption
A1.2.1.5 Promote collaboration tools that enable remote working
A1.2.1.6 Strengthen incentives for sustainable mobility
A1.2.1.7 Limit the use of HCFC-type refrigerants
A1.2.1.8 Install ventilation systems in power stations and high-risk areas
A1.2.1.9 Establish a system for the regular monitoring of air quality
A1.2.1.10 Select business partners based on their environmental commitments

- **Waste Management**

Table 4 summarizes the existing relationships between the EMP, the SDGs, and the aspirations, goals, and priority areas of the African Union's Agenda 2063. For EMP 2, this is SDG 12; aspiration 1, goal 7 and the priority area associated with goal 7 of the African Union's Agenda 2063.

Table 4. Relationship between the EMP 2, the SDGs, and the African Union's Agenda 2063.

		No	Title
Agenda 2030	**SDG**	12	Responsible consumption and production
Agenda 2063	**Aspiration**	1	A prosperous Africa, based on inclusive growth and sustainable development
	Goal	7	Economies and communities that are environmentally sustainable and resilient to climate change
	Priority area		Sustainable consumption and production patterns

This EMP, related to waste management, has the overall objective of ensuring that waste is managed in an environmentally sound manner in order to limit pollution. To achieve this objective, two (2) main effects have been identified:

1) EF-2.1: Waste production is significantly reduced;

2) EF-2.2: Waste recycling/recovery is promoted.

To achieve the desired changes (effects), six outputs are required:

1) EX-2.1.1: The waste management program, including prevention, reduction, recycling, and reuse strategies, is implemented;

2) EX-2.1.2: Responsible product management and purchasing procedures and policies are implemented;

3) EX-2.1.3: The information, education, and communication (IEC) program on sustainable development is communicated and implemented;

4) EX-2.2.1: Landfills and/or technical landfill sites and incinerators are compliant;
5) EX-2.2.2: Waste is sorted at source;
6) EX-2.2.3: Waste is treated, recycled, and recovered.

To achieve immediate results (outputs), several activities have been identified, the implementation of which will ultimately lead to better waste management (Table 5).

Table 5. EMP: Waste management.

	Intervention Logic	Objectively Verifiable Indicators	Verification Methods	Assumptions/ Risks
Objective 2	OBJ-2: Environmentally sound waste management is an effective way of reducing pollution	50% of the waste produced is managed in an environmentally sound manner		
Outcomes	EF-2.1: Waste generation is significantly reduced	80% of the waste management program is monitored	Monitoring of waste quantification Source: Waste management programme	The waste management program is available
	EF-2.2: Waste recycling/recovery is promoted	50% reduction in waste-related pollution	Monitoring of waste-related pollution Source: Environmental Performance Monitoring Table	Reports on pollution are available
Outputs	EX-2.1.1: The waste management program, including strategies for prevention, reduction, recycling and reuse, has been implemented	Percentage of actions in the waste management program that have been implemented	Monitoring of the waste management program Source: Waste management program	The waste management program is available
	EX-2.1.2: Procedures and policies for product management and responsible procurement are implemented	Percentage of procedures and policies that have been put in place and communicated	Monitoring of the communication plan for procedures and policies Source: Communication plan	The communication plan is available
	EX-2.1.3: The information, education and communication (IEC) program on sustainable development is communicated and implemented	Percentage of IEC program activities that are communicated to stakeholders and implemented	Monitoring of the IEC programme Source: IEC programme	The IEC activities are relevant
	EX-2.2.1: Landfills, engineered landfill sites and incinerators are compliant	Percentage of waste management systems in compliance	Monitoring of the waste management program Source: Waste management program	The waste management program is available
	EX-2.2.2: Waste is sorted at source	Percentage of waste sorted at source	Monitoring of waste sorting Source: Waste management program	
	EX-2.2.3: Waste is treated, recycled and recovered	Percentage of waste treated, recycled, recovered and/or reused	Monitoring of the waste management program Source: Waste management program	

Continued

Activities	A.2.1.1.1: Reduce the negative environmental impact of waste generation through prevention, reduction, recycling and reuse
	A2.1.1.2: Implement a waste management programme
	A2.1.2.1: Introduce procedures for the environmentally sound management of chemicals and all waste throughout their life cycle
	A2.1.2.2: Implement a responsible procurement policy and promote sustainable practices in public procurement
	A2.1.3.1: Establish an information, education and communication program on sustainable development and a lifestyle in harmony with nature
	A.2.2.1.1: Establish controlled landfill sites and/or technical landfill sites and incinerators that comply with regulations
	A2.2.1.2: Establish retention and collection systems
	A2.2.1.3: Ensure that wastewater settling tanks are operational
	A2.2.2.1: Set up a system for sorting waste at source
	A2.2.2.2: Set up a waste recycling system
	A2.2.2.3: Establish waste recovery schemes for waste from weeding and brush-clearing (composting, reuse, etc.)
	A2.2.3.1: Implement an eco-design policy
	A2.2.3.2: Introduce support materials and effective communication

- **Pollution Management and Improvement of the Living Environment**

Table 6 summarizes the relationships between the EMP, the SDGs, and the aspirations, goals, and priority areas of the African Union's Agenda 2063. For EMP 3, these are SDGs 1, 2, 4, 5, 7, and 8; aspirations 1 and 6; goals 1, 4, 5, 7, 17, and 18; and priority areas associated with the goals of the African Union's Agenda 2063.

Table 6. Relationship between EMP 3 and the SDGs and the African Union's Agenda 2063.

		No	Title
Agenda 2030	**SDG**	1, 2, 4, 5, 7, 8	SDG1: End poverty in all its forms everywhere SDG2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture SDG4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all SDG5: Achieve gender equality and empower all women and girls SDG7: Ensure access to affordable, reliable, sustainable, and modern energy for all SDG7: Ensure access to affordable, reliable, sustainable, and modern energy for all
Agenda 2063	**Aspiration**	1, 6	(1) A high standard of living, quality of life, and well-being for all citizens (6) An Africa whose development is people-driven, harnessing the potential of Africans, especially women and youth, and caring for children

Continued

Goal	1, 4, 5, 7, 17, 18	(1) A high standard of living, quality of life, and well-being for all citizens (4) Transformed economies (5) Modern agriculture for increased productivity and production (7) Environmentally sustainable and climate-resilient economies and communities (17) Full gender equality in all areas of life (18) Engaged and empowered youth and children
Priority area		▪ Income, jobs, and decent work ▪ Poverty, inequality, and hunger ▪ Modern and livable housing and quality basic services ▪ Sustainable and inclusive economic growth ▪ Economic diversification and resilience ▪ Agricultural productivity and production ▪ Sustainable consumption and production patterns ▪ Empowerment of women and girls ▪ Violence and discrimination against women and girls ▪ Empowerment of young people and children

This EMP, linked to nuisance management and improvement of the living environment, has the overall objective of reducing nuisances and improving the living environment for surrounding populations. To achieve this objective, two main effects have been identified:

1) EF-3.1: Nuisances related to the operation of RIMA facilities are limited;

2) EF-3.2: The living environment for surrounding populations is improved.

To achieve the desired changes (effect), eight outputs are required:

1) EX-3.1.1: An inventory is carried out based on an assessment of sensitivity to nuisances;

2) EX-3.1.2: Environmental measurements are taken at regular intervals, and mitigation measures are implemented;

3) EX-3.1.3: Complaints from interested parties are addressed;

4) EX-3.1.4: The emergency plan is communicated, and emergency tests are carried out;

5) EX-3.2.1: Development programs are developed and funded;

6) EX-3.2.2: Awareness programs on all forms of discrimination, violence, etc. are developed and communicated;

7) EX-3.2.3: Educational institutions are established;

8) EX-3.2.4: Corporate Social Responsibility (CSR) is implemented in accordance with ISO 26000 (Guidelines on social responsibility, AFNOR, 2010).

To achieve immediate results (outputs), several activities have been identified, the implementation of which will ultimately enable better management of pollution and improve the living environment (**Table 7**).

Table 7. EMP: Managing nuisances and improving the living environment.

	Intervention Logic	Objectively Verifiable Indicators	Verification Methods	Assumptions/Risks
Objective 3	OBJ-3: Nuisances are reduced, and the living environment for local communities is improved	Nuisances associated with activities are reduced, and the quality of life for local communities is improved by 50%		
Effects	EF-3.1: Disturbances associated with the operation of RIMA facilities are limited	Disturbances are reduced by 50%	Monitoring of environmental measures Source: Measures monitoring table	Environmental measures are reliable
	EF-3.2: The living environment for local communities is improved	The living environment is improved by 50%	Surveys on the living environment Source: Survey results	The target respondents surveyed are representative of the population
Outputs	Output EX-3.1.1: The baseline assessment is carried out on the basis of an analysis of vulnerability to nuisances	Percentage of actions identified in the baseline assessment report that are implemented	List of actions identified in the report Source: Baseline report	The baseline assessment report is comprehensive
	EX-3.1.2: Environmental monitoring is carried out at regular intervals and mitigation measures are implemented	Number of identified non-conformities that have been rectified	Follow-up on non-conformities Source: Non-conformity tracking table	Non-conformities are recorded and addressed
	EX-3.1.3: Complaints from interested parties are addressed	Number of complaints from interested parties that are addressed	Complaints tracking Source: Complaints tracking table	Complaints are recorded
	EX-3.1.4: The emergency response plan is communicated, and emergency drills are carried out	Number of communication activities carried out regarding the emergency plan; number of emergency drills carried out per year	Monitoring of the communication plan and tests Source: Emergency Plan Communication and Testing Program	The emergency response plan is approved and communicated
	Output 3.2.1: Development programs are drawn up and funded	Number of activities arising from development programs that are carried out	Monitoring of development programme activities Source: Development program	Funding for the programs is available
	EX-3.2.2: Awareness-raising programs on all forms of discrimination, violence, etc. are developed and disseminated	Number of population groups reached by awareness-raising initiatives	Monitoring of the IEC program Sources: IEC program	The IEC programme is reliable
	EX-3.2.3: Schools are established	Number of schools established	Monitoring of implementation projects Source: List of projects	Projects are funded

Continued

	EX-3.2.4: Corporate Social Responsibility (CSR) is implemented in accordance with the ISO 26000 standard	Percentage of the requirements of the ISO 26000 standard that are implemented Number of follow-up audits carried out	Monitoring of actions arising from the standard's requirements Source: Implementation schedule for the standard	The timetable for implementing the standard is being adhered to
Activities	A.3.1.1.1.: Carry out an initial assessment of sensitivity to nuisances related to ambient air quality, sources of atmospheric pollutants, odours, allergenic substances, and electromagnetic fields emitted by electricity transmission and distribution networks A.3.1.2.1: Establish a protocol for environmental measurements (noise, light levels, particulate matter, etc.) A.3.1.2.2: Implement programs to manage nuisances relating to ambient air quality, sources of atmospheric pollutants, odours, allergenic substances and electromagnetic fields emitted by electricity transmission and distribution networks A.3.1.2.3: Limit dust by regularly watering the tracks, misting stockpiled materials and covering dust-generating materials with tarpaulins during transport A.3.1.3.1: Establish a complaints procedure for local residents A.3.1.4.1: Implement the emergency response plan in the Senegal River basin A.3.2.1.1: Establish agricultural development programs to completely eradicate extreme poverty throughout the river basin A.3.2.1.2: Ensure that poor and vulnerable people have rights to economic resources, access to basic services, ownership and control of land, natural resources, new technologies and adequate financial services A.3.2.1.3: Implement people-centered development strategies and invest in measures to eradicate poverty through the creation of decent jobs, entrepreneurship, creativity and innovation… A.3.2.1.4: End hunger and ensure that the poor and vulnerable have access to healthy, nutritious and sufficient food A.3.2.15: Establish social protection systems and measures A.3.2.1.6: Boost agricultural productivity and the incomes of small-scale producers, particularly women, indigenous peoples, family farmers, livestock farmers and fishers A.3.2.1.7: Ensure access to energy services for all communities living along waterways A.3.2.1.8: Implement awareness-raising programs on sustainable development, human rights, gender equality, the promotion of a culture of peace and non-violence, global citizenship and the appreciation of cultural diversity A.3.2.2.1: Implement awareness-raising programs on all forms of discrimination, violence and harmful practices against women and girls. A.3.2.2.2: Implement development-oriented policies that promote income-generating activities, the creation of decent jobs, entrepreneurship and youth employment A.3.2.3.1: Establish schools, literacy centers and training centers for vocational skills and ICT A.3.2.4.1: Introduce codes of ethics and professional conduct in all projects and programs A.3.2.4.2: Implement a Corporate Social Responsibility (CSR) policy across all OMVS structures			

- **Water Management**

Table 8 summarizes the existing relationships between the EMP, the SDGs, and

the aspirations, goals, and priority areas of the African Union's Agenda 2063. For EMP 4, this is SDG 6; aspiration 1, goal 7, and the priority area associated with goal 7 of the African Union's Agenda 2063.

Table 8. Relationship between EMP 4 and the SDGs and the African Union's Agenda 2063.

		No	Title
Agenda 2030	**SDG**	6	SDG6: Ensure access to water and sanitation for all and ensure sustainable water resource management
Agenda 2063	**Aspiration**	1	(1) A prosperous Africa, based on inclusive growth and sustainable development
	Goal	7	(7) Economies and communities that are environmentally sustainable and resilient to climate change
	Priority area		Water security

This EMP, related to water management, has the overall objective of optimizing water quantity and quality management. To achieve this objective, three main effects have been identified:

1) EF-4.1: Water quality is guaranteed;
2) EF-4.2: Wastewater pollution is reduced;
3) EF-4.3: The quantity of water required for all uses is guaranteed.

To achieve the desired changes (effects), eight outputs are required:

1) EX-4.1.1: A limnology laboratory meeting international standards is set up;
2) EX-4.1.2: Limnological measurement programs are developed and followed;
3) EX-4.1.3: Drinking water treatment systems are automated;
4) EX-4.2.1: All wastewater settling basins are operational;
5) EX-4.2.2: All sources of pollution are identified and treated;
6) EX-4.3.1: Local populations have access to drinking water;
7) EX-4.4.1: Hydroelectric production operations are optimized;
7) EX-4.4.2: The objectives of the Permanent Water Commission are achieved.

To achieve immediate results (outputs), several activities have been identified, the implementation of which will ultimately lead to better water management (Table 9).

Table 9. EMP: Water management.

	Intervention Logic	Objectively Verifiable Indicators	Verification Methods	Assumptions/Risks
Objective 4	OBJ-4: The management of water quantity and quality is optimized	The management of water quantity and quality is optimized by 80%		
Effects	EF-4.1: Water quality is guaranteed	Water quality is 100% guaranteed	Monitoring of physico-chemical and bacteriological parameters Source: Monthly limnology report	The physico-chemical and bacteriological data are reliable

Continued

	EF-4.2: Wastewater pollution is reduced	Pollutant loads reduced by 80%	Monitoring of pollution measurement parameters Source: Monthly limnology report	The data on pollution measurement parameters are reliable
	EF-4.3: The quantity of water required for all uses is guaranteed	The water supply for all uses is 80% guaranteed	Monitoring of water production volumes Source: Meter readings	Water meters are operational
Outputs	EX-4.1.1: A limnology laboratory meeting international standards has been established	Percentage of progress towards bringing the laboratory up to international standards	Monitoring of the laboratory upgrading project Source: List of projects	The limnology laboratory project is funded
	EX-4.1.2: Limnological monitoring programs are drawn up and adhered to	Number of limnological measurement campaigns carried out	Monitoring of the limnological measurement program Source: Monthly limnology report	The data from the campaigns are reliable
	EX-4.1.3: Drinking water treatment systems are automated	Percentage of drinking water treatment systems in compliance	Monitoring of the project to bring treatment systems into compliance Source: List of projects (technical plan)	The drinking water treatment systems project is funded
	EX-4.2.1: All wastewater settling tanks are operational	Number of functional settling tanks	Monitoring the volume of treated wastewater Source: Activity report	Wastewater is treated
	EX-4.2.2: All sources of pollution are identified and treated	Number of pollution sources identified and treated	Monitoring of sources of pollution Source: Monthly limnology report	The limnology report is available
	EX-4.3.1: Local communities have access to drinking water	Percentage of riverside communities with access to water	Monitoring of water distribution to communities Source: Activity report	Water distribution is operational
	EX-4.3.2: Hydropower generation operations are optimized	Percentage of annual reservoir management plans	Monitoring of generation Source: Report on hydroelectric power generation based on the volume of water used	The management plan is available
	EX-4.3.3: The objectives of the Standing Water Commission have been met	Achievement rate of the Permanent Water Commission's targets	Monitoring of water volume at the Bakel hydrograph Source: Report from the Hydrology and Planning Department	Water level measurement equipment is operational and calibrated
Activities	A.4.1.1.1: Establish a sub-regional reference limnology laboratory to monitor the physico-chemical, bacteriological and biological quality of water in the upper catchment, the river valley and the river delta			
	A.4.1.1.2: Acquire equipment for measuring physico-chemical, biological and bacteriological parameters			
	A.4.1.2.1: Conduct limnological monitoring campaigns throughout the Senegal River basin			
	A4.1.2.2: Draw up a drinking water quality control plan			

Continued

A.4.1.3.1: Set up automated water treatment systems
A.4.2.1.1: Combat water pollution and contamination
A.4.2.1.2: Set up systems for the treatment of wastewater and effluent
A.4.2.2.1: Prevent and reduce all types of water pollution, in particular that resulting from land-based activities, including waste in surface waters and nutrient pollution
A.4.2.2.2: Have plans for water networks (drinking water, raw water and wastewater)
A.4.2.2.3: Provide areas for washing vehicles, machinery and equipment
A.4.2.2.4: Establish a system for the collection and primary treatment of wastewater
A.4.3.1.1: Implement integrated water resources management
A.4.3.1.2: Make water supply network structures and facilities available to local communities
A.4.3.1.3: Install sub-meters in all water supply networks to distinguish between volumes consumed for different uses
A.4.3.1.4: Install water leak detection systems
A.4.3.2.1: Optimize the entire hydroelectric power generation process
A.4.3.3.1: Monitor the flow rates of the various tributaries
A.4.3.3.2: Monitor the lake level
A.4.3.3.3: Monitor water releases
A.4.3.3.4: Regulate the river flow

- **Biodiversity Management**

Table 10 summarizes the relationships between the EMP, the SDGs, and the aspirations, goals, and priority areas of the African Union's Agenda 2063. For EMP 5, this is SDG 15; aspiration 1, goal 7, and the priority area associated with goal 7 of the African Union's Agenda 2063.

Table 10. Relationship between EMP 5, the SDGs, and the African Union's Agenda 2063.

		No	Title
Agenda 2030	**SDG**	15	SDG15: Protect and restore terrestrial ecosystems
Agenda 2063	**Aspiration**	1	(1) A prosperous Africa, based on inclusive growth and sustainable development
	Goal	7	(7) Economies and communities that are environmentally sustainable and resilient to climate change
	Priority area		Sustainable management of natural resources and conservation of biodiversity

This EMP is linked to biodiversity management. To achieve this objective, one main effect has been identified:

1) EF-5.1: Fauna and flora are maintained.

To achieve the desired changes (effect), three outputs are necessary:

1) EX-5.1.1: Reforestation programs are implemented;

2) EX-5.1.2: Biological monitoring programs are put in place;

3) EX-5.1.3: Campaigns to eradicate invasive alien species are planned.

To achieve immediate results (outputs), several activities have been identified, the implementation of which will ultimately enable better management of biodiversity (Table 11).

Table 11. EMP: Biodiversity management.

	Intervention Logic	Objectively Verifiable Indicators	Verification Methods	Assumptions/Risks
Objective 5	OBJ-5: Biodiversity is preserved	100% of endemic species protected		
Impacts	EF-5.1: Flora and fauna are maintained	80% of monitoring programs are adhered to	Monitoring of reforestation and species monitoring program activities Source: Reforestation programs, programs for monitoring endemic species, and programs for monitoring changes in fish fauna and the plankton community	All species are identified
Outputs	EX-5.1.1: Reforestation programmes are implemented	Number of trees planted per year	Monitoring of the number of trees planted Source: Reforestation programmes	Trees are planted
	EX-5.1.2: Biological monitoring programs are being implemented	Number of biological monitoring campaigns carried out	Monitoring of biological measurement activities Source: Limnology report	The biological parameters measured are reliable
	EX-5.1.3: Campaigns to eradicate invasive alien species are planned	Number of eradication campaigns carried out	Monitoring of the invasive species eradication project Source: Limnology report	Invasive alien species are eliminated
Activities	A.5.1.1.1: Establish mechanisms for the sustainable management and rational use of natural resources A.51.1.2: Establish mechanisms for the management and protection of river ecosystems by strengthening their resilience, in order to prevent the serious consequences of their degradation and take measures to restore them to health and productivity A.5.1.1.3: Promote the sustainable management of all types of forest, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation A.5.1.1.4: Establish mechanisms to protect threatened species and prevent their extinction A.5.1.1.5: Ensure the conservation, restoration and sustainable use of terrestrial and freshwater ecosystems A.5.1.1.6: Implement awareness-raising programs on destructive fishing practices A.5.1.1.7: Take measures to put an end to poaching and the trafficking of protected plant and animal species A.5.1.2.1: Establish a biological monitoring program (fish and plankton) for water bodies A.5.1.3.1: Implement measures to combat invasive alien species, significantly mitigate the effects these species have on terrestrial and aquatic ecosystems, and control or eradicate priority species			

- **Combating Soil Pollution**

Table 12 summarizes the relationships between the EMP, the SDGs, and the aspirations, goals, and priority areas of the African Union's Agenda 2063. For GEP 6, these are SDG 15; aspiration 1, goals 5 and 7, and the priority areas associated with the goals of the African Union's Agenda 2063.

Table 12. Relationship between EMP 6, the SDGs, and the African Union's Agenda 2063.

		No	Title
Agenda 2030	**SDG**	15	SDG15: Protect and restore terrestrial ecosystems
Agenda 2063	**Aspiration**	1	(1) A prosperous Africa, based on inclusive growth and sustainable development
	Goal	5, 7	(5) Modern agriculture for increased productivity and production (7) Environmentally sustainable and climate-resilient economies and communities
	Priority area		Agricultural productivity and production Sustainable management of natural resources and conservation of biodiversity

This EMP, linked to the fight against soil and subsoil pollution, has the overall objective of protecting soils and subsoils from all pollution. To achieve this objective, two main effects have been identified:

1) EF-6.1: Reactive measures to combat soil pollution are under control;

2) EF-6.2: Measures to prevent soil pollution have been proven.

To achieve the desired changes (effect), four outputs are required:

1) EX-6.1.1: All contaminated soils are treated;

2) EX-6.1.2: Systems to combat soil degradation are in place and effective;

3) EX-6.2.1: The system for managing identified environmental emergencies is implemented and tested periodically,

4) EX-6.2.2: All used oil is treated.

To achieve immediate results (outputs), several activities have been identified, the implementation of which will ultimately enable better management of soil and subsoil pollution (Table 13).

Table 13. EMP: Combating soil pollution.

	Intervention Logic	Objectively Verifiable Indicators	Verification Methods	Assumptions
Objective 6	OBJ-6: Soils and subsoils are protected from all pollution	80% of polluted and degraded soils are treated and restored		
Impacts	EF-6.1: Reactive soil pollution measures are controlled	100% of soil pollution cases are reported and treated	Pollution Tracking Source: Activity Report	The causes of pollution have been identified
	EF-6.2: Soil pollution prevention measures are proven	80% of the actions resulting from emergency management programs are implemented and carried out	Follow-up on emergency prevention measures Source: Emergency Prevention Report	Emergency situations are identified

Continued

Outputs	EX-6.1.1: All contaminated soils are treated	Percentage of contaminated soil that is treated	Pollution Tracking Source: Activity Report	Contaminated soils are identified
	EX-6.1.2: Land degradation control systems are in place and effective	Percentage of land degradation programme activities that are carried out	Monitoring of land degradation control activities Sources: Activity reports	Activities to combat land degradation are carried out
	EX-6.2.1: The environmental emergency management system identified is implemented and tested periodically	Number of pollution control devices that are identified and periodically tested	Monitoring of pollution control measures Source: Activity Report	Pollution control measures have been put in place
	EX-6.2.2: All waste oils are treated	Amount of waste oil that is treated	Follow-up of the treatment of used oils Source: Used Oil Inventory	All used oils are collected
Activities	A.6.1.1.1: Combating soil pollution and contamination			
	A.6.1.1.2: Have absorbent available in places where the risk of soil pollution is proven			
	A.6.1.2.1: Reduce pollutants that are harmful to soil health			
	A.6.1.2.2: Combating desertification			
	A.6.1.2.3: Restore degraded land and soil, including land affected by desertification, drought and floods			
	A.6.2.1.1: Implement chemical containment systems corresponding to 110% of the quantity stored			
	A.6.2.1.2: Implement an emergency response system and manage contaminated soils			
	A.6.2.2.1: Look for ways of treating used oil from the emptying of transformers, generators, vehicles, etc.			

- **Health and Safety Management for Stakeholders**

Table 14 summarizes the relationships between the EMP, the SDGs, and the aspirations, goals, and priority areas of the African Union's Agenda 2063. For GMP 7, these are SDGs 3 and 8; aspiration 1, goals 1 and 3, and the priority areas associated with the goals of the African Union's Agenda 2063.

Table 14. Relationship between EMP 7 and the SDGs and the African Union's Agenda 2063.

		No	Title
Agenda 2030	**SDG**	3, 8	SDG3: Enable people to lead healthy lives and promote well-being for all ages SDG8: Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all
Agenda 2063	**Aspiration**	1	(1) A prosperous Africa, based on inclusive growth and sustainable development
	Goal	1, 3	(1) A high standard of living, quality of life, and well-being for all citizens (3) Healthy and well-nourished citizens
	Priority area		Social security and protection, including for people with disabilities Health and nutrition

This EMP, related to the management of the health and safety of stakeholders, has the overall objective of ensuring the health and safety of stakeholders. To achieve this objective, three main effects have been identified:

1) EF-7.1: The occupational health and safety of employees is considered;

2) EF-7.2: Preventive measures relating to hazards and risks are implemented;

3) EF-7.3: Safety culture is integrated into all activities.

To make the desired changes (effect), 12 outputs are required:

1) EX-7.1.1: Health monitoring programs are put in place;

2) EX-7.1.2: Health personnel are well trained;

3) EX-7.1.3: Health-related performance is monitored and communicated;

4) EX-7.1.4: Health and safety management systems in accordance with ISO 45001 and NFC 18510 are implemented and certified;

5) EX-7.2.1: Policies to combat drugs, alcohol, and tobacco are in place;

6) EX-7.2.2: Occupational risk mapping is carried out, and actions are implemented;

6) EX-7.2.3: Awareness, training, and communication programs on hazards and risks are developed and implemented;

7) EX-7.3.1: Road safety prevention policies are communicated and implemented;

8) EX-7.3.2: The internal operating plan (IOP) covering emergency prevention is implemented and tested;

9) EX-7.3.3: Chemical and hazardous materials management programs are developed and monitored;

10) EE-7.3.4: Safety audit programs are developed and implemented;

11) EX-7.3.5: Safety-related performance is monitored and analyzed.

To achieve immediate results (outputs), several activities have been identified, the implementation of which will ultimately enable better management of the health and safety of stakeholders (Table 15).

Table 15. EMP: Health and safety management for stakeholders.

	Intervention Logic	Objectively Verifiable Indicators	Verification Methods	Assumptions
Objective 7	OBJ-7: The health and safety of interested parties is guaranteed	Occupational health and safety is 100% guaranteed		
Impacts	EF-7.1: Consideration is given to the occupational health and safety of stakeholders	Occupational health and safety management systems according to ISO 45001 and NFC 18510 are 100% implemented (Occupational health and safety management systems—Requirements and guidelines for their use ISO 45001, AFNOR, 2018) (UTE, 2012)	Monitoring of the standards implementation schedule Source: Standards Implementation Project Report	The requirements of the standards are implemented

Continued

	FY-7.2: Hazard and risk prevention measures are implemented	The 100% single risk analysis document	Monitoring the implementation of the single document Source: Single document	Hazards and risks analysed
	EF-7.3: Safety culture is integrated into all activities	All staff and stakeholders are 100% involved in promoting the safety culture	Monitoring the level of involvement of staff and stakeholders Source: Level of Involvement Surveys	Staff and stakeholders are involved in promoting safety culture
	EX-7.1.1: Health monitoring programs are put in place	Number of health monitoring programme activities carried out	Monitoring of health programme activities Source: Health Programs	Health programme activities are effective
	EX-7.1.2: Health personnel are well trained	Number of trainings attended by health personnel	Follow-up of training actions Source: Training Plan	Training actions are relevant
	EX-7.1.3: Health-related performance is tracked and reported	Percentage of compliance of health-related performance is against their target values	Monitoring of health-related performance indicators Source: Dashboard	The indicators measured are relevant
	EX-7.1.4: Occupational health and safety management systems according to ISO 45001 and NFC 18510 are implemented and certified	Percentage of compliance with ISO 45001 and NFC 18510 requirements	Monitoring of the standards implementation schedule	The requirements of the standards are implemented
Outputs	EX-7.2.1: Policies to combat drugs, alcohol and tobacco are put in place	Number of activities of the programmes to combat drugs, alcohol and tobacco that are carried out	Monitoring of programmes to combat drugs, alcohol and tobacco Source: Programme Monitoring Report	The actions implemented are effective
	EX-7.2.2: Occupational risk mapping is carried out and actions implemented	Percentage of major risks identified and protection and prevention measures implemented	Monitoring the implementation of the single document Source: Single document	The hazards and risks identified are comprehensive
	EX-7.2.3: Hazard and risk awareness, training, and communication programs are developed and implemented	Number of awareness-raising sessions, training, and communication that are conducted	Monitoring of awareness-raising, training and communication programmes Source: Outreach, Training and Communication Program	Awareness-raising, training and communication actions are effective
	EX-7.3.1: Road safety prevention policies are communicated and implemented	Number of communication sessions that are held on road safety prevention	Road Safety Prevention Program Follow-up Source: Road Safety Prevention Program	Road safety activities are effective

Continued

	EX-7.3.2: The internal operation plan (POI) taking into account the prevention of emergency situations is implemented, and tests carried out	Number of actions resulting from the internal emergency plan that are carried out	Monitoring the implementation of the IOP Source: Internal Operations Plan	The internal operation plan is validated
	EX-7.3.3: Chemicals and Hazards Control Programs are developed and monitored	Number of chemicals controlled with their safety and summary data sheet	Monitoring the Chemicals Management Plan Source: List of chemicals	The dangers and risks associated with chemicals are under control
	EE-7.3.4: Security audit programs are developed and implemented	Number of audits completed	Audit Program Follow-up Source: Audit Program	Listeners are available
	EX-7.3.5: Safety-related performance is tracked and analyzed	Percentage of security-related performance that is compliant with their target values	Monitoring of performance indicators Source: Dashboards	Performance indicators are SMART
Activities	A.7.1.1.1: Combating STIs, HIV/AIDS and opportunistic diseases			
	A.7.1.1.2: Establish health programmes to combat waterborne and other endemic diseases			
	A.7.1.1.3: Promoting the mental health and well-being of staff and stakeholders			
	A.7.1.2.1: Strengthening the systems and skills of health personnel			
	A.7.1.3.1: Establish a health-related performance monitoring program			
	A.7.1.4.1: Implement occupational health and safety management systems according to ISO 45001 and NFC 18512			
	A.7.1.4.2: Promote occupational health and safety in the workplace and ensure the protection of all workers			
	A.7.2.1.1: Implement policies to combat drugs, alcohol and tobacco			
	A.7.2.2.1: Identify, assess and analyze occupational hazards for all activities			
	A.7.2.2.2: Implement corrective and preventive actions for occupational hazards and risks			
	A.7.2.3.1: Implement awareness/training programs on occupational hazards and risks			
	A.7.2.3.2: Implement occupational hazard and risk communication programs			
	A.7.3.1.1: Implement road safety prevention policies			
	A.7.3.2.1: Implement emergency prevention means			
	A.7.3.2.2: Implement the internal operation plan taking into account the risks of fire and explosion			
	A.7.3.3.1: Implement a chemicals and hazards control program			
	A.7.3.4.1: Implement a safety audit plan for all activities, facilities and structures			
	A.7.3.5.1: Implement a dam monitoring and periodic inspection program			
	A.7.3.5.2: Calibrate all dam and facility monitoring and measurement equipment			
	A.7.3.5.3: Establish a safety performance monitoring program			

- **Adaptation to Climate Change**

Table 16 summarizes the relationships between the EMP, the SDGs, and the as-

pirations, goals, and priority areas of the African Union's Agenda 2063. For EMP 8, this is SDG 13; aspiration 1, goal 7, and the priority area associated with goal 7 of the African Union's Agenda 2063.

Table 16. Relationship between EMP 8, the SDGs, and the African Union's Agenda 2063.

		No	Title
Agenda 2030	**SDG**	13	SDG13: Take urgent action to combat climate change and its impacts
Agenda 2063	**Aspiration**	1	(1) A prosperous Africa, based on inclusive growth and sustainable development
	Goal	7	(7) Economies and communities that are environmentally sustainable and resilient to climate change
	Priority area		Climate resilience and natural disaster preparedness and prevention

This EMP, linked to climate change adaptation, has the overall objective of ensuring that emergency measures to combat climate change and its repercussions are controlled. To achieve this objective, two effects have been identified:

1) EF-8.1: Preparedness and response to climate emergencies are tested;

2) EF-8.2: The carbon footprint and CO2emissions are reduced.

To make the desired changes (effect), three outputs are required:

1) EX-8.1.1: Climate mitigation measures are identified;

2) EX-8.1.2: IEC measures on climate change are identified and implemented;

3) EX-8.1.3: Scenarios for climate-related emergencies are identified and tested periodically;

4) EX-8.2.1: Carbon offset programs and monitoring mechanisms are deployed and evaluated.

To achieve immediate results (outputs), several activities have been identified, the implementation of which will ultimately enable better management of climate change adaptation (Table 17).

Table 17. EMP: Adaptation to climate change.

	Intervention Logic	Objectively Verifiable Indicators	Verification Methods	Assumptions
Objective 8	OBJ-8: Emergency measures to combat climate change and their impacts are under control	Number of emergencies that are identified and measures that are implemented		
Impacts	FY-8.1: Preparedness and response to climate emergencies is proven	Number of emergency response tests conducted	Monitoring of the Emergency Response Testing Program Source: Test reports	Emergency response tests are carried out
Outputs	EX-8.1.1: Climate mitigation schemes are identified	Number of climate mitigation schemes that are identified and actions that are implemented	Monitoring of the climate mitigation plan Source: Mitigation Program	The actions implemented are relevant

Continued

	EX-8.1.2: IEC devices on climate change are identified and implemented	Number of IEC activities on climate change that are carried out	IEC Program Monitoring Sources: IEC Program	IEC activities are relevant
	EX-8.1.3: Scenarios for climate-related emergencies are identified and tested periodically	Number of scenarios that are identified and the tests that are carried out	Monitoring of the Emergency Response Testing Program Source: Test reports	Emergency response tests are carried out
Activities	A.8.1.1.1: Implement mitigation mechanisms for extreme weather events and other economic, social or environmental shocks and disasters A.8.1.2.1: Establish information, education and communication mechanisms on climate change adaptation, mitigation and impact reduction, and early warning systems. A.8.1.2.2: Improve knowledge of the current and future impacts of climate change A.8.1.3.1: Define and implement scenarios and test them periodically to prepare for emergencies due to climatic hazards			

- **Monitoring Environmental Performance**

This EMP, relating to environmental performance monitoring, is not associated with the SDGs and Agenda 2063 as its specific purpose is to monitor the achievement of the objectives of the various EMPs.

Its overall objective is to improve environmental performance. To achieve this objective, two effects have been identified:

1) EF-9.1: Environmental regulatory compliance is ensured;

2) EF-9.2: The effectiveness of established actions and programs is measured.

To make the desired changes (effects), five outputs are required:

1) EX-9.1.1: Regulatory compliance monitoring and assessment are carried out;

2) EX-9.1.2: The environmental compliance program is implemented;

3) EX-9.2.1: Performance indicators (IOV) are identified and calculated, monitored, and communicated;

4) EX-9.2.2: The environmental management system according to ISO 14001 is implemented (AFNOR, Environmental management systems. Requirements and guidelines for use NF EN ISO 14001, 2015);

5) EX-9.2.3: Environmental audits are planned and implemented.

To achieve immediate results (outputs), several activities have been identified, the implementation of which will ultimately enable better management and monitoring of environmental performance (Table 18).

Table 18. EMP: Monitoring environmental performance.

	Intervention Logic	Objectively Verifiable Indicators	Verification Methods	Assumptions
Objective 9	OBJ-9: Environmental Performance Is Improved	80% of performance tracked and analyzed		

Continued

Impacts	FY-9.1: Environmental regulatory compliance is ensured	80% regulatory compliance rate	Follow-up of the management procedure, monitoring and legal and regulatory evaluation Source: Monitoring table for legal and regulatory monitoring and evaluation	Legal and regulatory requirements are identified and assessed
	FY-9.2: The effectiveness of established actions and programs is measured	80% environmental performance achievement rate	Monitoring of environmental performance indicators Source: Dashboards	The indicators measured are relevant
Outputs	EX-9.1.1: Regulatory compliance monitoring and assessment are conducted	Monitoring and regulatory evaluation are done for 100% of the activities	Follow-up of the management procedure, monitoring and legal and regulatory evaluation Source: Monitoring table for legal and regulatory monitoring and evaluation	Legal and regulatory requirements are identified and assessed
	EX-9.1.2: Environmental Compliance Program is in place	Regulatory compliance monitoring programs are followed at 80%	Monitoring of the compliance action plan Source: Regulatory Compliance Follow-up Action Plan	The proposed actions are relevant
	EX-9.2.1: Performance indicators are identified and calculated, tracked and communicated	Performance indicators are tracked 100%	Monitoring of environmental performance indicators Source: Dashboards	The indicators measured are SMART
	EX-9.2.2: The environmental management system according to ISO 14001 is implemented	ISO 14001 standards requirements are 100% met	Monitoring of the ISO 14001 implementation schedule Source: Standards Implementation Project Report	The requirements of the standards are implemented
	EX-9.2.3: Environmental audits are planned and implemented	Environmental audit programs are followed at 80%	Follow-up of the environmental audit programme Sources: Audit Program	The environmental audit program is available
Activities	A.9.1.1.1: Identify and analyze the applicable legal and regulatory requirements			
	A.9.1.1.2: Carry out legal and regulatory monitoring			
	A.9.1.1.3: Assess environmental legal and regulatory compliance			
	A.9.1.2.1: Implement and monitor environmental compliance programs			
	A.9.1.2.2: Implement environmental measurement campaigns			
	A9.2.1.1: Identify indicators to measure environmental performance			
	A.9.2.1.2: Track measurement indicators			
	A.9.2.1.3: Implement measures to improve environmental performance			
	A.9.2.1.4: Communicating environmental performance			
	A.9.2.2.1: Implement the environmental management system according to ISO 14001			
	A.9.2.3.1: Establish environmental audit systems			

3.2. Discussions

The results of this study should be interpreted as a proposed management framework, rather than as evidence of outcomes already achieved. The analysis of the Manantali operational assessment identified 16 significant environmental aspects, and this study translates the associated management needs into nine proposed management practices, structured in accordance with the GAR. Consequently, statements regarding improvements in organisational capacity, environmental performance, social conditions, adaptability or learning should be formulated in forward-looking terms: these are expected outcomes of future implementation and monitoring, rather than outcomes demonstrated by this study.

The proposed performance targets of 80%, 90%, and 100% are useful as management objectives, but they cannot be interpreted as measurable performance outcomes in the absence of baseline values, denominators, methods and assessment periods.

The implementation of various environmental management programs during the operational phase of hydroelectric facilities and structures in accordance with the RBM could enable the results to be assessed across four areas: 1) the ability to understand, which is assessed through the degree of knowledge of the organizational reality, itself a function of the understanding developed by managers, employees, and other stakeholders in the organization with regard to five organizational variables (mission, vision, performance targets, available resources, past performance); 2) the ability to deliver, which is assessed through results relating to management efforts and gains achieved in terms of the political-administrative interface, resource optimization, and the development of the offering; 3) adaptability, which is assessed through results obtained in terms of strategic implementation, restructuring, operational process reviews, project design/execution, leadership renewal, and major cultural transformations; and finally 4) learning capacity, which is assessed through the organization's evaluation subsystem. The results obtained, as well as the gaps between the results and the targets in terms of day-to-day management of operations, quality of services provided, strategic direction, and, finally, overall improvement, should be used to facilitate both individual and organizational learning (Mazouz & Leclerc, 2008).

For EMP1 concerning the optimization of energy resources, it should be noted that a significant proportion (just under a quarter) of the world's population does not have access to electricity, a commodity that is now considered essential for a decent standard of living. This mainly concerns poor populations who do not yet have access to it, but also populations who are too far away from the major networks (Multon et al., 2011). Hydropower is the world's largest source of renewable electricity. It generates around 16% of the world's electricity from more than 1200 GW of installed capacity. In Africa, hydroelectric power has long been an important part of many electricity systems. Its technical potential on the continent is enormous. It is estimated at 350 GW and could generate nearly 1200 TWh per year, or three times the current consumption level of sub-Saharan Africa. Hydro-

power is therefore one of the solutions that can help African countries achieve their energy transition. It enables at least two of the seventeen sustainable development goals to be achieved, notably SDG7 (Fondja Wandji & Kamdem, 2020); hence, the need to implement the proposed actions for better optimization of energy resources.

With regard to EMP 2, relating to waste management, it should be noted that the issue of waste is becoming increasingly pressing in a context characterized by rapid urban and demographic growth, while also being influenced by rapid changes in production and consumption patterns (Cirelli & Florin, 2015); however, waste production is more critical in developing countries, which do not always have the necessary means to manage it properly. At the same time, the composition of this waste has shifted from organic waste (food waste) to complex materials (end-of-life products, plastics, and packaging) that pose major risks to health and the environment (Mazama Sukamai, Bompeta Lombo, Yadoli Kosanga, & Holenu Mangenda, 2024). The urgent need for waste management must focus on the principles of the circular economy, which is based on seven pillars: recycling, extending the useful life of products, responsible consumption, the functional economy, industrial and territorial ecology, and eco-design. These pillars highlight the importance of practices such as reuse, repair, recycling, rental, collaborative consumption, the fight against food waste, organic and bulk products, and the adoption of eco-design (Bourdin & Torre, 2023).

EMP 3 concerns the management of nuisances and improvement of the living environment. Controlling the nuisances associated with operational activities can substantially improve the living environment. Indicators of quality of life have evolved along with the concept of development. From the concept of economic development with indices linked to GNP (Gross National Product) and/or GDP (Gross Domestic Product), we moved on to the concept of human development assessed by the Human Development Index (HDI), before arriving at today's concept of sustainable development (N'dahoule, 2018). Today, this multidimensional concept is at the heart of planning and development projects and has become a collective demand for well-being supported by society and a political promise involving both the state and local authorities (Barbarino, 2005). Remaining a major challenge, quality of life refers to several concepts, including the improvement of living conditions and the environment, recognized as a determining factor in the physical and psychological well-being of city dwellers (Mebirouk, 2019).

EMP 4 relates to water management. Among the resources that contribute to the development of human activities, water has several characteristics that distinguish it from all others: it is essential to life; it is omnipresent (it makes up 65% of the human body and covers 70% of the Earth's surface); it is available in strictly fixed quantities, dictated by the laws of conservation and the water cycle. The fact that it is essential to life on Earth makes it a resource that is coveted more than any other: its scarcity keeps entire populations trapped in poverty and fuels political conflicts that can eventually lead to armed conflict (Baechler, 2012). Added to this is climate change, which plays a decisive (and negative) role in future water

availability, as the water cycle is one of the systems most sensitive to this phenomenon, with impacts on freshwater accessibility, the quality of available water, and the destructive potential of water through the increase in extreme weather events (Kundzewicz et al., 2008); hence, the importance of implementing the proposed activities.

EMP 5 concerns biodiversity management. It appears that the construction of hydroelectric dams leads to the creation of reservoirs (as in the case of Manantali) of varying sizes, causing the transformation of a lotic environment into a lentic environment, with profound changes to the ecosystem and very worrying socio-environmental repercussions (Faye, Ndao, & Sambou, 2023). In this context, aquatic populations are profoundly altered: the disappearance of rheophilic species upstream is partially offset by the development of stagnant water species; the disappearance of species that reproduce in floodplains downstream. Dams are responsible for the permanent disappearance of endemic rheophilic species that cannot adapt to the new ecological conditions they face (Lévêque, 2005). The implementation of the activities proposed for EMP 5 will make it possible to limit the irreversible consequences on biodiversity in the short and medium term.

EMP 6 relates to the fight against soil pollution. The concept of soil pollution refers to all forms of pollution affecting any type of soil (agricultural, forest, urban, etc.). Polluted soil in turn becomes a potential source of direct or indirect dissemination of pollutants into the environment, via water, dust emissions, gas emissions, or via the reconcentration and transfer of pollutants by living organisms (bacteria, fungi, plants, which are in turn eaten by animals) (Zouboulis, Loukidou, & Matis, 2004). Soil is considered polluted when it contains one or more pollutants or contaminants that are likely to cause biological, physical, and chemical alterations and pose a lasting, real, and potential risk to human health and/or the environment due to pollution of the environment resulting from current or past activity. Implementing the proposed activities will therefore make it possible to better combat soil pollution.

EMP 7 concerns the management of the health and safety of interested parties. All organizations (dam operators) are responsible for the occupational health and safety of their workers and other people who may be affected by their activities. This responsibility includes promoting and preserving their physical and mental health. To better manage health and safety, a workplace health and safety management system has been put in place to enable organizations to provide safe and healthy workplaces, prevent work-related injuries and illnesses, and continuously improve their performance (AFNOR, 2018). This management system, combined with all the proposed activities, will enable better management of the health and safety of interested parties.

EMP 8 concerns adaptation to climate change. The most commonly used definition of the adaptation of human systems to climate change is that of the Intergovernmental Panel on Climate Change (IPCC), namely "a process of adjusting to current or expected climate and its consequences in order to mitigate adverse

effects and exploit beneficial effects" (IPCC, 2012). The scientific recommendations of the Intergovernmental Panel on Climate Change (IPCC) are clear. If we want to keep global warming below 1.5˚C to 2˚C and avoid irreversible and disastrous consequences for our societies, we must achieve climate neutrality by 2050 at the latest; hence, the importance of implementing the activities proposed under EMP 8 (CSET, 2020).

EMP 9 concerns the monitoring of environmental performance. Societal expectations for sustainable development, transparency, and accountability have evolved with legislative reinforcement and increased pressure on the environment due to pollution, inefficient use of resources, inappropriate waste management, climate change, ecosystem degradation, and biodiversity loss. This has led organizations to adopt a systematic approach to environmental management through the implementation of environmental management systems with the aim of contributing to the environmental pillar of sustainable development [8]. The implementation of an environmental management system in accordance with reference standards such as ISO 14001 makes it possible to monitor all environmental performance during the operational phase of hydroelectric facilities. This approach also facilitates the implementation of the nine environmental management programs defined in this study.

The proposed environmental management strategy can then be tested by means of a baseline study, followed by periodic monitoring. Once implementation has begun, changes in the indicators can be compared with the baseline situation and, where the system allows, with defined reference groups or control conditions. This would provide the empirical basis for determining whether EMPs are actually improving their environmental and social performance.

4. Conclusion

The management strategies proposed in this chapter are based on nine (9) environmental management programs, each defined by a general objective that specifies its framework. The various general objectives are associated with the effects, outputs, and activities resulting from the studies conducted below, as well as the SDGs and the African Union's Agenda 2063. For each objective, effect, and output (intervention logic), objectively verifiable indicators, means of verification, and assumptions have been defined. The defined indicators will be measured at regular intervals based on the means of verification and assumptions identified. Analysis of the indicators will enable corrective and/or preventive measures to be taken if the target value is not achieved. In view of the various existing global standards, particularly those relating to the sustainability of hydropower, which enable the certification of individual hydropower projects adapted to the preparation, implementation, and operation phases, the implementation of the nine programs will facilitate certification with the advanced requirements for obtaining an additional label during the operational phase of hydroelectric facilities and structures.

It is necessary to continue this study in order to report on the baseline assess-

ment, the implementation process, and the measured outcomes, so that the effectiveness and added value of the nine PGE programs can be assessed empirically.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

AFNOR (2010). *Guidelines on Social Responsibility.* https://www.iso.org/standard/42546.html

AFNOR (2015). *Environmental Management Systems. Requirements and Guidelines for Use NF EN ISO 14001.* AFNOR.

AFNOR (2018). *Occupational Health and Safety Management Systems—Requirements and Guidelines for Their Use ISO 45001.* AFNOR.

Baechler, L. (2012). La bonne gestion de l'eau: Un enjeu majeur du développement durable. *L'Europe en Formation, 365,* 3-21. https://doi.org/10.3917/eufor.365.0003

Barbarino-Saulnier, N. (2005). *From Quality of Life to Urban Diagnosis, towards a New Evaluation Method—The Case of the City of Lyon.* Ph.D. Thesis, Lumière University Lyon 2.

Bourdin, S., & Torre, A. (2023). L'économie circulaire, nouveau levier de développement et de transition écologique pour les territoires. *Population & Avenir, 763,* 4-7. https://doi.org/10.3917/popav.763.0004

CEQ (1973). *Council on Environmental Quality, Federal Register.* Federal Register. https://ceq.doe.gov/docs/laws-regulations/FR-1973-08-01-38-FR-20550-CEQ-NEPA-Guidelines-revised.pdf

CIMA (2017). *Environmental and Social Impact Assessment (ESIA) of Priority Lines and Rehabilitation Works at Manantali.*

Cirelli, C., & Florin, B. (2015). *Sociétés urbaines et déchets. Éclairages internationaux.* Presses Universitaires François Rabelais, 450 p. https://shs.hal.science/halshs-01218613

Cisse, C. (2016). *Living in the Shadow of the Manantali Dam: Social Representations of Impacts in Surrounding Camps and Villages.* Ph.D. Thesis, Paris 8 University.

COTA (2007). *La Gestion Axee Sur Les Resultats.* https://www.servicevolontaire.org/livres/developpement/LA_GESTION_AXEE_SUR_LES_RESULTATS.pdf

CSET (2020). *Adaptation to Climate Change and the World of Work.* https://www.etuc.org/en/adaptation-climate-change

Dione, O. (1996). *Recent Climate Change and River Dynamics in the Upper Basins of the Senegal and Gambia Rivers.* Ph.D. Thesis, Lyon 3 Jean Moulin University.

Faye, J. M. (2024). *Study of the Environmental Impacts of OMVS Hydroelectric Developments on the Physical, Chemical, and Biological Quality of Water: The Case of the MANANTALI Hydroelectric Dam.* Ph.D. Thesis, Iba Der Thiam University of Thiès (UIDT).

Faye, J. M., Ndao, S., & Sambou, L. E. V. (2023). Evolution of the Physico-Chemical Quality of the Water in the Manantali Dam Reservoir from 1989 (One Year after Impoundment) to 2022. *Journal of Geoscience and Environment Protection, 11,* 351-366. https://doi.org/10.4236/gep.2023.119022

Faye, J. M., Ndao, S., & Sambou, L. E. V. (2024a). Comparative Study of Physico-Chemical and Biological Water Quality Upstream and Downstream of the Manantali Dam and Hydropower Plant from 2019 to 2023. *Journal of Geoscience and Environment Protec-*

tion, 12, 111-131. https://doi.org/10.4236/gep.2024.1210007

Faye, J. M., Ndao, S., & Sambou, L. E. V. (2024b). Management of Significant Environmental Aspects and Impacts in Accordance with the ISO 14001:2015 Standard during the Operation and Maintenance Phase of Senegal River Basin Development Authority Hydroelectric Works and Facilities: The Case of Manantali Dam. *Journal of Geoscience and Environment Protection, 12,* 89-110. https://doi.org/10.4236/gep.2024.1210006

Faye, J. M., Ndao, S., & Sambou, L. E. V. (2024c). Study of the Biological Quality of the Water in the Manantali Dam Reservoir: Analysis of the Fish Fauna and Plankton Communities. *Journal of Agricultural Chemistry and Environment, 13,* 100-114. https://doi.org/10.4236/jacen.2024.131007

Fondja Wandji, Y. D., & Kamdem, J. S. (2020). Hydroelectric Revenue in Africa: An Assessment with Taxation And optimization of Total Production Costs. *Région et Développement, 52,* 147-170.

IPCC (2012). *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation—A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change.* https://www.ipcc.ch/report/managing-the-risks-of-extreme-events-and-disasters-to-advance-climate-change-adaptation/

Kundzewicz, Z. W., Mata, L. J., Arnell, N. W., Döll, P., Jimenez, B., Miller, K. et al. (2008). The Implications of Projected Climate Change for Freshwater Resources and Their Management. *Hydrological Sciences Journal, 53,* 3-10. https://doi.org/10.1623/hysj.53.1.3

Leduc, G., & Raymond, M. (2000). *Environmental Impact Assessment: A Decision-Making Tool.* Éditions MultiMondes.

Leopold, L., Clarke, F., Hanshaw, B., & Balsley, J. (1971). *A Procedure for Evaluating Environmental Impact* (p. 360). U.S. Geological Survey Circular.

Lévêque, C. (2005). Dam environment consequences. *Les colloques de l'Académie d'Agriculture de France, 1,* 33-43.

Mazama Sukamai, J., Bompeta Lombo, J., Yadoli Kosanga, C., & Holenu Mangenda, H. (2024). *The Impact of Household Waste on the Urban Environment in the Mpila Neighborhood, Ngaba Commune* (p. 13). HAL Open Science.

Mazouz, B., & Leclerc, J. (2008). *Integrated Management by Results.* Presses de l'Université du Québec.

Mebirouk, H. (2019). L'Amélioration urbaine, une action plurielle pour rechercher la qualité de vie. Quels effets sur la population et le cadre de vie dans les ensembles collectifs d'Annaba (nord-est Algérien). *Analele Universitatii Bucuresti: Geografie/Annals of the University of Bucharest—Geography Series, 68,* 75-97. https://doi.org/10.5719/aub-g/68.1/5

Multon, B., Moine, G., Aubry, J., Haessig, P., Jaouen, C., Thiaux, Y., & Ben Ahmed, H. (2011). *Energy Resources and Solutions for Supplying Electricity to Isolated Populations.* Electrotechnique du Futur. https://hal.science/hal-00674833/

N'Dahoule, Y. R. (2018). Methodological Contribution to the Evaluation of the Sustainability of the Living Environment. *Revue de Géographie de l'Université de Ouagadougou, 7,* 177-194.

Severino, J. M., & Naudet, J. D. (2009). *Manantali Dam, Joint Ex-post Evaluation. Summary Report.* https://www.eib.org/attachments/ev/ev_manantali_rapport_de_synthese_fr.pdf

Treabaol, L., & Chabal, J. P. (2003). ELA of the Adjarala Hydroelectric Project (Togo-Benin): The Aquatic Environment Component. *African Journal of Environmental Assess-*

ment and Management, 5, 55-65.

UTE (2012). *Operations on Electrical Works and Installations and in an Electrical Environment—Prevention of Electrical Risks NFC 18-510.*

Zouboulis, A. I., Loukidou, M. X., & Matis, K. A. (2004). Biosorption of Toxic Metals from Aqueous Solutions by Bacteria Strains Isolated from Metal-Polluted Soils. *Process Biochemistry, 39,* 909-916. https://doi.org/10.1016/s0032-9592(03)00200-0