Environmental and Social Impact Assessment

KAPICHIRA DAM REHABILITATION PROJECT

Volume I : Baseline description and impact assessment

EGENCO
Chayamba Building, No. 7 Victoria Avenue, Blantyre
MALAWI



PUBLIC

September 15, 2026

FINAL DRAFT REPORT

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LIST OF ABBREVIATIONS AND ACRONYMS

AIDS	Acquired Immunodeficiency Syndrome
a.s.l	Above Sea Level
ASTM	American Society for Testing and Materials
BOD	Biological Oxygen Demand
CIA	Cumulative Impact Assessment
COD	Chemical Oxygen Demand
CR	Critically Endangered
dBa	A-weighted decibels
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
E-Flow	Environmental Flow
EGENCO	Electricity Generation Company (Malawi) Limited
EIA	Environmental Impact Assessment
EN	Endangered species
EPRP	Emergency Power Restoration Project
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESS	Environmental and Social Standards
EU	European Union
FAO	Food and Agriculture Organization
FSL	Full Supply Level
GBV	Gender Based Violence
GoM	Government of Malawi
GRM	Grievance Redress Mechanism
HIV	Human Immunodeficiency Virus

HPP	Hydro Power Plant
IAS	Invasive Alien Species
ICT	Information and Communication Technologies
IDA	International Development Association
IUCN	International Union for Conservation of Nature
masl	meters above mean sea level
MEPA	Malawi Environment Protection Authority
MOH	Ministry of Health
MSCE	Malawi School Certificate of Education
NCDS	Non-Communicable Diseases
NT	Near Threatened
ORP	Oxidation Reduction Potential
PM	Particulate Matter
PMF	Probable Maximum Flood
PPE	Personal Protective Equipment
RAP	Resettlement Action Plan
SEA	Sexual Exploitation and Abuse
SP	Studio Pietrangeli
SVTP	Shire Valley Transformation Project
TA	Traditional Authority
TDS	Total Dissolved Solids
TIC	Total Inorganic Carbon
TOC	Total Organic Carbon
TSS	Total Suspended Solids
UNFCCC	United Nations Framework Convention on Climate Change
USBR	United States Bureau of Reclamation
VECs	Valued Ecosystem and Social Components
VU	Vulnerable
WHO	World Health Organization

EXECUTIVE SUMMARY

This summary focuses on the description of the baseline situation and the assessment of impacts (volume 1) of the Environmental and Social Impact Assessment (ESIA). The Environmental and Social Management Plan (ESMP) relating to this ESIA is contained in volume 2 of the study.

INTRODUCTION

Presentation of the Project

The Kapichira Hydropower Plant (HPP), located in Chikwawa District, within traditional Authority Kasisi, in southern Malawi, is a critical asset in the country's energy infrastructure. With an installed capacity of 129.6 MW, it represents 30% of EGENCO's generation capacity and contributes 23% of Malawi's total installed capacity. As the most downstream facility in the Shire River cascade, Kapichira HPP is situated within the Majete Wildlife Reserve, a nationally protected area managed by African Parks under a long-term public–private partnership with the Department of National Parks and Wildlife.

The region is highly vulnerable to natural disasters, particularly flooding. Tropical Storm Ana in January 2022 caused severe damage to Kapichira HPP, including overtopping of protective structures, erosion of the dam, and destruction of steel components on the spillway bridge. The event also disrupted electricity generation and damaged infrastructure related to the Shire Valley Transformation Program (SVTP), an irrigation initiative financed by the World Bank (referenced P158805). The SVTP irrigation project is linked to Kapichira dam through an integrated intake structure.

An Emergency Power Restoration Project (referenced P178914 by the World Bank) has been implemented by the Government of Malawi – Ministry of Finance and Economic Affairs through a standalone operation prepared under World Bank emergency procedures. The project has two main components: the first relates to generation, and the second to transmission and distribution. The project examined here forms part of Component 1, entitled "Kapichira Dam Rehabilitation and Strengthening". This component is implemented by Electricity Generation Company (Malawi) Limited (EGENCO).

In May 2023, Phase 1 of the Kapichira Hydropower Dam Rehabilitation and Strengthening component was completed. Phase 1 primarily involved the construction of a temporary upstream cofferdam and emergency rehabilitation works to restore reservoir water levels and resume electricity generation.

Phase 2 of the project adopts a "build back better" approach aimed at rehabilitating and strengthening the damaged infrastructure using an improved engineering design, that addresses the technical and operational deficiencies exposed by Tropical Storm Ana. This phase also includes upgrades to operational systems and the development of a Dam Safety Plan.

In January 2024, EGENCO appointed Tractebel Engineering S.A. (France), in association with RUO Consultants Ltd. (Malawi), to carry out the Environmental and Social Impact Assessment (ESIA) for Phase 2 of the Kapichira Dam Rehabilitation Project. This assessment is based on the revised design developed by the Owner's Engineer.

Objectives of the ESIA

The ESIA aims to:

- Ensure compliance with Malawi's environmental and social regulations;
- Align with the World Bank's Environmental and Social Framework, in particular with Environmental and Social Standard 1;
- Integrate stakeholder engagement in accordance with the World Bank Environmental and Social Standard 10;
- Define key management, mitigation and enhancement measures for predicted impacts and risks in the Environmental and Social Management Plan (volume 2 of this study).

Several critical issues to be addressed during Phase 2 were identified and are detailed in the ESIA, including:

- Site constraints, as construction activities and associated facilities are located within a restricted area bordered by the existing dam, the Shire River, and the Majete Wildlife Reserve. The ESIA was closely coordinated with the design study to assess layout and access options (e.g., quarry site) and ensure integration of environmental, health, safety, and social considerations.
- Protected area proximity, as Kapichira HPP lies partially within the Majete Wildlife Reserve and entirely within its buffer zone. The ESIA considered the ecological sensitivity of this area and involved continuous consultation with reserve managers to avoid delays or operational restrictions.
- Access roads and the location of the quarry and borrow sites, as well as the contractor's camp were closely scrutinised.
- Sediment management. The project presents environmental and social risks related to sediment management, particularly concerning the downstream Elephant Marsh Ramsar site. Phase 1 initiated sediment removal, while Phase 2 focuses on sustainable sediment management. The ESIA builds on basin-wide sediment assessments and cumulative impact studies conducted under the Mpatamanga project, among others.
- Environmental Flow requirements were reviewed and validated in the ESIA to mitigate downstream impacts.

LEGAL AND INSTITUTIONAL FRAMEWORK

Malawi's 2004 National Environmental Policy was identified as key for this study. This policy establishes the framework for sustainability, underpinning EIAs and ESMPs, and promoting socio-economic development through sound environmental management. It addresses issues such as resource use, ecosystem integrity, environmental health, and citizens' rights and responsibilities, including legal recourse against harmful activities. Complementing this, the 2002 National Environmental Action Plan integrates environmental considerations into development planning, defines stakeholder roles, and addresses challenges such as population growth, poverty, and illiteracy. It establishes measures to prevent environmental degradation and ensure sustainable resource use.

The ESIA also reviewed all other relevant national policies, including those related to land, forestry, fisheries, employment and labour, gender, and public health. Furthermore, it includes an assessment of applicable international environmental conventions and agreements ratified by the Government of Malawi. The project must consider obligations under these instruments and address any associated environmental and social impacts.

The Project will also comply with the World Bank's Environmental and Social Framework (ESF), its relevant Environmental and Social Standards (ESS 1 to 6, ESS 8 and 10), the WBG Environmental, Health, and Safety Guidelines (EHSGs), and other applicable Good International Industry Practices (GIIP)..

PROJECT DESCRIPTION

Overview of Kapichira HPP characteristics

The Kapichira Dam is an earth-filled zoned embankment, 820 m in length and averaging 22 m in height. The main embankment lies between the spillway and the fuse plug wing. Kapichira Hydropower Plant operates as a run-of-river scheme with a small reservoir (4.5 Mm³ total storage) providing daily regulation for peaking services, ensuring supply during peak demand.

Kapichira components to be rehabilitated

The project aims to enhance resilient operation of the 129.6 MW Kapichira hydropower plant through the rehabilitation of the Kapichira dam and the upgrade of spillway. It should be noted that the hydropower plant is not affected by this rehabilitation.

Phase 2 of the Kapichira dam rehabilitation requires works on the associated components of the dam: The main spillway gates, the embankment dam, the emergency spillway, the right embankment and the training dyke.

As it is partly integrated into the Kapichira dam, the project will also rehabilitate the permanent intake for the Shire Valley Transformation Program project.

At the end of the rehabilitation works, part of the current embankment material, located between the existing training dyke and the dam embankment, will be removed in order to restore the function of the training dyke and allow reservoir water to feed the permanent SVTP irrigation intake.

The construction activities will require the following facilities (see the following map): a quarry site for embankment materials, a borrow site for impervious core construction, a disposal area for surplus excavated material, a batching plant for concrete production, a temporary contractor campsite and a permanent camp for EGENCO staff.

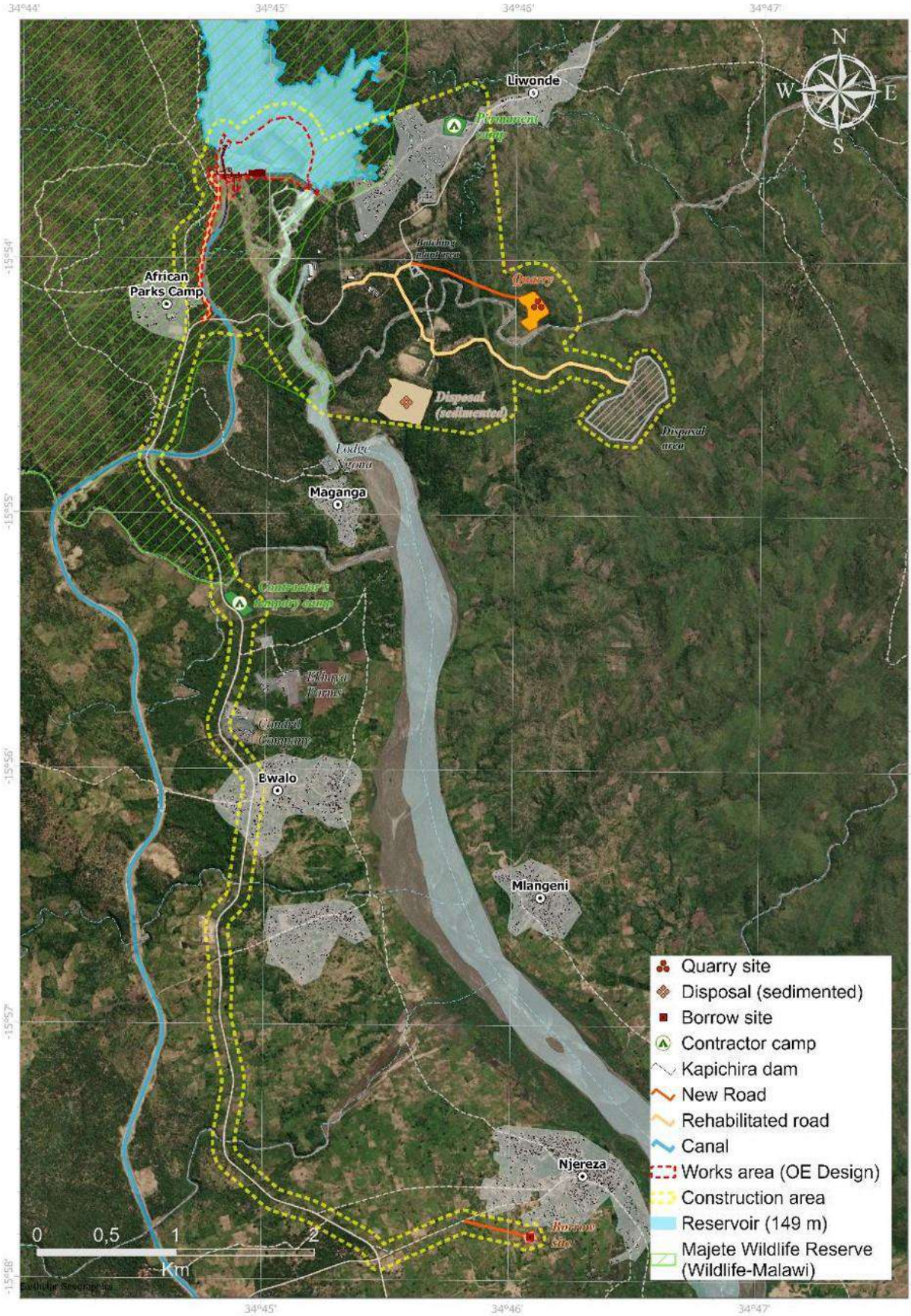


Figure 0-1: Kapichira project area

Project's areas of influence

The project's direct footprint includes mainly the dam and reservoir areas. The direct footprint area (in red on the map) is the most sensitive area during the construction phase, and must also be considered during the operation phase.

The construction influence area (in yellow on the map) includes the direct footprint area and the construction facilities including the quarry and borrow sites, the disposal site, the camps, and the access roads. It primarily aims to address the construction phase impacts, such as noise, visual impact, air pollution, traffic, and interactions with local communities.

The downstream influence area refers to the area downstream of the dam and extends from the Kapichira HPP tailrace to upstream of Elephant Marsh, encompassing the Shire River channel, riparian areas, wetlands dependent on river flows, and flood-prone zones such as the Chikwawa floodplain.

METHODOLOGY FOR THE BASELINE

Methodology for the assessment of the physical environment

The methodology for the assessment of the physical environment was primarily based on existing data. Complementary investigations were carried out through water sampling, noise level measurements and air quality assessments in the construction area. The field investigations were organised in two phases, from 6 to 16 August 2024 and from 21 to 22 November 2024.

Methodology for the assessment of the biological environment

After analysing existing studies within the project area of influence, the Consultant undertook complementary fauna and flora investigations in the construction influence area during the dry season in August 2024 and for additional components of the construction influence area in April 2025.

Methodology for the assessment of the human environment

The socioeconomic assessment combined remote sensing, desk-based research, and fieldwork. Satellite imagery analysis provided an initial overview of land use, habitat density, and infrastructure. Field investigations included district-level interviews with administrative and traditional leaders, village-level surveys within the construction influence area, complemented by household-level questionnaires. Eight villages were surveyed between 23 and 30 September 2024.

ENVIRONMENTAL AND SOCIAL BASELINE DESCRIPTION

Description of the physical environment

Key considerations for the physical environment include the Shire River, sedimentation issues, and climate change impacts:

- The Shire River, Malawi's largest river and the sole outlet of Lake Malawi, stretches approximately 700 km through southern Malawi before joining the Zambezi River in Mozambique. Its natural flow has been altered by four dams—Kamuzu (1965), Nkula (1966), Tedzani (1973), and Kapichira (2000). It should be noted that Mpatamanga HPP planned upstream of Kapichira will further disrupt the natural flow of the Shire River.

- Sedimentation: A bathymetric survey revealed that Kapichira Reservoir had lost over 40% of its initial live storage and 59% of its gross capacity after 13 years of operation in 2013, equating to a 4.3% annual loss. This reduction limits the peaking capacity critical for meeting energy demand. Overall, sedimentation is among the key issues described in the ESIA.
- Climate Change: Cyclonic events are the primary drivers of major floods in the project area. These events, delivering 200–300 mm of rainfall within 24 hours, occur during the rainy season when catchments are saturated. Their frequency has increased since 2015. Analysis indicates that peak floods rise more sharply for lower return periods. For a 20-year return period, increases range from 42% to 117% depending on the climate change scenario. All scenarios underscore the need for conservative design margins to ensure long-term resilience.
- The air quality data as well as the water quality samples in the construction influence area comply with the national environmental requirements as well as the WHO guidelines.

Description of the biological environment

The project area is located within the tropical and subtropical grasslands, savannas, and shrublands biome. The ecoregions found in the project area are the Southern Miombo Woodlands and the Zambezian and Mopane Woodlands.

The main protected and internationally recognised areas in the vicinity of the project are:

- The Majete Wildlife Reserve, located within the project's direct footprint, is a model of successful habitat restoration and anti-poaching under African Parks management. The reserve was created in 1955 and officially declared a protected area in 1975. It hosts iconic species such as the elephant, lion, leopard, buffalo, giraffe, cheetah, and black rhino, many reintroduced after local extinction. Several threatened species have been recorded, including the Black Rhino (Critically Endangered), African Elephant (Endangered), and African Wild Dog (Endangered). Although the reserve is fenced, its proximity to the project area increases the risk of impacts during construction.
- Elephant Marsh, located on the floodplain of the Lower Shire River, is one of the key wetland ecosystems in the downstream area. It was officially designated as a Ramsar site in 2017, reflecting its ecological importance and its role in the conservation of wetlands of international importance. This remarkable ecosystem covers a vast area encompassing a mosaic of rooted aquatic vegetation, floating vegetation and open bodies of water bordered by meadows, reedbeds and islands where reeds, shrubs and palms grow.

The main results from the 2024 biological field survey are as follows:

- About flora:
  - In all sites, the majority of flora species were listed as Least Concern or not evaluated in relation to the global IUCN red list except for one Near Threatened, *Dalbergia melanoxylon*, a species recorded in several sampling areas, commonly known as African blackwood, which faces significant threats from overharvesting due to its valuable timber. Other valuable species like *Pterocarpus angolensis, Combretum molle* or *Burkea Africana* are present on the quarry site and heavily targeted for timber and charcoal.

- Seven (7) protected tree species were confirmed to be present in the project area: *Terminalia sericea, Burkea africana, Cordyla africana, Dalbergia melanoxylon, Combretum molle, Sclerocarya birrea* and *Pterocarpus angolensis*. All these species fall under Part II of the plant protected species schedule. These species are considered vulnerable or rare. Most of them seemed to thrive in Majete Wildlife Reserve's protected environment, but also on customary land (e.g. quarry site) where they are threatened by charcoal and timber production.
- Fifteen (15) species found were identified as invasive species with 80% being terrestrial species. The presence of aquatic invasives, while low during the field survey, is still notable in the project area. The aquatic species of greatest concern are those that may affect power generation such as *Potederia crassipes* (Water hyacinth).

- About aquatic fauna: In the Shire River, the presence of fish species of conservation concern was confirmed in the project area of influence, including *Oreochromis mossambicus* and *Opsaridium microlepis* (both classified as Vulnerable by the IUCN). These species are particularly sensitive to hydrological changes and anthropogenic pressures. *Oreochromis karongae* (classified Critically Endangered by the IUCN) was identified in the dam reservoir, but no viable populations are present due to the ecological state of the Middle Shire River.
- About avifauna: 137 bird species were encountered during the 2024 field survey. All recorded species were classified as Least Concern on the IUCN Red List.
- About terrestrial fauna:
  - 142 terrestrial invertebrate species were recorded during the 2024 survey. The invertebrates sampled during this survey do not appear to be classified as threatened at national and international levels.
  - 36 herpetofauna species (26 reptiles and 10 amphibians) were identified with the African Python – *Python sebae* – classified as Near Threatened, which was identified in the Majete Wildlife Reserve, in the construction influence area.
  - 61 mammal species were recorded, including large herbivores, carnivores, and small mammals, many of which are classified as species of conservation concern.
    - Within the Majete Wildlife Reserve along the banks of the Shire River (including the reservoir), the most recorded species include large herbivores such as Eland (*Taurotragus oryx*), Impala (*Aepyceros melampus*), Nyala (*Tragelaphus* angasii), Waterbuck (*Kobus ellipsiprymnus*), Common wildebeest (*Connochaetes taurinus*) African buffalo (*Syncerus caffer*), African elephant (*Loxodonta africana*) and Hippopotamus (*Hippopotamus amphibius*). Large carnivores such as lion (*Panthera leo*) and leopard (*Panthera pardus*) are also present but were identified with indirect sightings (carcasses of herbivores and footprints).
    - Outside the Majete Wildlife Reserve, some indirect and direct sightings of species present in the Majete Wildlife Reserve were recorded in the direct footprint area: footprint of Hippos; scats of Bushbuck (*Tragelaphus scriptus*), Common warthog (*Phacocoerus aethiopicus*), Plains zebra (*Equas quagga*), Honeybadger (*Mellivora capensis*), Nyala (*Tragelaphus angasii*), Waterbuck (*Kobus ellipsiprymnus*), African wild cat (*Felis silvestris lybica*), Impala (*Aepyceros melampus*), Porcupine (*Hystrix africaeaustralis*) and Serval (*Laptailurus serval*); sightings of Chacma baboon (*Papio hamadryas ursinus*).

- Two small rodent species were identified: the pouched mouse (*Saccostomus campestris*), recorded in multiple locations including in the direct footprint area, and the multimammate mouse (*Mastomys natalensis*), found along the downstream Shire Riverbank. Both species are classified as Least Concern (LC) by the IUCN.
- In the downstream influence area, twenty-one (21) mammal species were recorded on the left bank of the Shire River, with chacma baboon and Bushveld gerbil (*Tatera leucogaster*) as the most frequent species. Eight (8) mammal species were recorded on the right bank of the Shire River, with the vervet monkey (*Cercopithecus aethiops*) as the most frequent species.
- In the Chikwawa floodplain and the upper part of Elephant Marsh, twenty (20) mammal species were identified, with no threatened or near-threatened species.

The Critical Habitat Assessment further identified 11 species meeting critical habitat criteria across terrestrial, aquatic, and wide-ranging ecological zones, including Black Rhinoceros, two vulture species (White-headed and White-backed), six waterbird species, and one turtle species. The Black Rhinoceros, vultures, and turtle qualify under Criterion 1 for Critically Endangered or Endangered species.

The ecological challenges of the Kapichira dam rehabilitation project are significant and can be considered at two levels:

- Within the direct footprint area (near the Majete Wildlife Reserve):
  - The proximity of threatened species and natural habitats is a top priority.
  - The significant aquatic habitat degradation in Kapichira reservoir due to riverbank erosion, sediment accumulation, and fluctuating water levels.
- Within the area of influence (Lower Shire River – Elephant Marsh), issues related to water flow, sedimentation, and hydrological fluctuations require particular attention to minimize impacts on downstream ecosystems.

Description of the human environment

Chikwawa District has a relatively low population density (116 inhabitants/km²), with a predominantly young demographic and high fertility rates.

In the construction influence area:

- The average household size is 4.7.
- The age and sex pyramid is quite similar as in Chikwawa District with a majority of young population (less than 18 years old).
- 65% of households are headed by men, which is similar to the national level.
- 85,9% of households are characterised by people of Yao ethnicity.
- 96,6% of households are Christian.
- The Chichewa language is spoken in the project area, as in the district.
- 68% of the household heads are literate such as the national level, with gender disparity: literacy among women is 51%, compared to 72% among men.
- 88% of households live in their own houses, with no difference between female or male headed households.

- 91,7 % of households use borehole as the most common source of water for domestic use.
- 64% of households use pit latrines without a slab for sanitation.
- No history of tribal clashes was reported in the project area.

The 2024 survey showed that the source of income comes from task-based work for 43.5% of the people, from the combination of task work and farming for 21.4% of the people, from the combination of task work, business and farming for 9.9% of the people. In total, 83% of household income comes from task-based work, which is more than the national level and the district level.

ENVIRONMENTAL AND SOCIAL RISKS AND IMPACTS

Environmental and Social risks for this project have been rated high in the project appraisal document from the World Bank (IDA – 6 June 2022) because the capacity of EGENCO with regard to environmental and social management and its knowledge of the ESF requirements of World Bank financed projects was noted to have been limited on previous World Bank funded project, even though since then improvements have been made on staffing under the current project to ensure adequate attention to safeguards issues. There is also significant risk to biodiversity if mitigation measures are not implemented appropriately, including at Majete Wildlife Reserve, fish biota within the river, and the Ramsar Elephant Marsh wetland downstream of the project site.

Risks and impacts during the construction phase

The construction phase is expected to last approximately 3.5 years.

No major impact was identified due to the project activities, mainly due to the fact that Kapichira is an existing dam with a power plant already in operation. The assessed impacts of moderate significance are as follows:

- About physical environment:
  - Deterioration in air quality due to dust and gas emissions, mainly due to transport activities;
  - Increase in noise level, mainly due to the quarry activity and transport activity;
  - Risk of erosion and modification of the physico-chemical properties of the soil, mainly due to the proximity of river banks from the construction area;
  - Disaster risk due to the lack of emergency spillway;
- About biological environment:
  - Risk of loss, fragmentation and degradation of natural habitats and flora, due to the need for construction facilities such as temporary camp site, quarry site, borrow area, disposal area and corresponding new access roads;
  - Spread of flora invasive species;
  - Disturbance of wildlife due to proximity to the Majete Wildlife Reserve;
  - Risk of human-wildlife conflict and increased poaching due to the proximity of wildlife from the construction area;
  - Risk of aquatic mortality and loss of aquatic habitats;

- Specific impacts to the critical habitat qualifying species such as the Black Rhino and African Wild dog confined in the Majete Wildlife Reserve, the Vultures, the Black Heron, the African Openbill, the African Skimmer, the Whiskered Tern, the Collared Pratincole and the Basra Reed-warbler primarily associated in the Elephant Marsh.

- About human environment:
  - Risk of violence based on gender, due to the presence of workers;
  - Risk of damage to cultural heritage, by uncovering archaeological artefacts during excavation works or by damaging a community church site at the vicinity of the quarry site;
  - Loss of land due to the acquisition of land for construction facilities;
  - Change in land use due to the construction activities.

All these impacts after mitigation are considered to be minor, except for the two last impacts:

- Land acquisition for temporary facilities will require compensation. Although no physical displacement is expected, a Resettlement Action Plan (RAP) is necessary to detail compensation measures for land loss.
- Use of community land for construction facilities (primarily agricultural land without permanent structures) will alter land use and affect livelihoods. This impact also requires compensation through a RAP.

It should be noticed that employment opportunities could have a longer-lasting positive impact at the local level by prioritizing the employment of local workers from the TA Kasisi.

Risks and impacts during the operation phase

No major impact was identified due to the project activities during the operation phase, as Kapichira is an existing dam with power plant already in operation. The assessed impacts of moderate significance are as follows:

- About physical environment:
  - Disturbance of the sediment balance and erosion of the Shire River with the current operating procedures;
  - Siltation of the Shire River downstream of the dam.
- About biological environment:
  - Risk of trapped fauna in the island between the main spillway and emergency spillway;
  - Risk of disturbance of aquatic wildlife due to sediment management;
  - Risk of human-wildlife conflict;
  - Risk of site invasion by invasive exotic species during equipment maintenance;
  - Reduction of downstream nutriment load affecting species dependent on nutrient-rich wetland habitats.
- About human environment:
  - Health and safety risks for the communities due to disaster risks.

All these impacts after mitigation are considered to be minor, except for the reduction of downstream nutrient load, because the proposed measure—remobilizing dredged sediment downstream—requires further investigation regarding sediment quality and existing downstream loads.

It should be noticed that disaster risk will be reduced due to the presence of emergency spillway providing a significant positive impact on the physical, biological, and human environment. This benefit could be maximized by implementing an Emergency Preparedness Plan.

Cumulative impacts

The cumulative impacts result from the combination of impacts from other relevant past, present and reasonably foreseeable developments. The objective is to assess the cumulative environmental and social impacts of the Kapichira dam rehabilitation project with other developments, in particular across the Shire Basin. The study has considered the Rapid cumulative impact assessment carried out for the Mpatamanga hydropower project.

Two major projects are expected to interact with the Kapichira Dam rehabilitation:

- Mpatamanga Hydropower Project: Planned for construction on the Shire River, approximately 11 km upstream of Kapichira, this project will alter the hydro-sedimentary regime and increase pressure on biological and human environments. Both projects are scheduled to commence construction in 2026.
- Shire Valley Transformation Program: The SVTP irrigation project, which includes an intake structure integrated into Kapichira Dam, will require clear coordination of reservoir management for dual uses—energy generation and irrigation—while maintaining environmental flows downstream. SVTP aims to irrigate approximately 43,370 ha in Chikwawa and Nsanje Districts through three main canals totalling about 133 km, improving food security and economic prospects. Stage I includes the intake structure at the western embankment of Kapichira Reservoir, designed to supply water by gravity to over 22,000 ha, including 10,000 ha of new irrigation land. Both uses must ensure compliance with environmental flow requirements to protect downstream ecosystems.

The ESMP (volume 2 of this report) has considered the measures for these two projects to design the relevant measures for this project, in particular about the sediment management plan and the biodiversity management plan.

ANALYSIS OF ALTERNATIVES

Alternative with « No project »

The emergency spillway would not be repaired, increasing the likelihood of uncontrolled reservoir emptying during extreme floods—events projected to intensify under climate change, with design flood increases of 42–117% for a 20-year return period. Maintenance of the main spillway would become costly due to persistent hoisting system failures, while sediment management would remain inadequate, causing negative downstream impacts on ecosystems, including the Elephant Marsh Ramsar site. Additionally, the risk of dam failure from sediment accumulation and extreme climatic events would remain unmitigated.

Alternatives about construction technologies

- Emergency Spillway: The TOPS gate was selected as it allows debris and sediment management with low management. No negative impact on the environment has been identified; this is the most environmentally friendly option.

- Permanent Intake: Self-regulating gates were chosen for their cost-effectiveness, technical reliability, and environmental performance. This design ensures flow regulation even if one gate fails.
- Training Dike: The current layout was retained as:
  - it keeps the area upstream the outlet works free from significant sediment deposition,
  - it facilitates the dredging operation as the deposition occurs mainly in a confined area of the reservoir upstream the training dyke,
  - it leads to higher velocity in case of flushing operation as the main flow path is confined in a narrow channel located in the left side of the reservoir.

Alternatives about construction facilities

- Quarry Site: Among four options, Alternative 4 was selected for its proximity to the dam site, minimizing transport through villages, reducing greenhouse gas emissions, and avoiding nearby settlements.
- Contractor's Camp: Alternative 1 was chosen for its closeness to the dam (lower fuel use), absence of nearby water sources (reducing pollution risk), existing access road (avoiding new road construction), and distance from villages and cultural heritage sites. The site is agricultural land with no equipment and poses no biodiversity concerns.
- Clay site: Among four options, the alternative chosen was the one that could deliver sufficient clay material for the need of the project. No option could avoid the need for land acquisition.

PUBLIC CONSULTATION AND STAKEHOLDER ENGAGEMENT

Effective stakeholder engagement can improve the environmental and social sustainability of projects, enhance project acceptance, and make a significant contribution to successful project design and implementation. The Environmental and Social Standard ESS10 applies to all projects supported by the World Bank through investment project financing such as this project. It should be noticed that the construction activities are located within the existing footprint and reservoir of Kapichira Hydropower plant and reservoir. However, access to the different sides of the construction site will be through local villages and Majete Wildlife Reserve, and the SVTP project site, as well as through EGENCO'S Kapichira HPP property.

Key stakeholders included national companies, administrative and customary authorities, and communities living upstream and downstream of the dam. Stakeholder engagement followed ESS10 principles of early, open, inclusive, and continuous participation throughout the project lifecycle. The process began with institutional consultations in May 2024, followed by public meetings, interviews with village leaders, and focus group discussions in seven villages. Approximately 100 participants from Bwalo and 50 from Liwonde were consulted, raising concerns about land loss, noise, air pollution, social risks, and cultural heritage issues, while also acknowledging benefits such as improved livelihoods and business opportunities. Proposed mitigation measures included community engagement, provision of personal protective equipment for workers, improved health services, and cultural ceremonies to address spiritual concerns.

Institutional stakeholders — EGENCO, Chikwawa District Council, traditional leaders, African Parks — expressed support for the project, emphasizing employment opportunities and corporate social responsibility. Key issues identified included land acquisition, waste management, road safety, wildlife interactions, and quarry restoration. Recommended actions include strengthening agreements on land use, enhancing community sensitization, implementing safety measures, and restoring impacted landscapes.

The Consultant, with the participation of EGENCO, conducted final public consultations meetings located within the construction influence area between 26-27 November 2025. Key stakeholders meetings with the Chikwawa District Environmental Sub-Committee and the African Parks were organised on 25 November 2025. These consultations aim to inform stakeholders about the progress and content of the ESIA, gather the opinions of those affected by the project on development choices, and present the results of the study to them in order to gather their opinions on the proposed measures. The outcome of the activity was the inclusion of the opinions gathered during the consultations in this study.

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

Detailed mitigation and monitoring measures are presented in the ESMP (Volume 2 of the ESIA) including the stakeholder engagement plan (Appendix A of the volume 2) as well as the Sexual Exploitation and Abuse / Sexual Harassment action plan (Appendix B of the volume 2) for the project.

Due to land acquisition for the quarry site, the borrow site and the contractor campsite, a resettlement action plan, including a livelihood restoration program, was carried out and is provided in a separate document.

1. INTRODUCTION

1.1. Project background and justification

1.1.1. Project Background

1.1.1.1. CONTEXT OF THE KAPICHIRA HYDROPOWER PLANT

The state-owned Electricity Generation Company (Malawi) Limited (EGENCO) is responsible for the operation, maintenance, and improvement of the power generation facilities owned by the Government of Malawi. These include hydroelectric, thermal and solar power plants. Currently, EGENCO operates four hydropower schemes: Nkula, Tedzani, Kapichira and Wovwe.

Kapichira Hydropower Plant (HPP) is located in Chikwawa District, 70km to the south-west of Blantyre in the southern region of Malawi (see the Figure 1-1). It has an installed capacity of 129.6MW and is the largest contributor to the National Grid whereby it contributes to 30% of EGENCO's installed generation capacity accounting for 23% of Malawi's total installed capacity. Kapichira dam includes an under-construction irrigation intake for the Shire Valley Transformation Program (SVTP), an irrigation program[1] financed by the World Bank. In the coming future, the new hydropower development should consider the development of Mpatamanga HPP upstream Kapichira HPP.

It is the most downstream HPP in the Shire River HPP cascade and located within the Majete Wildlife Reserve, a national protected area established in 1955, managed by African Parks which entered into a 25-year public–private partnership with the Malawi Department of National Parks and Wildlife (DNPW) in March 2003.

Sediment management is a significant issue for Kapichira HPP. A significant volume of sediment has accumulated upstream of the dam since Kapichira was first commissioned in 2000. It is thought that sediment deposition has been greater than expected because reservoir levels have been managed at a higher level than originally planned, to allow for peaking generation. The scheme was originally designed as self-flushing, but this is not effective at the higher reservoir levels, and the scheme did not incorporate structures that could be used for sediment flushing. EGENCO was managing sediment accumulation by dredging and weekly flushing.

Kapichira hydropower plant is a strategic asset at the heart of Malawi's electricity supply, providing a significant share of the country's hydropower generation. However, its exposure to extreme floods and other climate-related risks has revealed critical vulnerabilities. The Emergency Power Restoration Project aims to restore Kapichira's generating capacity while enhancing its resilience to future climate change impacts, thereby strengthening Malawi's long-term energy security.

[1] The SVTP aims at irrigating about 43 370 ha of land in Chikwawa and Nsanje Districts.

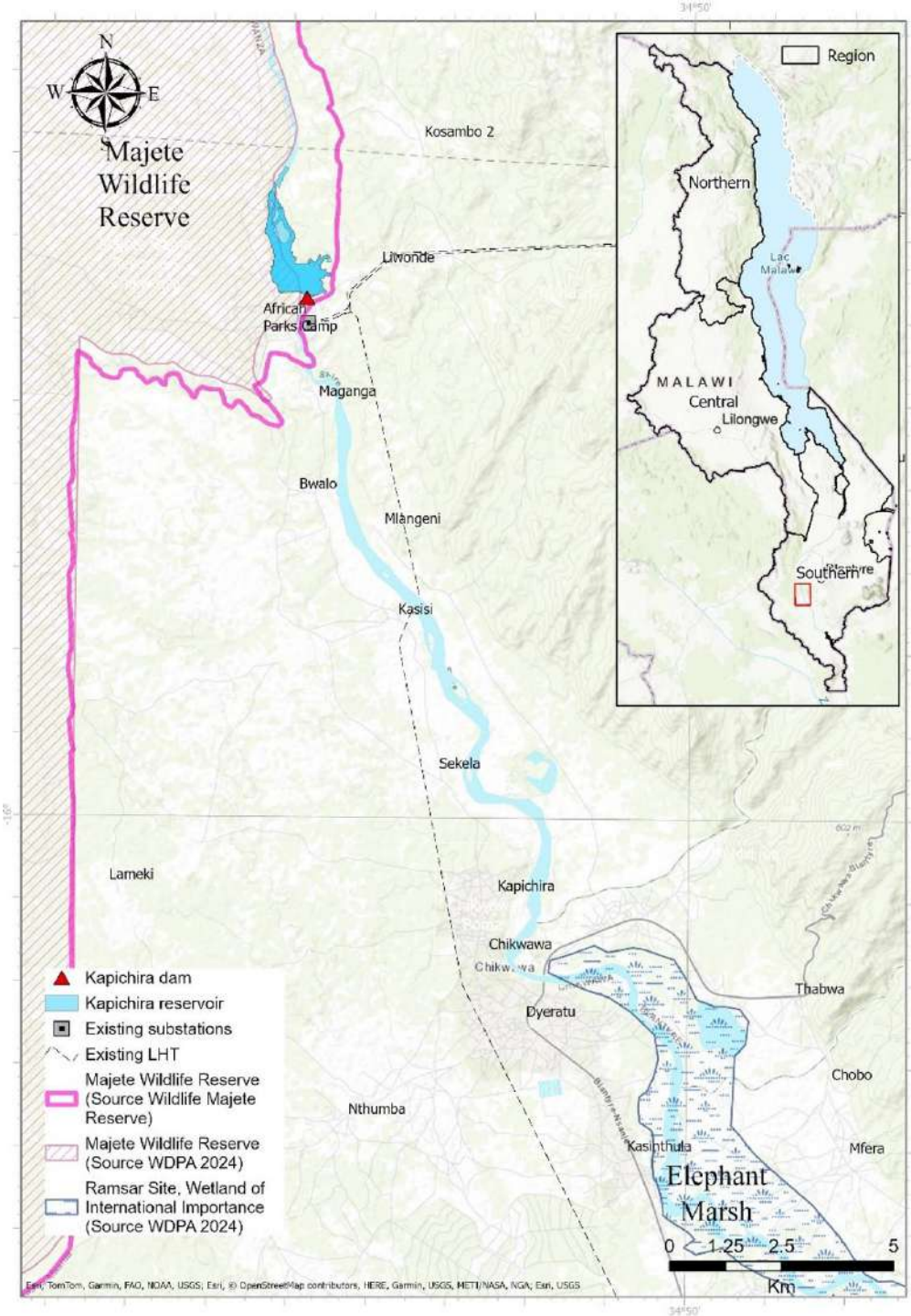


Figure 1-1: Location of the Kapichira hydropower dam

1.1.1.2. CONTEXT OF THE TROPICAL STORM ANA

The region, and project area, is vulnerable to natural disasters especially flooding and drought. Cyclone Bansi and Tropical Storm Chedza in 2015, Hurricane Ida in 2019 and Tropical Storm Ana 2022 have each caused devastating floods and state of disaster emergencies.

The January 2022 floods caused by the tropical storm Ana resulted in overtopping of a river training dike, failure of the 160m long fuse plug, and overtopping part of the dam wall (including the training dyke and fuse plug) on the right bank, as well as erosion of

the main dam slopes and crest, and damage to steel structures on the spillway bridge of the station. Following the fuse plug failure, the reservoir emptied, and electricity generation stopped.

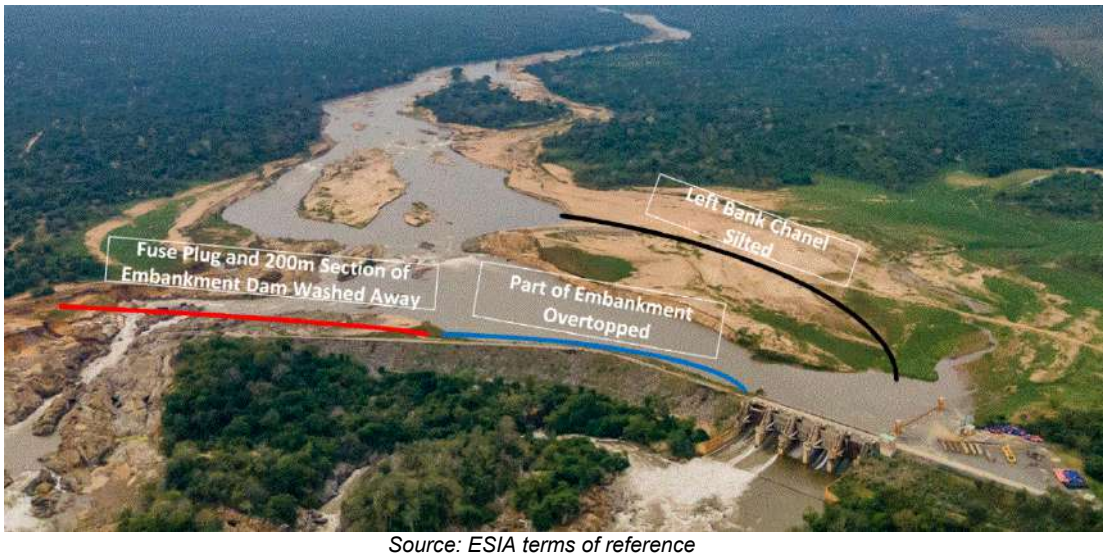
Tropical Storm Ana, which extensively damaged Kapichira HPP's dam and fuse plug, also damaged the under-construction irrigation intake and part of the main canal for the Shire Valley Transformation Program (SVTP), an irrigation program financed by IDA (P158805).

The figures 1-2 and 1-3 show the situation of the dam shortly after the flood.



Source: Studio Pietrangeli Consulting Engineers, 100GENRSP002B, Preliminary Design Report, November 2024

Figure 1-2: General view of Kapichira dam after the cyclone in September 2022



Source: ESIA terms of reference

Figure 1-3: Location of structures damaged by the floods caused by the tropical storm Ana

In 2022, Kapichira dam sustained partial damage due to this event. However, it was back to full operation in May 2023, when the phase 1 of the Emergency Power Restoration Project was completed as described hereafter.

1.1.2. Emergency Power Restoration Project

1.1.2.1. CONTEXT OF THE EMERGENCY POWER RESTORATION PROJECT

The Emergency Power Restoration Project (EPRP) is implemented through the Government of Malawi – Ministry of Finance and Economic Affairs financed by the World Bank Group (International Development Association). The EPRP has two components: (1) Kapichira Hydropower Dam Rehabilitation and Strengthening and (2) Transmission and Distribution Network Restoration.

Electricity Generation Company (Malawi) Limited (EGENCO) is the implementing entity for the component (1) Kapichira Hydropower Dam Rehabilitation and Strengthening. This component includes two phases:

- The phase 1 is for “Energy restoration”, to be implemented through raising water levels back to operational levels and by developing a temporary coffer dam upstream of the damaged infrastructure.
- The phase 2 is to “Build-back better”, which includes rehabilitating the damaged Kapichira dam and spillways based on a revised design, and to improve Kapichira HPP sediment management. This phase is covered by this ESIA.

Electricity Supply Corporation of Malawi Limited (ESCOM) is the implementing entity responsible for the Component 2 relative to the transmission and distribution network restoration. The damage caused by the tropical storm has been in various degrees including complete line sections, isolated structures and damage to specific equipment and materials in a manner that permanent rehabilitation works shall have to be undertaken comprising of complete line construction works, replacement of structures, and of specific equipment and materials. ESCOM’s infrastructure affected by Tropical Storm Ana include both transmission (132kV & 66kV) and distribution (33kV, 11kV and 400V lines) networks where a number of power line components have been affected. This ESIA and associated ESMP do not cover this Component 2.

1.1.2.2. PHASE 1: ENERGY RESTORATION

Energy restoration was achieved by raising water levels back to operational levels and developing a temporary coffer dam upstream of the damaged infrastructure. Initiation of sediment removal from the reservoir was also included in phase 1.

The phase 1 works, funded by EGENCO, included the construction of cofferdam sections, including cement-soil cofferdam, constructed by SVTP in the area where the fuse plug failure occurred. These works were not funded by the World Bank[2]. The

[2] Based on the project Appraisal Document (Report No: PAD5022) from International development Association, on June 6, 2022: The Shire Valley Transformation Project (SVTP) canal intake, located immediately upstream of the Kapichira Dam, also suffered significant damage during the Tropical Storm. The damaged intake was under construction at the time of the storm event, which would have resulted in its higher vulnerability to flood impact, in comparison to completed and commissioned infrastructure. Reconstruction of this intake would directly interface with and benefit from some of the reconstruction works for the Kapichira Main Dam. The SVTP had unallocated funds that are proposed to be deployed towards construction of the cofferdam and initial protections works for Kapichira Dam. An amount of up to US$15 million was available from the SVTP to fund part of the initial reconstruction works for Kapichira.

environmental and social instruments will be considered through SVTP's updated ESMP.

Other phase 1 works were the repair of spillway gates, the desilting of the left bank[3] channel of the reservoir, and the temporary reinstatement of a bridge on the access road. The phase 1 works lasted from December 2022 to May 2023 with the Kapichira hydropower plant operating at full capacity with the temporary cofferdams in place (see the Figure 1-4).



Source: Studio Pietrangeli drone photo, August 2023 from Studio Pietrangeli Consulting Engineers, 100GENRSP002B, Preliminary Design Report, November 2024

Figure 1-4: Situation of Kapichira dam rehabilitation at the end of Phase 1

1.1.2.3. PHASE 2 : BUILD-BACK-BETTER

Phase 2, goal of this current phase of the project, includes the rehabilitation of the damaged infrastructure based on a revised design, and the improvement of Kapichira HPP sediment management.

Based on a revised design that would address key technical and operational features that contributed to the failure, this component will (i) rehabilitate damaged infrastructure (mainly the dam), (ii) upgrade the Kapichira scheme to enhance the resilience of the hydropower scheme (especially the main and emergency spillways), and (iii) support companion actions on operation and maintenance and sediment management.

The estimated duration of the main construction activities is estimated for approximately 44 months.

[3] Which was used in the EGENCO dyke, so not actually removed from the storage area.

The Owner's Engineer Consultancy

Phase 2 started with the mobilization of international consultancy firm Studio Ing. G. Pietrangeli S.r.l., who were appointed as Owner's Engineer (OE), for EGENCO.

The OE has reviewed damage and previous design of the Kapichira scheme. On this basis and while integrating the new needs for SVTP irrigation intake, the OE has modelled hydraulic and sediment flows under different build back better scenarios and recommended detailed scope of rehabilitation and upgrade for key infrastructure such as the dam, emergency spillway, and main spillway. The OE should as well propose an upgrade to ease operation and maintenance of the gates since they were identified as part of the root causes of the damage as well as develop the relevant Dam Safety Plan.

The ESIA Consultancy

In January 2024, EGENCO appointed Tractebel Engineering S.A. (France) in association with RUO Consultants LTD. (Malawi) as the Consultant for an Environmental and Social Impact Assessment (ESIA) for Kapichira Dam Rehabilitation Project, Phase 2 based on the design from the OE. Contractual commencement of services was on 25 March 2024. The organization chart of the Consultant's ESIA team is shown in the Appendix O.

1.2. Purpose of this report

The report at hand is on the Environmental and Social Impact Assessment for the phase 2 "build back better" of Kapichira Hydropower Dam Rehabilitation and Strengthening[4], based on the design studies provided by the Owner's Engineer.

The ESIA includes the baseline description and impact assessment which addresses E&S risks and impacts (Volume 1) and the Environmental and Social Management Plan (Volume 2).

The terms of reference providing detailed requirements for preparing the full scale Environmental and Social Impact Assessment for the proposed phase 2 of Kapichira dam rehabilitation and strengthening project were issued by Malawi Environmental Protection Authority (MEPA) to EGENCO on 22 April 2024 (See Appendix A). The ESIA was initiated in April 2024.

1.3. Objectives of the environmental and social impact assessment

1.3.1. Objectives of the ESIA

The ESIA for the Kapichira Hydropower Dam Rehabilitation and Strengthening, has the following main objectives:

[4] The component is relative only to the dam, and not to the transmission and distribution network.

- Assess the environmental, health, safety and social risks and impacts of Phase 2 of the Kapichira Rehabilitation Project in the project's area of influence (including auxiliary activities) and throughout the project life cycle, including all relevant direct, indirect, and cumulative environmental and social risks and impacts, in compliance with the applicable ESSs 1–10 from the World Bank's Environmental and Social Framework and applicable World Bank Group Environmental Health and Safety (EHS) Guidelines and other relevant Good International Industry Practice (GIIP) as well as with the environmental laws and regulations of the Government of Malawi such as the Environment Management Act, No. 19 of 2017;
- Consider the environmental and social risks and impacts of alternative siting and methodology options, including an auxiliary spillway near the right bank or fuse plug with stilling basin, SVTP intake position, quarry locations; and contribute environmental and social considerations on siting and design decisions to the Owner's Engineer ;
- Identify environmental and social management measures, applying the mitigation hierarchy, including project siting, planning, design and implementation measures, and identify opportunities to enhance the positive impacts of the project ;
- Conduct stakeholder engagement as an integral part of the assessment and planning of management measures in accordance with the World Bank's Environmental and Social Standard ESS-10 and the Malawian Environment Management Act, No. 19 of 2017;
- Comply with Malawi's environmental and social protection regulations (in particular the Environment Management Act, No. 19 of 2017) in a manner to enable EGENCO to obtain an environmental license for Phase 2 of the Kapichira Rehabilitation Project.

The expected results of the environmental and social impact assessment are to identify all the potential impacts and risks of the project (physical, biological and socio-economic), to identify and analyse options likely to avoid or minimise potential negative impacts (volume 1) and to provide elements for an effective environmental and social management plan (Volume 2) to deal with the residual impacts and risks in the preparation, construction and operation activities relating to the Kapichira Hydropower Dam Rehabilitation and Strengthening.

1.3.2. Key issues for the ESIA

The terms of reference highlighted the key issues to consider during the phase 2 of the project, as follows:

- Construction works and ancillary facilities will be partly within an area constrained by the existing dam, the downstream river, and Majete Wildlife Reserve.
  - Therefore, the ESIA was carried out closely with the design study to understand construction stage layout and access options (e.g., quarry and spoil locations) and ensure that environmental, health, safety and social aspects are fully integrated into decision-making.
- Kapichira HPP lies partly in the Majete Wildlife Reserve and wholly within its buffer zone which African Parks actively manages and has fenced.
  - Therefore, the ESIA took into consideration the adjacent biodiverse and critically sensitive area of Majete Wildlife Reserve and its buffer zone. Furthermore, the Majete Wildlife Reserve managers were consulted at all stages of the ESIA with the aim of avoiding repeated delays in Kapichira HPP rehabilitation or restrictions on operations.

- The project is expected to generate environmental and social risks and impacts related to sediment management, including on the downstream Elephant Marsh Ramsar site. Physical removal of the accumulated sediment has begun under Phase 1, and the development of measures for the sustainable management of sediment is a key part of Phase 2. According to the 2022 MEPRP Environment and Social Commitment Plan[5], a basin-wide sediment assessment, a comprehensive HPP-cascade sedimentation strategy, and a basin cumulative impact assessment were prepared under Mpatamanga project.
  - Therefore, based on these works, the Kapichira Dam Rehabilitation Project focused on the critical aspects of sediment management and cumulative impacts pertaining to Kapichira's operations.
- The main road to access Kapichira HPP is the T416 road from Chikwawa Boma. This road includes several river crossings. Of particular relevance is the Chilala River bridge and the Mwalija village river crossing. Both of these crossings were significantly damaged during the tropical storm Ana floods. EGENCO has undertaken temporary works to re-instate these crossings. However, permanent upgrades are needed to maintain integrity during future floods and ensure access for heavy construction vehicles throughout the project and operations. This may involve environmental and social risks due to increased traffic.
  - Therefore, the access roads were part of the study area, with the development of traffic and road safety management plan.
- To reduce downstream impacts, the project must implement the existing environmental flow requirements at Kapichira Dam provided in the operation and maintenance manual for civil works.
  - Therefore, the ESIA reviewed and verified the environmental flow requirements.
- Phase 1 of the project included the construction of a coffer dam (cement-soil dam).
  - Therefore, the ESIA considered the environmental and social risks and impacts of decommissioning this coffer dam and related activities such as the disposal of coffer dam materials.

1.3.3. ESIA report's organisation

The remainder of the report is structured as follows:

- Chapter 2: Legal and institutional framework
- Chapter 3: Project description
- Chapter 4: Methodology for the baseline
- Chapter 5: Environmental and social baseline description
- Chapter 6: Environmental and social risks and impacts
- Chapter 7: Analysis of alternatives
- Chapter 8: Public consultation and stakeholder engagement.

[5] As part of the financing agreement, the ESCP sets out material measures and actions that the Borrower shall carry out or cause to be carried out, including, as applicable, the timeframes of the actions and measures, institutional, staffing, training, monitoring and reporting arrangements, and grievance management. The ESCP also sets out the environmental and social instruments that shall be adopted and implemented under the Project, all of which shall be subject to prior consultation and disclosure, consistent with the ESS, and in form and substance, and in a manner acceptable to the World Bank.

2. LEGAL AND INSTITUTIONAL FRAMEWORK

2.1. Introduction

This chapter reviews some of the national and international legislative and regulatory framework that support implementation of the Kapichira Dam phase two rehabilitation project for generation of hydropower in Malawi. Implementation of the Kapichira dam project will need to consider these policy and legal frameworks during all the phases of the project.

2.2. Malawi policies relevant to the project

2.2.1. The Malawi vision 2063

The Malawi vision 2063 sets national goals that will facilitate the realization of the aspirations of the people of Malawi. The Malawi 2063 is aligned to the Sustainable Development Goals whose overall objective is to create a better and sustainable future for all. The Malawi Vision 2063 has three pillars which include Agricultural Productivity and Commercialization, Industrialization and Urbanization.

Environmental Sustainability (Enabler 7) is one of the key enablers for the implementation and achievement of the Malawi vision 2063 agenda. Environmental sustainability is central in ensuring sustainable development. Development programmes based on minimizing depletion of natural resources can be sustained without causing further harm to the environment. The environmental sector in Malawi continue to face a wide range of challenges including natural disasters and climate adversities; environmental degradation; weak institutional capacity and coordination exacerbated by political interference in regulation and enforcement; limited awareness of environmental best practices; data gaps and limited funding for environment sustainability initiatives. In addition, poor waste management coupled with loss of forest cover have increased the destruction risks on flora and fauna and endangered species. Enabler 7 identifies key issues that needs to be considered during the implementation of the project.

2.2.2. National Environmental Policy, 2004

The 2004 National Environment Policy prescribes the policy and institutional arrangements necessary for effective delivery of sustainability agenda and provides the basis for Environmental Impact Assessment and environmental management plans.

The National Environmental Policy promotes sustainable social and economic development through the sound management of the environment and natural resources in the country. The policy specifically addresses issues of environmental security for health and wellbeing of people, sustainable utilization and management of the country's natural resources, long-term self-sufficiency in food and energy, ecosystem integrity and sustainable environment and natural resources management. The policy promotes the rights of every person to a clean environment while emphasising on the duty of every person to promote sustainable utilization and management of the environment and natural resources, including taking legal action against any person whose activities or omissions have or are likely to have adverse effects on the environment.

The National Environmental Action Plan (2002) is a reference guide for the integration of environmental considerations into development planning. It outlines strategies and actions for the protection and management as well as defines roles and responsibilities of various actors (state and non-state) in the management of environment. It explains the nexus of population growth, poverty and illiteracy has led to sub-optimal and unsustainable resource utilization of the environmental and natural resources in the country. In order to protect the environment from further degradation, the Plan sets out the actions that need to be considered in any development activities to guarantee environmental protection.

The policy provides guidance to the implementation of Kapichira Dam Rehabilitation project which as to be implemented in line with the National Environmental Policy and recognise the roles and responsibilities as outlined in the policy.

2.2.3. National Land Policy, 2002

The policy provides an institutional framework for democratizing land management and outlines procedures for protecting land tenure rights, land-based investments, and management of development at all levels. The policy provides for tenure reforms that guarantee security and instil confidence and fairness in land transactions. The Chapter 9 of the policy emphasizes on protection of the environment and land resources. The policy also provides guidance on issues relating to compensations of people affected by the project especially those whose land will be acquired if required.

Kapichira Dam Rehabilitation project will require land acquisition for construction activities such as for the borrow pits, quarry and workers' camps which is found on customary land around the project area. The policy provides guidance for land acquisition and compensations of the project affected person in case of land loss due to the project. The policy also outlines the land administration structure at customary level that the project management will need to follow in order to acquire land.

2.2.4. National Forest Policy, 2016, and Forest Landscape restoration Strategy, 2017

The National Forest Policy is a key instrument providing guiding principles, policy statement and strategies on the management of forest resources in the country. The goal of the policy is the conservation, establishment and protection as well as management of trees and forests for sustainable development in the country. The policy promotes sustainable management and utilization of forests, woodland and tree resources in the country.

The policy prevents unnecessary changes in land-use that promote deforestation, or endanger the protection of forests which have cultural, biodiversity or water catchment values. It also discourages establishment of any development activities in gazette forests unless proven to be environmentally friendly for which suitable intersect oral and local consultations will be conducted. Above all, the policy advocates the carrying out of environment impact assessment where actions are likely to have significant adverse impacts on important forests and other resources. It is expected that implementation of this project will take into consideration provisions articulated in the policy.

The 2017 Forest Strategy seeks to reinforce landscape governance by strengthening local by laws for the use and management of trees and other natural resources; expand communication and outreach to share information broadly about restoration techniques and benefits, and to mobilize a restoration movement; ensure increased socioeconomic benefits accrue to communities and individual households investing in implementing

restoration; and mainstream integrated landscape management approaches and increased support for implementing restoration in development programs at all levels.

Although the Kapichira dam project have minimal impact on forests, as no significant changes on the existing dam are made to the extent of land required for Project structures or to the Project's operation, the project will avoid clearing forest patches and other environmentally sensitive areas such as wetlands and riverbanks and will restore pieces of land that may get degraded as a result of the project.

2.2.5. National Wildlife Policy, 2018

The final National Wildlife Policy, approved in August 2018, outlines the comprehensive approach to wildlife conservation in Malawi. It emphasizes the importance of preserving selected examples of biotic communities, protecting aesthetic beauty and safeguarding populations of rare, endemic, and endangered species of wild plants and animals. The policy also highlights the significance of protected areas in the conservation of biodiversity and the protection of natural resources.

The Kapichira Dam project is being implemented in Majete Game Reserve which is a protected area. This means that the implementation of all activities under the project must comply with all the requirements of this policy.

2.2.6. National Fisheries and Aquaculture Policy, 2016

The policy is promoting sustainable fisheries resource utilisation and aquaculture development in order to contribute to food and nutrition security and economic growth of the country. The policy aims to ensure the sustainable harvesting of fish stocks and other aquatic organisms to prevent overfishing and maintain biodiversity. Policy Priority Area 1 (Capture Fisheries) refers to the harvesting of fisheries resources from the natural water bodies such as lakes and river systems.

The Kapichira Dam rehabilitation project is being implemented on the Shire River which is one of the important water systems for capture fisheries. The Elephant Marsh, one of the Ramsar sites within the Shire River, is also an important Areas of Biological Significance in Malawi. The majority of the people in the lower shire derive their livelihoods from fisheries. The rehabilitation of Kapichira Dam has to consider the significant role of the Shire River to the fisheries communities in the district as well as the impacts on the fisheries resources downstream including the Elephant Marsh.

2.2.7. Disaster Risk Management Policy, 2015

The policy is aimed at ensuring that disaster risk management is mainstreamed in development planning and policies of all sectors in order to reduce the impact of disasters and ensure sustainable development in the country.

The project is going to be implemented on the Shire River, which is prone to flooding. The project will endeavour to integrate disaster related concerns in the design of the dam to be rehabilitated and develop a disaster risk management plan to be implemented during the construction and operation of the dam.

2.2.8. National Energy Policy, 2018

The National Energy Policy (2018) of Malawi aims to provide a guiding framework for increased access to affordable, reliable, sustainable, efficient, and modern energy for all sectors and every person in the country. It emphasizes the importance of private sector participation and sustainable and clean energy accessible to all. The policy also focuses on energy efficiency and mitigating environmental, social, safety, and health impacts of energy production and utilization. It is underpinned by a robust, investor-friendly, and consumer-sensitive regulatory regime. The policy is a result of extensive consultations involving various stakeholders and is a key component of Malawi's National Development Agenda and Sustainable Development Goals.

The country is highly depended on hydropower to generate most of energy requirements. Therefore, the rehabilitation of the Kapichira dam is in line with the government agenda of improving access to energy by all in the country.

2.2.9. National Water Policy, 2005

The National Water Policy intends to address all aspects of water including resource management, development and service delivery. The intention of the policy is to ensure sustainable management and utilization of water resources in the country. The policy promotes provision of water of acceptable quality and of sufficient quantities, as well as ensure availability of efficient and effective water and sanitation services for Malawian and for the enhancement of the country's natural ecosystems. The policy emphasizes protection and use of water resources has been accorded the highest priority over other uses by this policy.

The policy relating to riverbank cultivation states: "there shall be no agricultural and infrastructure construction activities below the 477-metre above mean sea level contour line along Lake Malawi and below the 100-year flood water level along rivers, except where written authority from the responsible Minister is granted".

The Kapichira Dam Rehabilitation project requires pollution control and consider access to water by the downstream users as well as the relevant stakeholder's involvement when necessary.

2.2.10. National Irrigation Policy, 2016

The policy focus is to increase agricultural production and productivity for local and export use using irrigation technologies that consider climate change, to improve national and household incomes, food and nutritional security; to improve irrigation service delivery; to increase employment opportunities and enhance land and water productivity through sustainable land tenure arrangements, catchment management and water harvesting.

The irrigation intake is part of the dam rehabilitation project and will integrate the needs for the Shire Valley Transformation Project to follow this policy.

2.2.11. National Employment and Labour Policy, 2013

The policy provides a framework for promoting productive and decent employment in the economy and increase compliance with labour standards by employers, investors and workers. It also aims at unleashing the potential for Malawi to move onto a development path that is more inclusive, pro-poor and job rich thereby strengthening

the link between economic growth and job creation on one hand and poverty reduction on the other hand. The policy offers an opportunity for Government to take a more holistic and focused approach in addressing the challenge of unemployment, underemployment, and low productivity as part of the national strategy to fight widespread poverty among the population. Recruitment and management of workers will be in line with policy and labour law.

2.2.12. National Gender Policy, 2015

The policy was developed to strengthen gender mainstreaming and women empowerment at all levels in order to facilitate attainment of gender equality and equity in Malawi. The policy promotes mainstream gender issues in the national development process in order to enhance the participation of women and men, and girls and boys in sustainable and equitable development for poverty eradication. The policy prioritises gender in education and training; health; agriculture, food security and nutrition; natural resources, environment and climate change management; economic development; governance and human rights. The policy also prioritizes gender perspective in gender-based violence and capacity of the national gender machinery.

The implementation of this project will take into consideration the provisions of this policy especially on workplace discrimination and gender-based violence. Employment by the contractors particularly during the construction phase should not be biased towards men and that the benefits accruing from project activities benefit both men and women equally. This will ensure compliance to World Bank ESS2 on Labor and Working Conditions and the Employment Act, 2000.

2.2.13. National Health Policy, 2018

The policy provides a unified guiding framework for achieving the health sectors goals through addressing the identified key health challenges and their root causes. The policy aims to ensure a robust health care delivery system in the country. The policy is a key and most important governance framework for aligning all stakeholders towards addressing the identified health sector challenges.

The Kapichira dam project implies therefore that the project implementation has to consider the health of the people and workers in line with the National Health Policy.

2.2.14. National Policy on Equalization of Opportunities for Persons with Disabilities, 2006

The Malawi National Policy on Equalization of Opportunities for Persons with Disabilities is a comprehensive framework aimed at promoting the rights of persons with disabilities and ensuring their full and equal participation in society. The policy is designed to address the challenges faced by persons with disabilities in Malawi, including poverty, unemployment, social isolation, and discrimination. It emphasizes the integration of disability issues in all government development strategies, planning, and programs, and calls for an integrated management system of planning, implementation, and monitoring at all levels. The policy also supports capacity building and public education and awareness about disability. It is linked to other national policies, legislation, and instruments, such as the Constitution of Malawi, which prohibits discrimination on the grounds of disability and promotes the inclusion of people with disabilities. The policy aims to benefit not only persons with disabilities but also society as a whole by addressing disability issues across all aspects of life, including economic, social, cultural, political, environmental, and technological.

The policy has implications on the recruitment of workers during the construction and operation of the Dam rehabilitation project.

2.2.15. National HIV/AIDS Policy, 2012

The goals of the National HIV/AIDS Policy are: (1) to prevent the further spread of HIV infection; and (2) to mitigate the impact of HIV/AIDS on the socioeconomic status of individuals, families, communities and the nation. In order to attain these goals the policy initializes the improvement in the provision and delivery of prevention, treatment, care and support services for People Living With AIDs ; reduction individual and societal vulnerability to HIV/AIDS by creating an enabling environment; strengthening the multi-sectoral and multi-disciplinary institutional framework for coordination and implementation of HIV/AIDS programmes in the country and ensures that each sector formulates and implements sector-specific HIV/AIDS policies and that there is effective coordination between sectors in a multi-sectoral national response to HIV/AIDS.

National HIV/AIDS Policy identifies migrant workers and women among highly vulnerable people to transmission of HIV/AIDS and other sexually transmitted diseases. An application of migrant workers is that some single male migrant workers would be at an increased likelihood of contracting HIV/AIDS. The reason is that some migrant workers may approach and indulge in casual sexual intercourse with infected local female partners in the surrounding local communities or some sex workers. In addition, increased disposal of income from migrant workers may enhance some workers to indulge in extra-marital affairs with either local girls or married women within the surrounding villages. These sexual activities would enhance the spread of HIV/AIDS among workers and local people. In order to minimize the risks, this ESIA will recommend mitigation measures.

2.2.16. National Climate Change Management Policy, 2016

The policy provides strategic direction for Malawi's priorities for climate change interventions and outlines an institutional framework for the application and implementation of adaptation, mitigation, technology transfer and capacity building measures. It seeks to guide programming of interventions for reduction of greenhouse gas emissions in the atmosphere, as well as adapting to the adverse effects of climate change and climate variability. The development of this Policy is in tandem with national aspirations, as well as regional and international obligations. The Policy aims at guiding the implementation of relevant provisions enshrined in the United Nations Framework Convention on Climate Change and the Kyoto Protocol, and the Paris Agreement at the national level. Among the specific objectives of the policy, is the management of impacts of climate change through interventions that build and sustain the social and ecological resilience of Malawians.

Power generation from Kapichira has been adversely affected by the negative impact of climate change. It is therefore imperative that the rehabilitation of Kapichira Dam develop robust adaptation and mitigation measures to climate change to ensure that the “build back better” is achieved.

2.2.17. National Sanitation Policy, 2008

The National Sanitation Policy provides a framework for the development of programmes to transform the hygiene and sanitation situation in Malawi. It provides both guidelines and an action plan whereby all the people of Malawi will have access to improved sanitation, safe hygienic behavior will be the norm and recycling of solid and

liquid waste will be widely practiced leading to healthier living conditions, a better environment and a new way for sustainable wealth creation.

The implementation of this project should therefore ensure that sanitation issues addressed by the policy should be met during the construction and operation of the Dam as outlined in this policy.

2.2.18. National Cultural Policy, 2015

Malawi's National Cultural Policy aims to ensure the sustainable preservation and promotion of the country's cultural heritage. It focuses on the following key areas: Cultural Heritage (Protecting national monuments, artefacts, relics, museums, and cultural expressions such as music, folklore, crafts, fine arts, traditional dances, language, literature, and religion); Economic Development (Recognizing the potential economic importance of culture, including the flourishing of cultural and creative industries, which contribute to poverty reduction and sustainable socio-economic development); National Identity (Enhancing the sense of national identity and unity through the promotion of cultural practices, beliefs, and values); Global Influence (Addressing the impact of globalization and foreign cultural practices on indigenous cultural practices, ensuring their preservation and education); UNESCO Engagement (Collaborating with UNESCO to promote cultural and heritage-related economic development, including the inscription of cultural properties on the UNESCO Representative List of the Intangible Cultural Heritage of Humanity). The policy is a collaborative effort among various stakeholders, including the government, civil society organizations, and development partners, to ensure the best interest of all Malawians.

2.2.19. Mines and Minerals Policy, 2013

This policy provides a framework to guide the development of adequate infrastructure to support development of mining in the country. As the country has prioritised mining in its development agenda, reliable energy supply is very important if the national agenda is to be achieved.

The rehabilitation of Kapichira dam needs a quarry and borrow sites which should comply with this policy.

2.3. Legal framework

2.3.1. Republic of Malawi (Constitution) Act, Act 20 of 1994

The constitution is the supreme law of the country.

Section 13 (d) of the Constitution provides a broad framework for sustainable environmental management at various levels in Malawi. Among other issues, it calls for prudent management of the environment and accords future generations their full rights to the environment. The Constitution provides the fundamental principles that require the State to promote the welfare and development of the people by progressively adopting and implementing policies and legislation aimed at achieving gender equality, adequate nutrition, adequate health care and responsible management of the environment.

Section 3 of the Constitutions lays the basis for the Environment Management Policy and Environment Management Act which stipulates the need for every person or project to take all necessary and appropriate measures to protect and manage the environment.

The constitution guarantees the welfare and development of all people of Malawi. One of the roles of the state is to promote and enhance the quality of life and to recognise standards of living as a key indicator of success of government policies.

The Constitutions also stipulates that all persons have equal status before the law. It also recognises the rights of the people during the compensation process. It provides that expropriation of property for development is permissible only when done for public utility and only when there has been adequate notification, appropriate compensation and the right to appeal to a court of law.

2.3.2. Environment Management Act, No. 19 of 2017

This Act concerns the conservation and management of the environment in Malawi and prescribes environmental standards. It also concerns the conservation and management of biological (genetic) resources. The Act consists of 119 sections divided into 17 Parts, covering main areas of environmental concern as follows: Preliminary (I); General principles (II); the Environment Protection Authority (III); Other Institutional Arrangements for Environmental Management (IV); Environmental Planning (V); Environmental and Social Impact Assessment, Audits and Monitoring (VI); Environmental Standards (VII); Management Of The Environment and Natural Resources (VIII); Pollution control (IX); Biological and Genetic Resources (X); Environmental Protection Orders and Environmental Easements (XI); Inspection, analysis and records (XII); Financial Provisions (XIII); Environmental Fund (XIV); Offences (XV); Dispute Settlement (XVI); Miscellaneous provisions (XVII)..

Part II defines environmental obligations and the right to a clean and healthy environment.

Part III establishes the Malawi Environment Protection Authority ("MEPA") and defines its functions and powers. It shall be the principal agency for the protection and management of the environment and sustainable utilization of natural resources.

In line with section 9 of the Act, MEPA shall review and approve Environmental and Social Impact Assessments and other relevant environmental assessments.

The Act empowers the minister responsible for environment under Section 31 to categorise type and size of projects for which an ESIA is required.

Section 55 of the Act stipulates that the project proponent “has the duty to manage any waste generated by his activities or the activities of those persons working under his direction in a way and in a manner that he does not cause ill health to other persons or damage to the environment.” This also applies to the contractor.

Section 57 explains that a licence is needed for the generation, handling, storage, transport, destruction of any waste other than domestic waste. This applies to the handling of hydrocarbons, used in the construction machinery on-site, as well as the handling of cement/concrete used in the constructing.

Section 60 of the Act emphases that “a person shall not discharge any hazardous substance, oil or other mixture containing oil in any waters or any other segment of the environment except in accordance with the guidelines prescribed by the Authority in consultation with a relevant lead agency.”

Section 61 explains that there shall be no discharge or emission of effluent into the aquatic environment except under a licence issued by the Authority.

The Act further provides for imposition of environmental protection orders in Section 72 in respect of actions that the MEPA may deem detrimental. The act defines penalties in sections 105 and 106 in respect of non-compliance to the act.

The Kapichira dam project requires an Environmental and Social Impact Assessment that must be approved by MEPA.

2.3.3. Energy Regulation (Amendment) Act, No. 1 of 2025

The Malawi Energy Act of 2004 encompasses several key provisions aimed at establishing a structured and regulated energy sector in the country. The Act establishes the Malawi Energy Regulation Authority (MERA), which is responsible for regulating the energy sector, including electricity and renewable energy.

Section 9 of the Act empower the Authority to regulate the activities of the energy industry in Malawi. Amongst the many responsibilities the Act empowers the Authority to perform such function as licensing and regulation of the energy sector, set out the roles and responsibilities of Electricity Supply Corporation of Malawi (ESCOM) and other entities involved in electricity generation, transmission, and distribution.

The Act encourages the development and use of renewable energy sources, promoting sustainable and environmentally friendly energy practices. The Act also provides for the protection of consumers regarding the supply and pricing of energy services, ensuring that they have access to affordable and reliable energy. In addition, the Act encourages partnerships between public and private sectors to enhance investment and service delivery in the energy sector.

Section 28 and 29 of the Act stipulates that no person may establish, operate, carry on or be involved in an energy undertaking in Malawi, without a licence issued by the Authority.

The main objective of the Kapichira dam is the production of energy (hydropower).

2.3.4. Water Resources Act, No. 2 of 2013

The Water Resources Act (2013) provides for the management, conservation, use and control of water resources, for the acquisition and regulation of rights to use water.

The Act is Section 4 promotes the rational management and use of the water resources of Malawi, allow for orderly development and use of water resources for all purposes, control pollution and promote the safe storage, treatment, discharge and disposal of waste and effluent which may pollute water, harm the environment and human health.

Section 10, empowers the National Water Resources Authority to receive and determine applications for permits for water use, monitor and enforce conditions attached to permits for water use, regulate and protect water resources quality from adverse impacts, in accordance with guidelines in the National Water Policy, determine charges to be imposes for the use of water from any water resource.

Section 39 states that a water abstraction license is required by any person for the abstraction, impoundment and use of water from a water resource, drainage of any swamp or other land.

Part VIII, Section 89 (1) of the Act prohibits any person who owns, controls, occupies or uses land on which an activity or process is or was performed to pollute water resources and which, unless authorized under this Part, causes, has caused or is likely to cause pollution of a water resource. The Act further tasks all occupiers of a land to prevent pollution from occurring, continuing or recurring.

Part X is relative to the safety of dams and flood management. The section 117 is relative to the regulations regarding dam safety and prevention of flood risk.

The Kapichira dam is located on the Shire River, requiring taking consideration of this act.

2.3.5. Irrigation Act 2001, No. 16 of 2001

The Act governs irrigation activities in Malawi. The Act stipulates that every public officer and any authority in Malawi to comply with the National Irrigation Policy and Development Strategy. The Act establishes the National Irrigation Board which shall advise the Government and other stakeholders on policy matters relating to irrigation and drainage and shall also, among other things, approve standards and guidelines for the development and management of irrigation and drainage. The Act provides for local community participation in development and management of irrigation and drainage by allowing the Minister to enter into irrigation management agreement with an irrigation management authority. The agreement shall provide for a management plan and assistance to be provided by the Government. The Act also sets out regulation-making powers of the Minister.

Considering that the SVTP is drawing its water from Kapichira Dam, rehabilitation of this dam has to consider the provision of the Act and Irrigation Policy as well as strategy in order not to compromise the aspiration of SVTP. Necessary consultations with the relevant Minister responsible for Irrigation must be implemented before rehabilitation works.

2.3.6. Fisheries Conservation and Management Act, No. 25 of 1997

This Act is to make provision for the regulation, conservation and management of the fisheries of Malawi.

Changing water flow in the Shire River could negatively affect fish spawning in the Elephant Marsh and biodiversity of the Shire River. The Kapichira dam rehabilitation project will identify potential adverse impacts that could be generated by project activities especially downstream.

2.3.7. Forest (Amendment) Act, No. 7 of 2020

This Act provides for the management and conservation of forestry resources in Malawi. Amongst other provisions, the Act provides for the identification and management areas of permanent forest cover as protection or production forest in order to maintain environmental stability; to prevent resource degradation and to increase social and economic benefits.

In addition, the Act provides for the augmentation, protection and management of trees and forests on customary land in order to meet basic fuelwood and forest produce needs of local communities and for the conservation of soil and water.

Due to the presence of Majete Wildlife Reserve, the Act is relevant to the implementation of the Kapichira Dam construction and rehabilitation project as it provides guidance on management and utilization of forest resources by all people involved in the project including the contractors.

2.3.8. National Parks and Wildlife (Amendment) Act, No. 11 of 2017

The National Parks and Wildlife (Amendment) Act of 2017 in Malawi strengthens environmental protection and wildlife conservation through several key provisions:

- Environmental and Social Impact Assessments (Part IV): Any activity proposed within or near protected areas must undergo an environmental and social impact assessment if it has the potential to negatively affect wildlife species or their habitats. The process can be initiated by any individual or entity with reasonable grounds to believe that an action may harm biodiversity, ensuring public participation in conservation efforts.
- Establishment of Protected Areas and Classification of Species (Parts V & VI): The Act formally designates National Parks and Wildlife Reserves as conservation areas. It also updates the classification of protected species, aligning them with International Union for Conservation of Nature (IUCN) categories. All species listed in the Act are now recognized as endangered, reinforcing legal protection measures against their exploitation.

The National Parks and Wildlife (Protected, Endangered and Listed Species) Declaration (Order, 2017) of the National Parks and Wildlife Act provides a schedule of protected species in three parts, namely:

- Part I - Any plant or fungi species in a protected area that is not already defined as either endangered species or a listed species within the order);
- Part II - Any plant or fungi species categorized as Endangered by the IUCN, any plant or fungi species listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), and a prescribed list of additional species; and
- Part III - Any plant or fungi species categorized as Critically Endangered by the IUCN, any plant or fungi species listed in Appendix I of CITES.

In the Part XIII, The Act introduces strict penalties for offenses committed within protected areas. These include poaching, illegal waste disposal, introducing non-native plant species, and lighting fires in sensitive ecosystems. These measures aim to deter harmful activities and ensure long-term protection of Malawi's biodiversity.

The Kapichira dam rehabilitation project is located in the Majete Wildlife Reserve, which is a protected area.

2.3.9. Waste Management and Sanitation Regulations, 2008

These Regulations specifically provide for waste management and sanitation.

Part II places a duty on local authorities to prepare waste management plans and to operate and maintain a municipal sewage collection system for their area of jurisdiction, and to promote integrated waste management systems.

Part III deals with management of general or municipal solid waste including: (a) waste separation at source; (b) the collection of the general or municipal solid waste at such a

frequency as to prevent the piling of waste; and (c) disposal of solid waste at a plant identified and maintained by a competent local authority.

Part IV deals with solid waste recycling and recycling facilities. It identifies which materials can be recycled and the procedure for obtaining authorization to operate a disposal site or plant.

Part V focuses on management of municipal solid liquid waste including discharge of effluent and of municipal liquid waste into the environment.

Management of hazardous waste including: (a) labelling requirements and leaflets for containers or packages of hazardous wastes; and (b) treatment and disposal of hazardous waste and infectious wastes are dealt with under Part VI of the Regulations.

Part VII of the Regulations deal with transporting and storage of waste and require any person intending to engage in the business of transportation, handling or storage of wastes to apply for a license to do so. Further, the Part also provides for the conditions upon which such licenses are to be granted.

Part VIII relates to waste disposal site or plants; these are required to be licensed and Part VIII provides the conditions attached to such licenses.

The transboundary movement of hazardous waste is dealt with in Part IX of the Regulations.

The activities of the Kapichira dam rehabilitation will generate waste.

2.3.10. Mines and Minerals Act, No. 25 of 2023

The Mines and Minerals Act 2023 is the primary legislation governing the mining sector in Malawi. It is officially known as Law No. 25/2023 and regulates all matters related to prospecting, exploration, and mining of minerals in the country. This act vests the entire property in, and control over, minerals under the Malawian jurisdiction.

Due to quarry site and borrow site required for the project, this act should be considered.

2.3.11. Pesticides Act, No. 8 of 2018

This Act provides for the control and management of the import, export, manufacture, distribution, storage, disposal and use of pesticides. The Act also establishes the Pesticides Control Board that enforces the provisions of the Act relating to pesticides and other incidental matters. It therefore protects the importation and use of expired products that can be hazardous to the environment and human health.

The use of such pesticides might be limited for the proposed Kapichira dam rehabilitation project.

2.3.12. Land (Amendment) Act, No. 5 of 2022

The Act was enacted to provide for land administration and management in Malawi.

Section 7 of the Act categorises land into public land and customary land or private land. Public land comprises of Government land and unallocated customary land.

The Land Act provide for land acquisition and compensation of people affected by any project. In line with the Act, project affected persons shall be compensated. Section 13

under section (1), (2) and (3), states that; “any person who by reason of any acquisition suffers any disturbance or loss or damage to any interest which he may have or immediately prior to the occurrence of any of the events referred to in this section, may have had in such land shall be paid such compensation for such disturbance, loss or damage as is reasonable."

The project should consider this Act due to the temporary land use for the construction camp and the borrow sites.

2.3.13. Customary Land (Amended) Act, No. 15 of 2022

This law repeals the customary Land Development Act of 1967 (cap 59:01) and provides for the management and regulation of customary law. The main issue under the law is the formalization of powers of traditional leaders on land allocation through land allocation. The law also established customary estates which makes all land parcels held by individual to be private land thereby safeguarding land tenure security of the individual family owners.

The project should consider this Act due to the land use for the construction camp and the borrow sites.

2.3.14. Land Acquisition and Compensation Amendment Act, No. 14 of 2022

The Lands Acquisition and Compensation Amendment Act (2022) sets out in detail, the procedures for acquisition of customary land by a private developer and by Government including how assessment of compensation shall be calculated.

In case of land acquisition, the processes and procedures for proclamation of the land to be acquired should follow the steps as provided for in the Act.

Section 4 (1) states that appropriate compensation of any acquisition of land by Government shall be assessed by valuer appointed by the Minister. Assessment of compensation shall be calculated based on loss of occupational rights; loss of land; loss of structure; loss of business; relocation cost; loss of good will; costs of professional advice; nuisance; loss or reduction of tenure; and disturbance if it is not too remote and is a natural and reasonable consequence of disposition of land.

The procedures set out in the Act are followed to ensure that the private landowners are fairly and equitably compensated in line with compensation assessment as outlined in this Act.

The project should consider this Act due to acquisition of land for the temporary construction camp and the borrow sites.

2.3.15. Monuments and Relics Act, Chapter 29:01, 2014

The Act governs the management and administration of monuments and heritage sites in Malawi.

Section 29. (1) of the Monuments and Relics Act reads, “A person in charge of any survey, excavation, exploration, construction or new development shall, at the earliest stages of planning for such activities, give notice to the Minister to enable, where necessary, rescue archaeology to be carried out in accordance with subsection (2)”.

Section 29 (2) mentions that Rescue archaeology of a monument or relic under subsection (1) shall be carried out by the Chief Antiquities Officer or any qualified person with an excavation permit issued by the Minister, and the cost of such work shall, unless the Minister otherwise directs, be borne by the person in charge of any survey, excavation, exploration, construction or other development.

The Monuments and Relics Act provides clear definitions of cultural resources in its tangible forms, comprising both movable and immovable physical cultural heritage.

The Kapichira dam project should consider this act due to the works activities (quarry, borrow sites, camp site). The project will adopt a chance find procedure during excavation or site works, in line with this Act’s provision.

2.3.16. Employment Act, No. 6 of 2020

The Employment Act establishes, reinforces, and regulates minimum standards of employment with the purpose of ensuring equity necessary for enhancing industrial peace, accelerate economic growth and social Justice and for matters connected therewith and incidental thereto. The Act covers Administration; Employment of Young People; Contracts, Hours of Work, Weekly Rest and Leave; Wages; and Discipline and Dismissal.

The employees for the Kapichira dam rehabilitation will need to sign contracts, which stipulates all the conditions of work including compliance to minimum wages, hours of work, code of conduct amongst other conditions considering this act.

2.3.17. Gender Equality Act, No. 3 of 2013

The Act addresses inequalities and human rights violations by focusing on: balancing reproductive and productive roles to enhance women’s participation in decision making; promoting legal and policy reforms and gender-sensitive data collection; addressing gender-based violence, including traditional practices that harm women, such as child marriage; raising awareness of women's strengths, vulnerabilities and needs in various settings including humanitarian situations; and involving men and boys in promoting gender equality and improving reproductive health.

The act requires quotas in the employment sector. Though this is perceived as not applicable to the private sector in terms of benchmarks, the directions are that employment opportunities should be offered equitable and that there will not be any form of discrimination based on sex in workplaces as provided in Section 2 of this Act.

The process of workers recruitment will consider this act for the Kapichira dam rehabilitation.

2.3.18. Occupational Safety, Health and Welfare Act, 1997

The Act makes provisions for the regulation of conditions of employment in workplaces with regard to safety, health and welfare of employees. It also provides for the inspection

of certain plant and machinery, the prevention and regulation of accidents occurring to persons employed or authorised to go into the workplace, and for some related matters.

The Act requires registration of workplaces and defines duties and responsibilities of employers and employees with regards to health, safety and welfare and the notification, and investigation of accidents, dangerous occurrences and industrial diseases.

The Kapichira dam rehabilitation project will employ workers, required that the contractor will follow this act.

2.3.19. HIV and AIDS Prevention and Management Act, No. 9 of 2018

This Act makes a provision for the prevention and management of HIV and AIDS; to provide for the rights and obligations of persons living with HIV or affected by HIV and AIDS; to provide for the establishment of National AIDS Commission; and to provide for matters incidental thereto or connected therewith.

In accordance with this Act, the Kapichira Dam Rehabilitation Project has to ensure that HIV and AIDS intervention measures are put in place, in a manner that they respond to the requirements of the Act.

2.3.20. Permitting obligations

Based on the texts cited above, the minimum licences required for the project are as follows. The Contractor will develop the needs based on the detailed construction activities in the contractor environmental and social management plan.

Table 2-1: List of licenses required for the Kapichira dam rehabilitation

No	Permit required	Description	Regulatory Reference	Issuing Institution
1	ESIA Certificate	ESIA Certificate	Environmental Management Act,2017	MEPA
2	Waste and Hazardous Waste License	License to store, transport and dispose of hazardous waste generated from construction site	Environmental Management Act, 2017. Pesticides Act, 2018	MEPA
3	Development Permission	Permission to develop access roads to quarry sites and borrow pits	Under the Local Government Act, 1998	Chikwawa District Council
4	Water Abstraction Permits	Permit to abstract water from the rivers or to drill boreholes for camp site	Water Resources Act, 2013	National Water Resources Authority (NWRA)
5	Workplace Registration certificate	Every workplace is required to be registered and must commit to abide by all of the country's labour laws	Occupation Safety Health and Welfare Act,1997	Ministry of Labour
7	Mining licence (For quarry site)	Any sourcing and mining of quarry and gravel	Mines and Minerals Act, 2023	Ministry of Mines
8	Permit to operate in Majete Game Reserve	Any person working in the protected areas must obtain permission from authorities	National Parks and Wildlife Act, 2017	Ministry of Tourism and Wildlife

As the dam is an existing dam without blockage of watercourses during the works, no license to operate and carry out works within the Shire River (dam) is required as per Water Resources Act of 2013 (refer to sections 111 and 114) of the Act for registration of the Dam with the Authority. The content of the licence will be checked before starting the works.

2.4. Review of relevant international conventions and agreements

The government of Malawi has signed and ratified several international agreements and conventions relating to the environment both at regional and global levels. Implementation of this project must take into consideration these international agreements and conventions and impacts associated with these conventions have to be addressed.

2.4.1. The Stockholm Convention on Persistent Organic Pollutants

The Stockholm Convention on Persistent Organic Pollutants was signed in Stockholm on May 22, 2001, and ratified by Malawi on February 27, 2009. Further, Amendments to Annex A and Annex C to the Convention were signed on May 15, 2015, and ratified by Malawi on the December 15, 2016. The Convention aims to protect human health and the environment from the effects of 29 listed persistent organic pollutants such as pesticides and industrial chemicals. The chemicals targeted are listed in 3 annexes of the Convention. Annex A (Elimination) lists those chemicals which parties must take measures to eliminate the production and use of. During the implementation of this project there is need to raise awareness amongst the contractors to ensure that all listed chemicals in this Annex are not used.

2.4.2. The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was adopted at Basel on March 22, 1989, and ratified by Malawi on April 21, 1994. The overarching objective of the Convention is to protect human health and the environment against the adverse effects of hazardous wastes. Of particular importance to this project is Article 4 (General Obligations) point #2 of the Convention which states that “each Party shall take the appropriate measures to: (a) ensure that the generation of hazardous wastes and other wastes within it is reduced to a minimum, taking into account social, technological and economic aspects; (b) ensure the availability of adequate disposal facilities, for the environmentally sound management of hazardous wastes and other wastes, that shall be located, to the extent possible, within it, whatever the place of their disposal.” The project proponent should, therefore, follow the relevant regulations as described EIA guidelines and EMA, 2017.

2.4.3. The Convention on Biological Diversity

The Convention on Biological Diversity was ratified by Malawi on February 2, 1994. Under the Convention, governments commit to conserve and sustainably use biodiversity. The Government has developed national strategies to promote sustainable use of its natural resources while protecting ecosystems and species diversity. The country has implemented the National Biodiversity Strategy and Action Plan (NBSAP),

aligning its conservation efforts with global targets such as the Aichi Biodiversity Targets and the Kunming-Montreal Global Biodiversity Framework. Through this, the strategy focuses on habitat protection, sustainable agriculture, community-based conservation, and integrating biodiversity considerations into national development planning. Additionally, the government works to strengthen legal frameworks, such as the National Parks and Wildlife Act, to enhance conservation efforts. However, challenges remain, including habitat degradation, climate change impacts, and human-wildlife conflicts, requiring continued investment in biodiversity conservation and sustainable development initiatives.

- Article 7 of the Convention (Identification and Monitoring) deals with identifying and monitoring the important components of biological diversity that need to be conserved and used sustainably.
- Article 8 (In-situ Conservation) discusses, conserving, rehabilitating and restoring degraded ecosystems and promoting the recovery of threatened species in collaboration with local residents. This Article also expounds upon the need to prevent the introduction of, controlling, and eradicating alien species that could threaten ecosystems, habitats or species. It further discusses the need for controlling the risks posed by organisms modified by biotechnology.
- Article 10 (Sustainable Use of Components of Biological Diversity) express the need for respecting, preserving and maintaining traditional knowledge of the sustainable use of biological diversity with the involvement of indigenous peoples and local communities.
- Article 13 (Public Education and Awareness) mentions the need to educate people and raising awareness about the importance of biological diversity and the need to conserve it.
- Article 14 (Impact Assessment and Minimizing Adverse Impacts) explains the requirement for “environmental impact assessment of its proposed projects” and promotes public participation, particularly regarding assessing the environmental impacts of development projects that threaten biological diversity. The afore mentioned items require the developer to carry out an environmental impact assessment on the project and to subsequently conserve and rehabilitate any areas of concern regarding biological diversity. The developer should also ensure suitable public education programmes.

2.4.4. The United Nations Framework Convention on Climate Change

The Government of Malawi ratified the United Nations Framework Convention on Climate Change (UNFCCC) on April 21, 1994. The ultimate objective of this Convention is the “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.” Most relevant to the construction and rehabilitation of Kapichira dam is Principle #3 of the Convention which states that “the Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects.”

2.4.5. The Paris Agreement

The Paris Agreement was signed on December 12, 2015, and ratified by Malawi on August 29, 2017. The Agreement is within the UNFCCC dealing with greenhouse gas emissions mitigation, adaptation and financing. The agreement aims to reduce global

greenhouse gas emissions in an effort to limit the global temperature increase in this century.

2.5. World Bank requirements

In 2016, the World Bank Environmental and Social Framework sets out a set of Environmental and Social Standards (ESS) that are applicable to the project to support the financing for the project and are summarised below.

- ESS 1 - Assessment and Management of Environmental and Social Risks and Impacts: this standard sets out the Government of Malawi responsibilities for assessing, managing and monitoring environmental and social risks and impacts associated with each stage of a project supported by the Bank through Investment Project Financing in order to achieve environmental and social outcomes consistent with the Environmental and Social Standards. This standard applies to the project due to the high environmental and social risks. The assessment of environmental and social risks and impacts are documented in the ESIA (volume 1 of the ESIA) for the project and the management of environmental and social risks and impacts are documented in the ESMP (volume 2 of the ESIA) for the project.
- ESS 2 - Labour and Working Conditions: this standard recognizes the importance of employment creation and income generation in the pursuit of poverty reduction and inclusive economic growth. Borrowers can promote sound worker-management relationships and enhance the development benefits of a project by treating workers in the project fairly and providing safe and healthy working conditions. The standard deals with labour conditions and management of working relationships, protection of workforce including limitations on child labour, grievance redress between employers and workforce, occupational health and safety, OHS matters relating to contract and community workers, and primary supply workers. This standard applies to the project, in particular during construction works, due to the presence of workers. The measures relative to the labour and working conditions are documented in the ESMP (volume 2 of the ESIA) for the project: Labour Management Plan; Occupational Health, Safety and Security Management Plan.
- ESS 3 - Resource Efficiency and Pollution Prevention and Management: this standard recognizes that economic activity and urbanization often generate pollution to air, water, and land, and consume finite resources that may threaten people, ecosystem services and the environment at the local, regional, and global levels. This ESS sets out the requirements to address resource efficiency and pollution prevention and management throughout the project life cycle. Of relevance to the project, the standard has requirements that the project should address, namely, pollution prevention and management, resource efficiency, water management, hazardous waste management and management of air pollution. The measures relative to the resource efficiency and pollution prevention and management are documented in the ESMP (volume 2 of the ESIA) for the project: Waste Management Plan; Hazardous Substances Management Plan; Resource Efficiency and Pollution Prevention management Plan; Sedimentation Control Plan; Sediment Management Plan.

- ESS 4 - Community Health and Safety: this standard addresses the health, safety, and security risks and impacts on project-affected communities and the corresponding responsibility of borrowers to avoid or minimize such risks and impacts, with particular attention to people who, because of their particular circumstances, may be vulnerable. The annex 1 of ESS4 is specific to safety of dams including the requirement about dam safety reports. This standard applies to the project, as the project is relative to an existing dam, as well as the proximity of communities to the construction area. The measures relative to the community health and safety are documented in the ESMP (volume 2 of the ESIA) for the project: Traffic and road safety management Plan; Community Health, Safety and security Plan; Construction Emergency Preparedness Plan; Dam Emergency Preparedness Plan.
- ESS 5 - Land Acquisition, Restrictions on Land Use and Involuntary Resettlement: this standard advance avoidance of involuntary resettlement where possible. Where involuntary resettlement is unavoidable, it will be minimized and appropriate measures to mitigate adverse impacts on displaced persons (and on host communities receiving displaced persons) will be carefully planned and implemented. This standard applies to the project due to the land use for the construction camp, borrow site and quarry, as the dam components do not require additional land acquisition. The measures relative to the land acquisition are documented in the Resettlement Action Plan for the project.
- ESS 6 - Biodiversity Conservation and Sustainable Management of Living Natural Resources: this standard recognizes that protecting and conserving biodiversity and sustainably managing living natural resources are fundamental to sustainable development and it recognizes the importance of maintaining core ecological functions of habitats, including forests, and the biodiversity they support. ESS6 also addresses sustainable management of primary production and harvesting of living natural resources and recognizes the need to consider the livelihood of project-affected parties, including Indigenous Peoples, whose access to, or use of, biodiversity or living natural resources may be affected by a project. This Standard applies to the project, in particular due to the presence of sensitive biodiversity areas such as the Majete wildlife reserve and Elephant Marsh in the project area of influence. The measures relative to the biodiversity conservation and sustainable management of living natural resources are documented in the ESMP (volume 2 of the ESIA) for the project: Biodiversity Management Plan; Restoration Plan for temporary affected areas; Environmental Flow Management Plan.
- ESS 7 - Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities: this standard recognizes that Indigenous Peoples/Sub- Saharan African Historically Underserved Traditional Local Communities have identities and aspirations that are distinct from mainstream groups in national societies and often are disadvantaged by traditional models of development. In many instances, they are among the most economically marginalized and vulnerable segments of the population. This standard does not apply to the project as there are no groups that meet the criteria for ESS7 in Malawi.
- ESS 8 - Cultural Heritage: this standard recognizes that cultural heritage provides continuity in tangible and intangible forms between the past, present and future. ESS8 sets out measures designed to protect cultural heritage throughout the project. This standard applies to the project, in particular during the construction activities in case of findings. The measures relative to the cultural heritage are documented in the ESMP (volume 2 of the ESIA) for the project: Cultural Heritage Management Plan.
- ESS 9 - Financial Intermediaries: this standard applies to Financial Intermediaries that receive financial support from the Bank. This standard does not apply to the project as no financial intermediaries will be used.

- ESS 10 - Stakeholder Engagement and Information Disclosure: this standard recognizes the importance of open and transparent engagement between the Borrower and project stakeholders as an essential element of good international practice. Effective stakeholder engagement can improve the environmental and social sustainability of projects, enhance project acceptance, and make a significant contribution to successful project design and implementation. This standard applies to the project from the first stage of this project. The effective stakeholder engagement is documented in the ESIA (volume 1 of the ESIA) for the project and the project's Stakeholder Engagement Plan is annexed in the ESMP (volume 2 of the ESIA).

In brief, the following standards ESS 1, 2, 3, 4, 5, 6, 8, 10 apply to the project. The standards ESS7 and ESS9 do not apply to the project.

The Project activities should also be consistent with the World Bank Group's Environmental, Health and Safety Guidelines (EHSGs)[6] and other relevant Good International Industry Practice (GIIP), such as the Good Practice Note on Dam Safety[7].

For this project, the World Bank has classified the risk category for environmental and social aspects as high.

The supporting instruments such as the Environmental and Social Impact Assessment, the Environmental and Social Management Plan, the Resettlement plan, are required for this project.

It should be noticed that Malawi's 2017 Environmental Management Act already incorporates the principles of environmental and social assessment. However, the World Bank's ESS requirements are generally more comprehensive and stringent, particularly with regard to labour management (ESS2), resettlement and livelihood restoration (ESS5), stakeholder participation (ESS10), vulnerable groups, biodiversity management (ESS6) and community health and safety (ESS4).

2.6. Gap analysis between the national legal framework with the World Bank environmental and social framework

Below is a high-level mapping of Malawi national legal and regulatory requirements against the applicable World Bank Environmental and Social Standards (ESS 1 to 6, 8 and 10) to the project.

Table 2-2: Gap analysis between Malawi legal framework with the World Bank Environmental and Social Standards

WB ESS	Main Requirement from WB ESS	Relevant Malawi Legal Framework	Gap Assessment
ESS1: Assessment and management of environmental and social risks and impacts	Environmental and social assessment, ESMPs, monitoring, stakeholder engagement	Environment Management Act, 2017; Environmental and Social Impact Assessment provisions; National Environmental Policy	Malawi law requires ESIA and environmental monitoring. However, ESS1 requires broader lifecycle social risk management, cumulative impacts, labour and SEA/SH risk assessment that may go beyond national requirements.

6 https://www.ifc.org/en/insights-reports/general-environmental-health-and-safety-guidelines
7 https://www.cawater-info.net/bk/dam-safety/files/cawep1-en.pdf

WB ESS	Main Requirement from WB ESS	Relevant Malawi Legal Framework	Gap Assessment
ESS2: Labour and working conditions	Fair labour, worker protection, OHS, grievance mechanism, prohibition of child and forced labour	Employment Act, 2020; Labour Relations Act; Occupational Safety, Health and Welfare Act; Workers Compensation legislation	Alignment on labour rights, OHS and freedom of association. ESS2 is more explicit regarding worker grievance mechanisms, contracted workers, supply-chain workers and labour management procedures.
ESS3: Resource efficiency and pollution prevention and management	Efficient resource use, waste management, pollution prevention, GHG emissions	Environment Management Act, 2017; Water Resources Act; Waste and pollution control regulations	Alignment for pollution control and waste management. ESS3 places greater emphasis on resource efficiency, climate considerations, GHG accounting and international good practice.
ESS4: Community health and safety	Public health, community safety, traffic safety, emergency preparedness, security personnel	Public Health Act; Disaster Risk Management legislation; Gender Equality Act; Environment Management Act	Malawi law addresses public safety and health. ESS4 has more detailed requirements on community exposure to project risks, dam safety, security forces, road safety and SEA/SH risks.
ESS5: Land acquisition, restrictions on land use and involuntary resettlement	Avoid/minimize displacement; compensation; livelihood restoration	Land Act (2022, as amended); Customary Land Act 2022; Land Acquisition legislation	Malawi law supports compensation for acquired land. ESS5 requires livelihood restoration, support for vulnerable persons, consultation and assistance to informal occupants beyond statutory compensation.
ESS6: Biodiversity conservation and sustainable management of living natural resources	Biodiversity protection, critical habitats, ecosystem services	Environment Management Act, 2017; National Parks and Wildlife Act; Forestry Act; Fisheries Conservation legislation	Malawi law protects biodiversity and natural resources. ESS6 introduces stronger requirements on critical habitats, biodiversity offsets, ecosystem services and no-net-loss approaches.
ESS8: Cultural heritage	Protection of tangible and intangible cultural heritage; chance finds	Monuments and Relics Act; Environment Management Act	National law protects cultural heritage sites. ESS8 requires broader management of intangible heritage and formal chance-find procedures in projects.
ESS10: Stakeholder engagement and information disclosure	Meaningful consultation, disclosure, grievance mechanisms	Environment Management Act, 2017 (public participation provisions); Access to Information Act; Local Government framework	Malawi law promotes public participation and access to information. ESS10 requires a formal Stakeholder Engagement Plan, ongoing engagement and project-level grievance mechanisms throughout the project lifecycle.

In the event of any discrepancy between the two, the more stringent requirement shall prevail.

2.7. ESIA process framework

The Environment Management Act (2017) and the Environmental Impact Assessment (EIA) Guideline (2025) provide the administrative framework of the ESIA process. The ESIA process is managed by the Malawi Environment Protection Authority (MEPA). The Authority works with other line Ministries/agencies and stakeholders.

According to Section 25 of the Act, the Malawi Environment Protection Authority shall establish Advisory Committees as advisers, consultants, reviewers or technical experts to assist in the conduct of its regulatory responsibilities. The advisory committee reviews all ESIA reports and make recommendations to the MEPA Board for Approval.

Under section 31 of the Environment Management Act, no one shall undertake any project for which an Environmental and Social Impact Assessment is required without the written approval of the Authority, and except in accordance with any conditions imposed in that approval. Section 31 also states that any other licensing authority shall not grant a permit or license for the execution of a prescribed project unless an approval for the project is granted by the Authority, or the grant of the permit or license is made conditional upon the approval of the Authority being granted.

The EIA process involves several stages as outlined in the 2025 Guidelines for environmental assessment document. The introduction to the guideline (Chapter 1) defines EIA, describes objectives of the EIA, prerequisites, and the statutory basis for EIA in Malawi, and indicates how EIA is integrated into general project planning processes. In Chapter 2, the EIA process, roles and responsibilities in Malawi are described. The guidelines and procedures for strategic environmental assessment are detailed in the Chapter 3. The guidelines and procedures for environmental and social impact assessment are outlined in Chapter 4. Environmental and social audit and inspection are outlined in the Chapter 5. Environmental review and approval process are included in the chapter 6.

26 appendices provide supportive information on several topics. The Appendix 21 of 2025 EIA guidelines, in part C, specifies that hydropower rehabilitation is a Category A project for which ESIA is mandatory.

For this project, the MEPA has required an ESIA on the 22nd of April 2024. The terms of reference for the ESIA are included in the Appendix A.

It should be noted that an ESIA is also required by the World Bank and must be approved by the Bank independently of MEPA.

3. PROJECT DESCRIPTION

3.1. Introduction

This chapter provides a technical description of the components of the dam to be rehabilitated as well as the temporary area required for the construction activities. It also describes the construction activities and operation mode of the scheme. It is structured as follows:

- The characteristics of the existing structures before Ana tropical storm (see chapter 1.1.1.2),
- The technical characteristics of the project, meaning the Kapichira dam components to be rehabilitated,
- The technical characteristics of the temporary facilities required for the rehabilitation of the dam,
- The description of project's areas of influence taken into consideration for the environmental and social analysis.

The technical Project information presented in this chapter is taken mainly from the 2025 Detailed Design documents prepared by Studio Pietrangeli Consulting Engineers. The following reports was used for the project description:

- Borrow area assessment Report, July 2025, Ref. 100GENRSP005A,
- Detailed Design Report, May 2025, Ref. 200GENRSP001A, volumes 1-3,
- Temporary camp and quarries: MCA Report, December 2024, Ref. 100GENRSP004A,
- Preliminary Design Report, November 2024, Ref. 100GENRSP002B,
- Field investigations Report, October 2023, Ref. 100GENRSP001A.

3.2. Characteristics of the Kapichira hydropower project

The construction of the Kapichira hydropower project began in 1994 and ended in 2000, when the plant was commissioned having an initial total installed capacity of 64.8 MW with two 32.4 MW turbines. In 2013, the installed capacity was increased to 129.6 MW, by adding two 32.4 MW turbines.

The Kapichira dam is an earthen-zoned embankment with a total length of 820m and an average height of 22m. The main embankment is between the spillway and fuse plug wing.

The main technical characteristics of the existing dam are described in the following table.

Table 3-1: Technical characteristics of the Kapichira dam

Components	Dimensions
Crest length	820 m
Maximum height	31 m
Upstream slope	1.8 – 2.0 /1 h/v
Downstream slope	1.6 – 2.0 /1 h/v
Crest elevation	149 masl
Crest width	8 m
Maximum Water Level	148.5 masl
Full Supply Level	147.0 masl
Minimum Water Level	144.0 masl

In addition, the following components are as follows:

- The main spillway system is located at the left side and is consisting of 5 radial gates, with a length of 15.3 m and a sill elevation of 134 masl.
- The power waterways have a length of 500 m and a diameter of 8.8 m.
- The powerhouse is made up of 4 turbines of Francis type. The installed power is 129.6 MW, and the design flow is 270 m^3/s.

The training dyke, on the right side, consists of an 570m long embankment (compacted fill from excavation) with a crest elevation of 149.0 masl (Maximum height = 12m).

Kapichira HPP is a run-of-river scheme with a small reservoir (4.5 Mm^3 as total storage) that provides daily regulation especially for peaking services, particularly important to guarantee supply during peak hours.

The Shire Valley Transformation program is an integrated development program managed by the Ministry of Agriculture. The SVTP project consists of a 52 km long section of main canal and up to 16 secondary pipelines linking the main canal with agricultural blocks. The permanent intake is integrated in the Kapichira dam to take water from the Kapichira reservoir for irrigation purposes. The permanent intake will, during operation, take around 50 m^3/s for the Shire Valley Transformation Project.

In January 2022, the SVTP irrigation intake was under construction (see the following figure). The site was located at the western embankment of the Kapichira reservoir, just upstream of the fuse plug and downstream of the training dike and surrounded by a cofferdam.



Source: M. Lino. Dam Safety report, 2022 – Adapted in: Kapichira dam rehabilitation project, phase 2, Independent Panel of Experts Mission 1 Report, July 2024

Figure 3-1: Elements of the original Kapichira scheme before the storm Ana in January 2022

3.3. Description of the Kapichira dam components to be rehabilitated

3.3.1. General layout of the dam

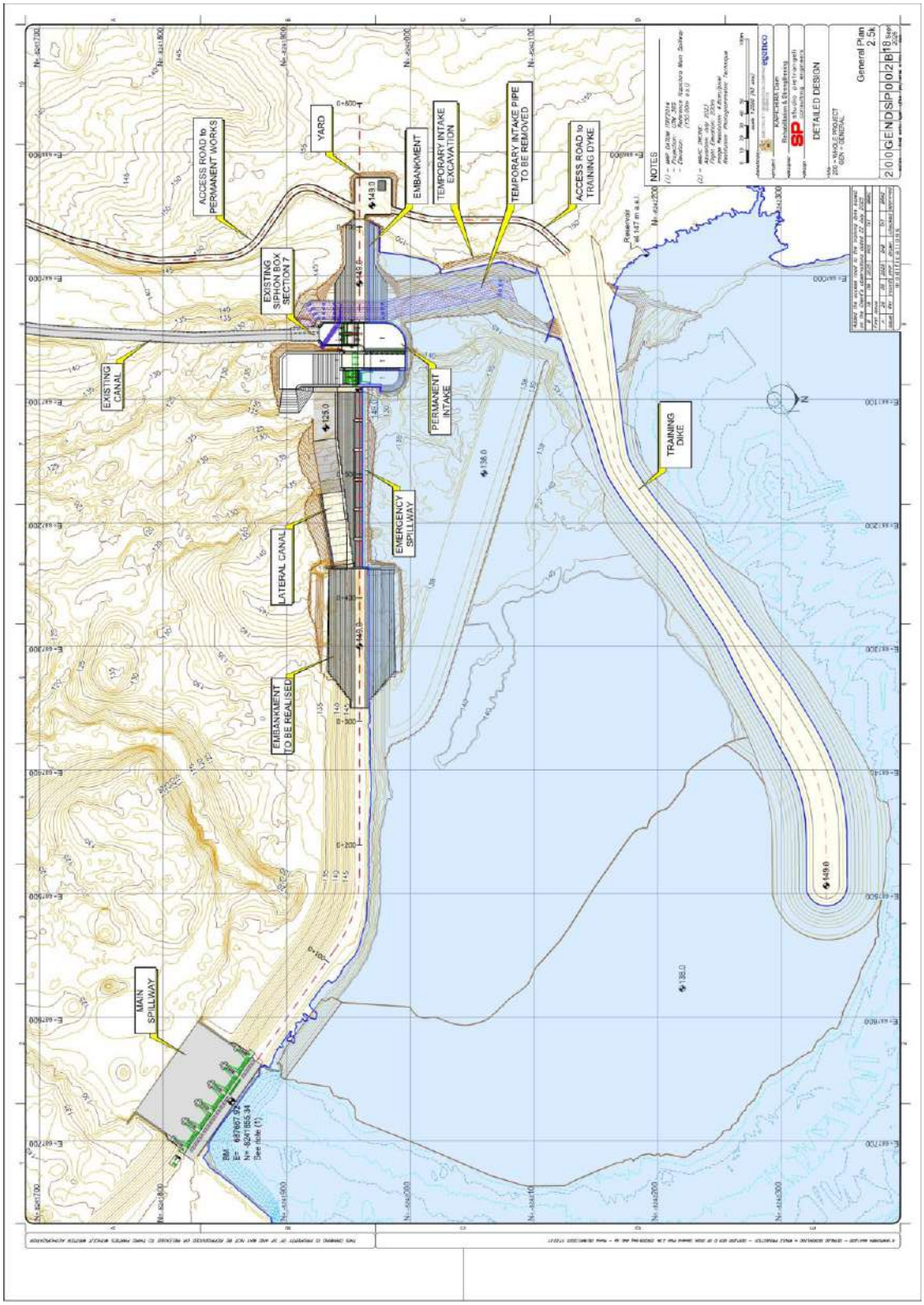
The project aims to enhance resilient operation of the 129.6 MW Kapichira hydropower plant through the rehabilitation of the Kapichira dam and the upgrade of spillway. It should be noticed that the hydropower plant is not concerned by this rehabilitation.

The design for Kapichira dam rehabilitation – phase 2 includes the associated components, as described in the following sub-chapters, on the east side to west side of the dam:

- The main spillway gates
- The embankment dam
- The emergency spillway
- The irrigation intake for SVTP
- The right embankment
- The training dyke.

Because it is partly integrated into the Kapichira dam, the project will also rehabilitate the permanent intake for the SVTP project.

The following figure, in A3 format in the Appendix P, shows the planned works to be undertaken by the Contractor for the rehabilitation of Kapichira dam as designed by the Owner's Engineer.



Source: Studio Pietrangeli Consulting Engineers, Detailed Design Report, May 2025

Figure 3-2: Topographic map with the project layout for Kapichira dam

3.3.2. Main spillway gate

The main spillway consists of a conventional concrete structure with five radial-gated bays, an ogee crest and common discharge apron with a ramped terminal sill structure that provides a degree of energy dissipation. The rated discharge capacity of the gated spillway is 8 750 m^3/s with water elevation of 148.5 masl.

Each radial gate is operated by a wire-rope hoist system by individual left and right-side hydraulic motor-driven winches mounted at bridge deck level directly above the gates. Two radial gates (gates 1 and 5) have a bottom-hinged flap section built into the top of each gate leaf, operated by a pair of hydraulic cylinders. The radial gates have been in operation for about 25 years.



Source: Studio Pietrangeli Consulting Engineers, 100GENRSP001A, Field investigations Report, October 2023

Figure 3-3: 3D model view about the spillway of Kapichira dam

During operation of the spillway radial gates, EGENCO personnel have experienced problems with the hoisting system due to breaking of ropes. The ropes have been replaced very often during the lifetime of the gates.

Table 3-2: Technical characteristics of the existing spillway to be rehabilited

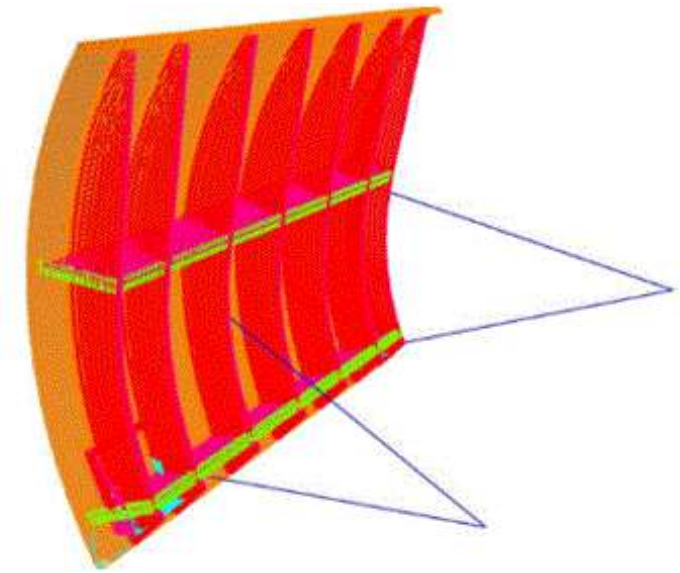
Component	Dimensions
Still elevation	143 masl
Total Overflow-Crest length	95.2 m
Net Overflow-Crest length	76.2 m
Chute slope	1:0.5 h/v
Chute length	12 m

Construction phase

The rehabilitation works relevant to the hydraulic steel structures, designed by the Owner's Engineer, consist of:

- Replacement of the existing hoisting system of each gate (wire-rope hoist system operated by individual hydraulic motor-driven winches) with a new hoisting system which consists of two hydraulic cylinders.
- Modification of the bottom part of gates to ensure a proper connection with the two oil-hydraulic cylinders.
- Refurbishment of all gates: Cleaning, sandblasting, replacement and/or repair welding, replacement of all wearing parts, replacement of gate sealing system, replacement of bottom steel sill beam of the gate, etc…
- Refurbishment of embedded parts (guides, sealing surfaces, trunnion bearings, etc…)
- Replacement of the existing set spillway stoplog, which was designed to reach an elevation of 144.5 masl and which is significantly deteriorated, with a new set spillway stoplog able to reach an elevation of 148.0 masl.
- Refurbishment and extension up to 148.0 masl of five (5) sets of spillway stoplogs embedded parts.

Repairing works consisting of the rehabilitation of the deteriorated surface of the chutes for all bays has been as well planned. The works will depend on the scenario if the steel reinforcements are exposed to air or not. If it is the case, a treatment of the reinforcement will be required with an active coating.



Source: Studio Pietrangeli Consulting Engineers, 200GENRSP001A, Detailed Design Report, May 2025

Figure 3-4: Finite element modele of the gate in its design configuration

Operation phase

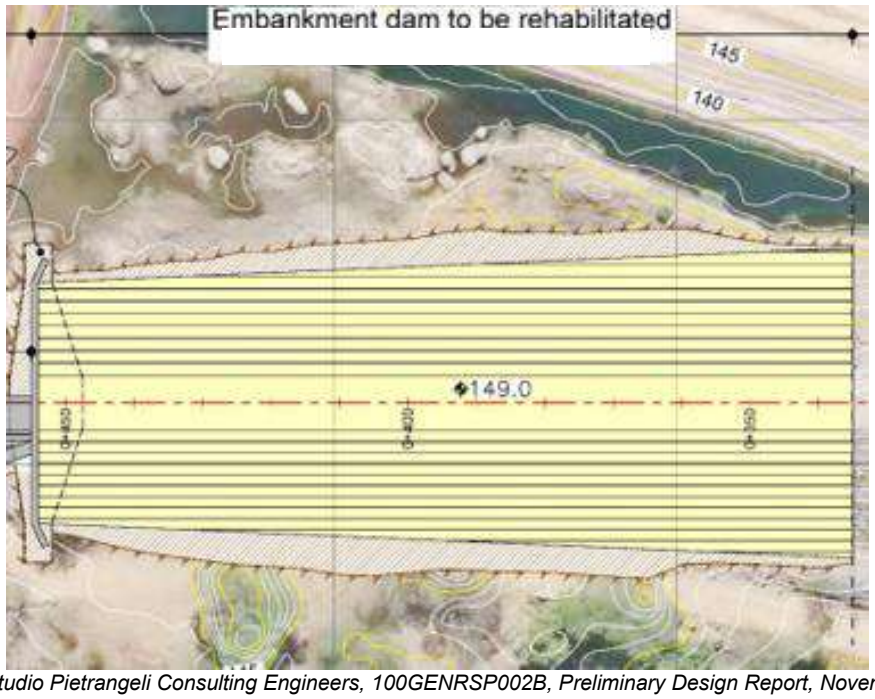
No changes are planned in the operation phase.

In order to minimise the deposition of sediment at the foot of spillway gates, for normal operation all gates should be operated with approximately equal gate opening. Operating Gates 1 and 2 alone (nearest to power intake) is most likely to affect sediment and silt clearance in the vicinity of the power intake.

For the de-silting mode, the reservoir should be set as low as possible, in the vicinity of minimum pool level, el. 144.

3.3.3. Embankment dam

The portion of the dam situated between the intact embankment and the emergency spillway (see the following figure) needs to be rehabilitated since part of it has been damaged during cyclone Ana.



Source: Studio Pietrangeli Consulting Engineers, 100GENRSP002B, Preliminary Design Report, November 2024

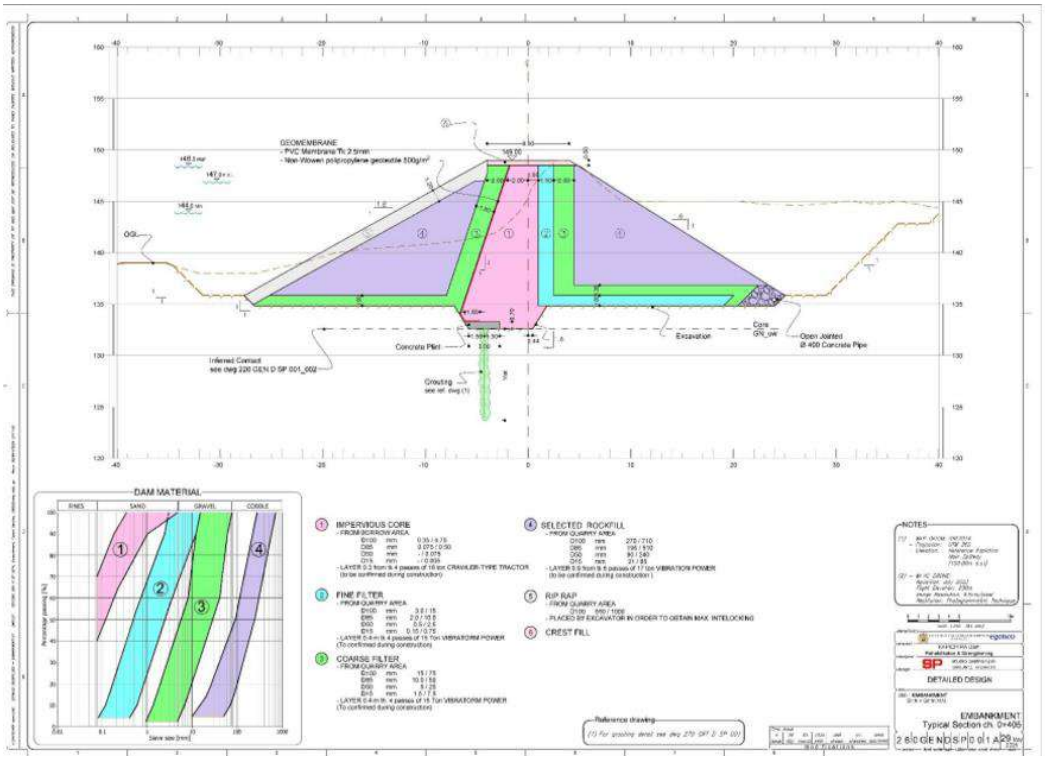
Figure 3-5: Layout for the embankment dam to be rehabilited

Construction phase

The embankment dam is an earth fill and rockfill embankment with a central clay core, with a maximum height of 12.5 m. The following table shows the main characteristics of dam after the rehabilitation.

Table 3-3: Technical characteristics of the Kapichira dam to be rehabilited

Component	Dimensions
Maximum crest length	112.70 m
Maximum dam height	16.40 m
Maximum base width	60.00 m
Upstream slope	1:1.8 h/v
Downstream slope	1:1.6 h/v
Crest road width	8 m



Source: Studio Pietrangeli Consulting Engineers, 200GENRSP001A, Detailed Design Report, May 2025

Figure 3-6: Embankment to be reconstructed

For the construction:

- the impervious core is constituted by material available from the borrow area located in the right bank at about 1.5 km upstream. This material will be laid in layers 0.3 m thick and compacted by 4 passes of an 18 tons crawler type tractor.
- The fine and coarse filter zones are transition material and consists of material available from the site selected quarry. This material will be laid with layer of 0.4 m thick and compacted with 4 passes of 15 tons vibratory roller.
- The rockfill material is located to both upstream and downstream shells. The material will be obtained from the site selected quarry. This material will be laid in layers 0.9 m thick and compacted by 6 passes of a 17 tons vibratory roller.
- The riprap is located in the upstream facing. This zone provides protection for the u/s face, especially during the oscillation of the reservoir water level. This zone is constituted by mid-sized crushed material, available from the selected quarry. It will be placed by excavator to obtain a maximum interlocking.

Furthermore, an artificial waterproofing geomembrane system located upstream of the impervious core will be foreseen to increase dam safety.

Operation phase

When the part of the training dyke, between the existing training dyke and the dam embankment, is dismantled, the water in the reservoir will feed the permanent irrigation intake. The function of the embankment dam will then be the same one as the original function.

3.3.4. Emergency spillway

The emergency spillway permits to discharge the floods during extreme weather conditions. The emergency spillway of Kapichira dam will be equipped with six (6) sets of TOPS gates. The rated discharge capacity of the emergency spillway is 2 784 m^3/s with a water elevation of 148.5 masl. In flood conditions, the TOPS gate shall open and close automatically in response to the water level in the dam.

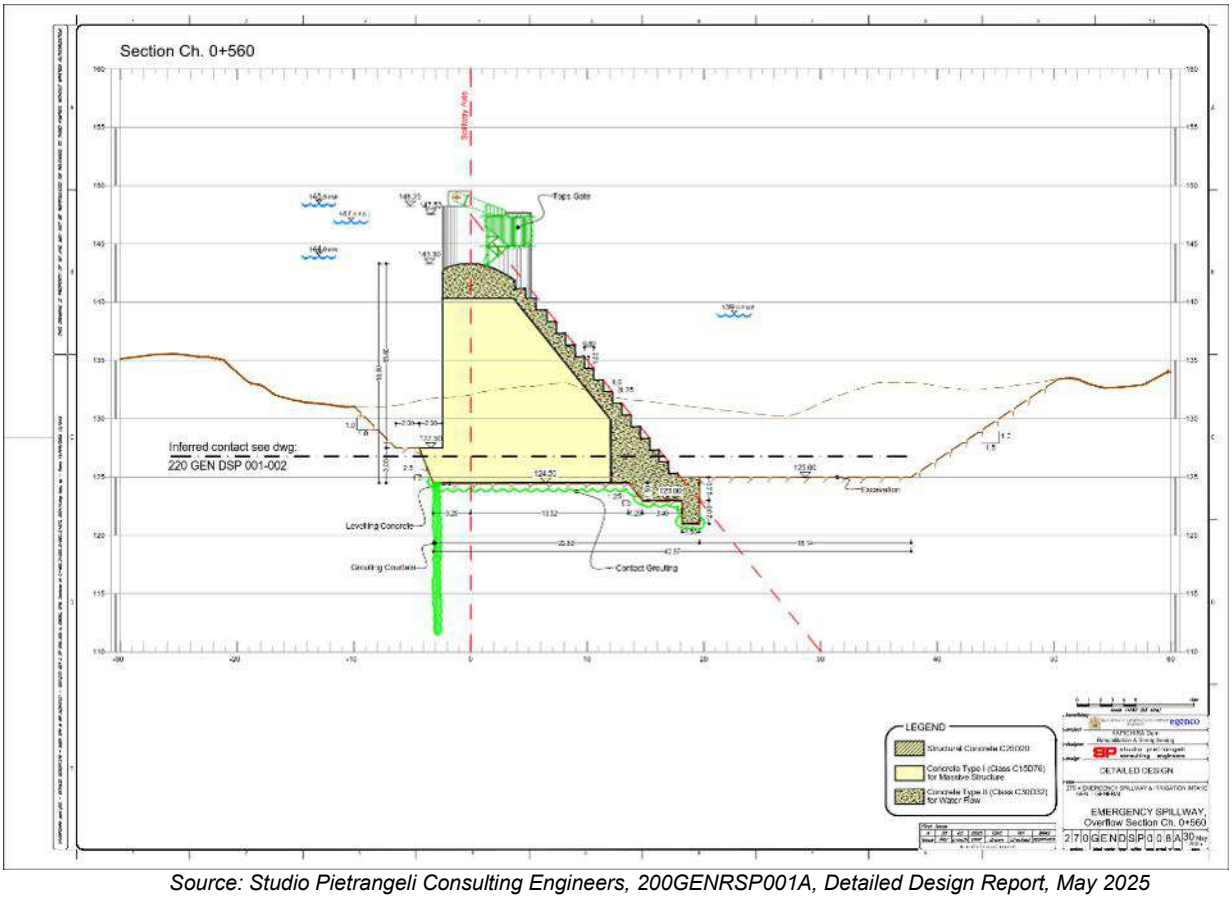
Construction phase

The new emergency spillway will be located in the same position as the collapsed right bank fill. The spillway structure includes:

- A controlled ogee crest spillway.
- A stepped the chute d/s the crest having slope 0.8:1 (h/v);
- Lateral canal to convey the water in the central part of the emergency spillway, with variable wide from about 15 to 29 m. The height of the walls is designed to discharge the PMF flow and varies 8.5 m to 9.0 m.
- A dissipation area consisting of rock excavation in correspondence with the highest section of the spillway.

Table 3-4: Technical characteristics of the emergency spillway to be rehabilited

Component	Dimensions
Length	143 m
Maximum height above foundation	20 m
Spillway still elevation	143.3 masl
u/s face slope	0 h/v
d/s face slope	0.8:1 h/v
Basic triangle vertex elevation	147.5 masl



Source: Studio Pietrangeli Consulting Engineers, 200GENRSP001A, Detailed Design Report, May 2025

Figure 3-7: Emergency spillway design

The work layout consists of replacing the 130 m long fuse embankment on the right side of the embankment dam with automatic TOPS gates fitted on an ogee spillway.

The estimated volume of concrete for the emergency spillway is approximately 25'000m^3.

Operation phase

The TOPS gate operating principle is presented in the following figure. They respond automatically in response to the rising water level in Kapichira to let floods pass and will then automatically close to retain the full supply level in the dam.



Source: Amanziflow - Studio Pietrangeli Consulting Engineers, 100GENRSP002B, Preliminary Design Report, November 2024

Figure 3-8: TOPS gate operationg principle

The emergency spillway needs to be able to discharge together with the main spillway the Probable Maximum Flood (PMF) estimated to be equal to 11 170 m^3/s, with maximum

water level of 148.50 masl. Therefore, a portion of the PMF will be discharged from the main spillway and the remaining part will be discharged from the emergency spillway.

The main spillway was designed to evacuate through the 5 radial gates the maximum discharge of 8 448 m³/s. Consequently, the discharge in charge of the emergency spillway is equal to 2 723 m³/s, which is in line with its rated discharge capacity (2 784m^3/s).

The spillway crest is designed in order to reproduce the lower nappe-profile of a sharp crested weir in order to have practically nil pressure on the spillway crest according to USBR standards and create a necessary transition between the conventional Ogee crest and the stepped chute. The transition is necessary to introduce the stepped profile as high as possible, but also to avoid that the flow, for low discharges, jumps the first steps.

The stepped chute has been foreseen to allow a greater energy dissipation than a smooth chute and to reduce the length of the stilling basin. The design of the stepped chute foresees that the geometrical characteristics, flow regime, velocity and residual energy of the stepped spillway chute are performed using a numerical model following the USBR standards criteria.

3.3.5. Irrigation intake for SVTP

The SVTP irrigation intake is located on the right side adjacent to the emergency spillway. Its scope is to safety transfer water from the reservoir through the existing box culvert siphon in the irrigation canal to meet the required water demand for irrigation purposes.

Construction phase

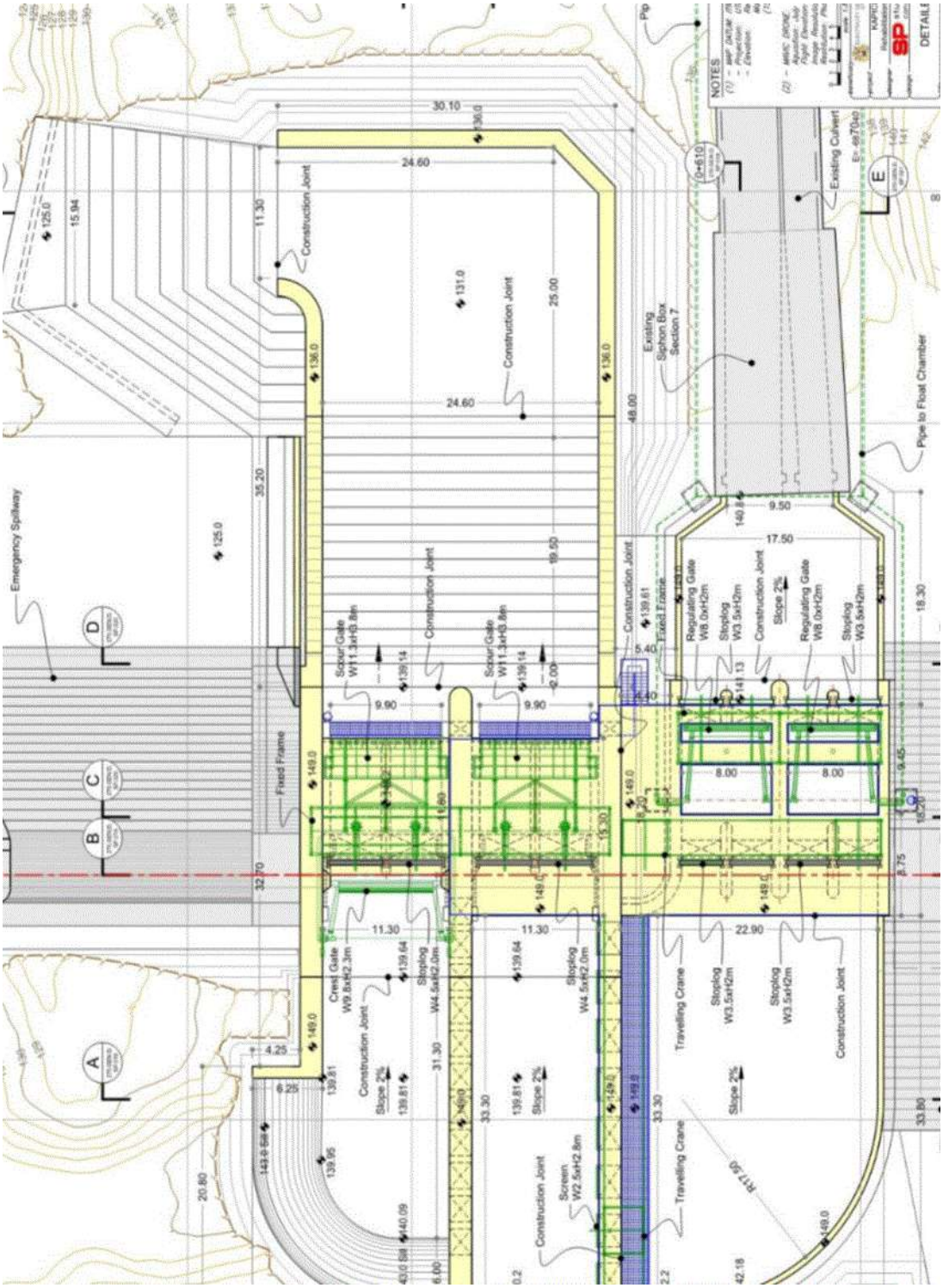
The scope of works consists of installing two automatic self-regulating gates. The permanent intake will then consist of a reinforced concrete structure approximately 100m long and 55m wide in total.

The flotsam and scour channel of the SVTP intake will be equipped with one (1) crest gate. The main purpose of the gate is to remove floating debris from entering the SVTP intake structure.

The technical characteristics of SVTP irrigation intake are described in the following table and figure.

Table 3-5: Technical characteristics of SVTP irrigation intake

Structure	Components	Dimensions
Sill (Ogee type profile)	Sill elevation	143 masl
	Sill length	30 m
	Max height	5 m
	u/s slope	0 h/v
	d/s slope	0.95:1 h/v
Flotsam and scour channel	Length	102 m
	Net width	11.30 m
	Invert level elevation	140.09/139.14/131masl
	Max height	11.5 m
	Wall thickness	2 m
	Slab thickness	2 m
	Bottom slab slope	2 %
	Crest gate for the removal of the flotsam	Width = 9.8 m Height = 2.3 m
	Scour gate for the removal of the coarse sediment	Width = 11 m Height = 4 m
	2 Stoplog	Width = 4.8 m Height = 3 m
Intake channel	Length	70 m
	Net width	22.90 m
	Invert level elevation	142.18/140.80 masl
	Max height	9 m
	Wall thickness	1.0/1.5m
	Slab thickness	1.5 m
	Bottom slab slope	2 %
	2 regulating gates	Width = 8 m Height = 2.6 m
	2 Stoplog U/S gates	Width = 4.8 m Height = 3 m
	2 Stoplog D/S gates	Width = 4.8 m Height = 3 m



Source: Studio Pietrangeli Consulting Engineers, 200GENRSP001A, Detailed Design Report, May 2025

Figure 3-9: Permanent irrigation intake layout

Operation phase

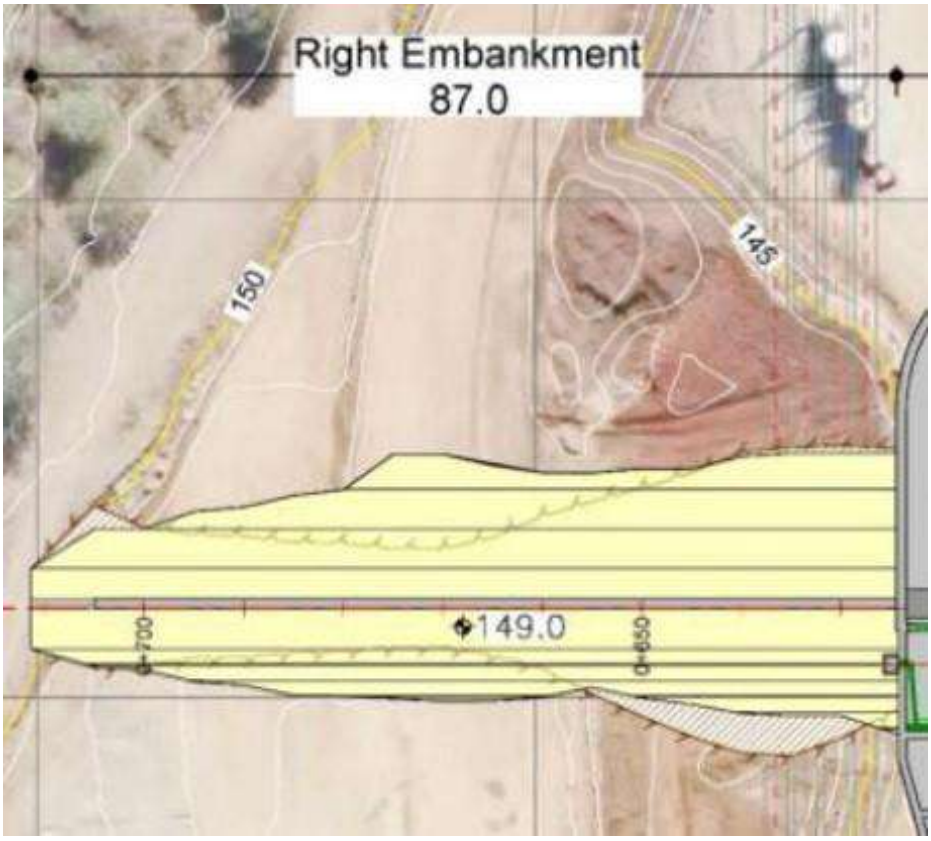
Part of the training dyke, between the existing training dyke and the dam embankment, will have to be dismantled to allow the water in the reservoir to feed the SVTP irrigation intake.

The discharge that the structure can divert under the assumption of the minimum reservoir elevation, i.e. 144.0 masl, is approximately 43 m^3/s. The discharge at maximum flow will be 50 m^3/s.

Two (2) canal regulating gates are envisaged for the SVTP intake to regulate the flow in the irrigation canal. Each canal regulating gate has been designed to discharge the maximum requested flow of 50m^3/s. This implies that even if one gate is out of service, because of malfunctioning or maintenance, the other gate can assure the maximum required flow to the irrigation system. The gates will maintain a constant downstream flow with a varying upstream head, and they will protect the off-take canal from flooding when there is a flood. In normal condition each canal regulating gate is actuated automatically.

3.3.6. Right embankment

The right embankment is located on the right bank of the river, between the SVTP irrigation intake and the right abutment. It will consist of an earth fill and rockfill embankment with a central clay core like the existing dam.



Source: Studio Pietrangeli Consulting Engineers, 100GENRSP002B, Preliminary Design Report, November 2024

Figure 3-10: Layout for the right enbankment dam to be rehabilitated

Construction phase

The main characteristics of the right embankment are briefly summarised hereafter.

Table 3-6: Technical characteristics of the right embankment to be rehabilited

Component	Dimensions
Maximum crest length	84.40 m
Maximum dam height	15.30 m
Maximum base width	60.00 m
Upstream slope	1:1.8 h/v
Downstream slope	1:1.6 h/v
Crest road width	8.00 m

The same material and construction characteristics will be used than the one for the embankment dam. To reduce the seepage in the foundation, a plastic diaphragm was adopted for the right embankment.

Operation phase

Temporary intake pipe will be removed. When the part of the training dyke, between the existing training dyke and the dam embankment, is dismantled, the water in the reservoir will feed the permanent irrigation intake. The function of the right embankment dam will then be the same one as the original function.

3.3.7. Training dyke

The design for the training dyke restores the functionality of this structure, which serves to direct the material transported by the river towards the spillway during flushing operations.

Construction phase

In order to restore its original functionality, part of the embankment, constructed in recent years, will be dismantled using mechanical excavation and dredging techniques.

Table 3-7: Technical characteristics of the training dyke to be rehabilited

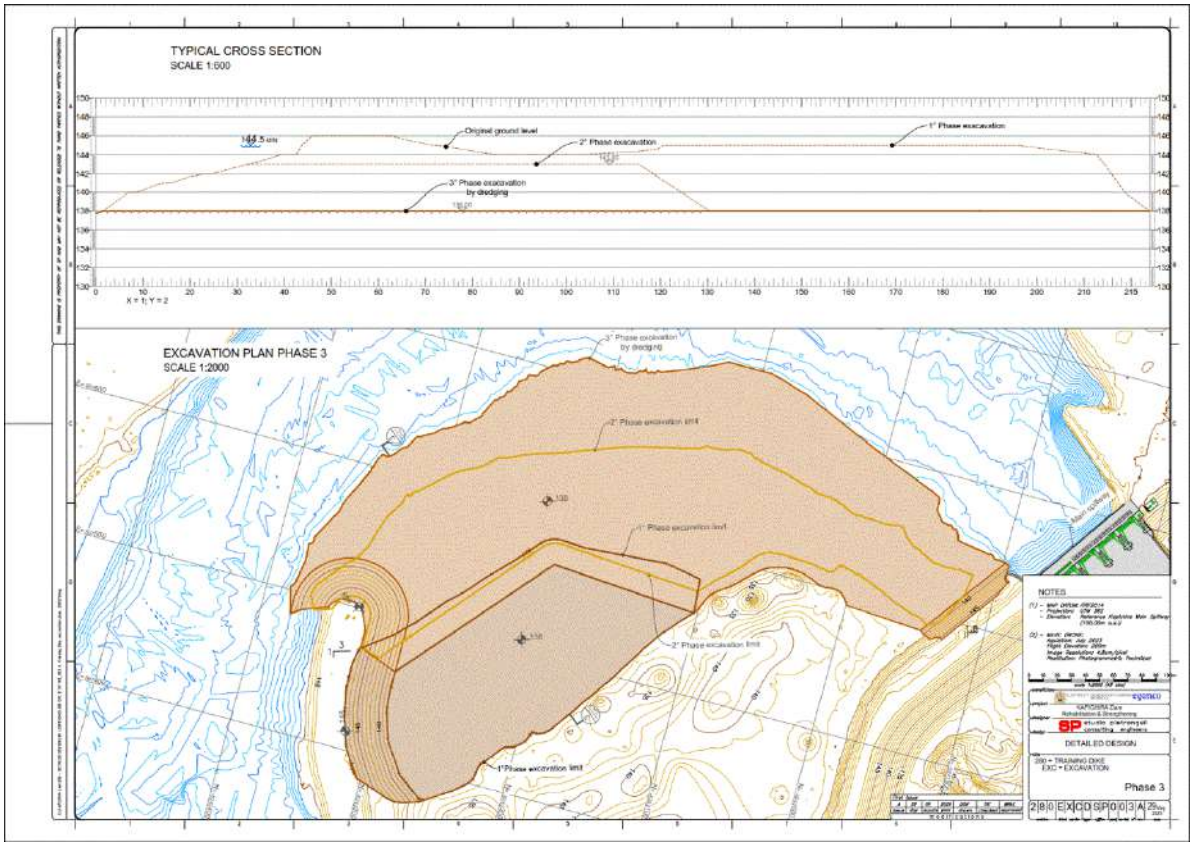
Component	Dimensions
Crest length	575 m
Crest elevation	149 masl
Crest road width	16.0/8.00 m
Upstream slope	3:1 h/v
Downstream slope	3:1 h/v

In order to increase the stability safety factor, the slope of the training dyke will be increased from 2:1 to 3:1 (h/v), which will require additional construction material. Rockfill material will be laid to both upstream and downstream shells. The material will be obtained from the selected quarry site.

At the end of the rehabilitation activities, part of the current embankment material, between the existing training dyke and the dam embankment, will be removed, both to restore the function of the training dyke and to allow the water in the reservoir to feed the permanent SVTP irrigation intake. This activity will be carried out when the other components (embankment dam, spillways and intake) are rehabilitated.

The estimated amount of material to be removed is 490 000 m^3. It will be removed according to the following steps and illustrated by the following figure:

- Step 1: removal of coarse and fine material, with mechanical equipment (excavators), in the south-west section up to a height of 138 m. This activity will be carried out with reservoir water level of approximately 144.0 masl.
- Step 2: Removal of coarse and fine material, with mechanical equipment (excavators), up to elevation 143 m in the remaining area section. This material will be removed using excavators, moving from the training dyke to the dam with the water level at approximately 144.0 masl.
- Step 3: Removal of fine materials throughout the entire area up to a depth of 138 m. This material will be removed by dredging with the water level at approximately 144.5 m. The dredged material will be stored in the disposal area for sedimented material on the left bank.



Source: Studio Pietrangeli Consulting Engineers, 200GENRSP001A, Detailed Design Report, May 2025

Figure 3-11: Excavation plan for the rehabilitation of the training dyke

Operation phase

The training dyke will serve to direct the material transported by the river towards the spillway during flushing operations. The sedimentation analysis, provided in the detailed design from the Owner Engineer, specified that the construction of a training dyke in the reservoir, on average, allows to reduce the deposition into the reservoir in a range of 10-15%.

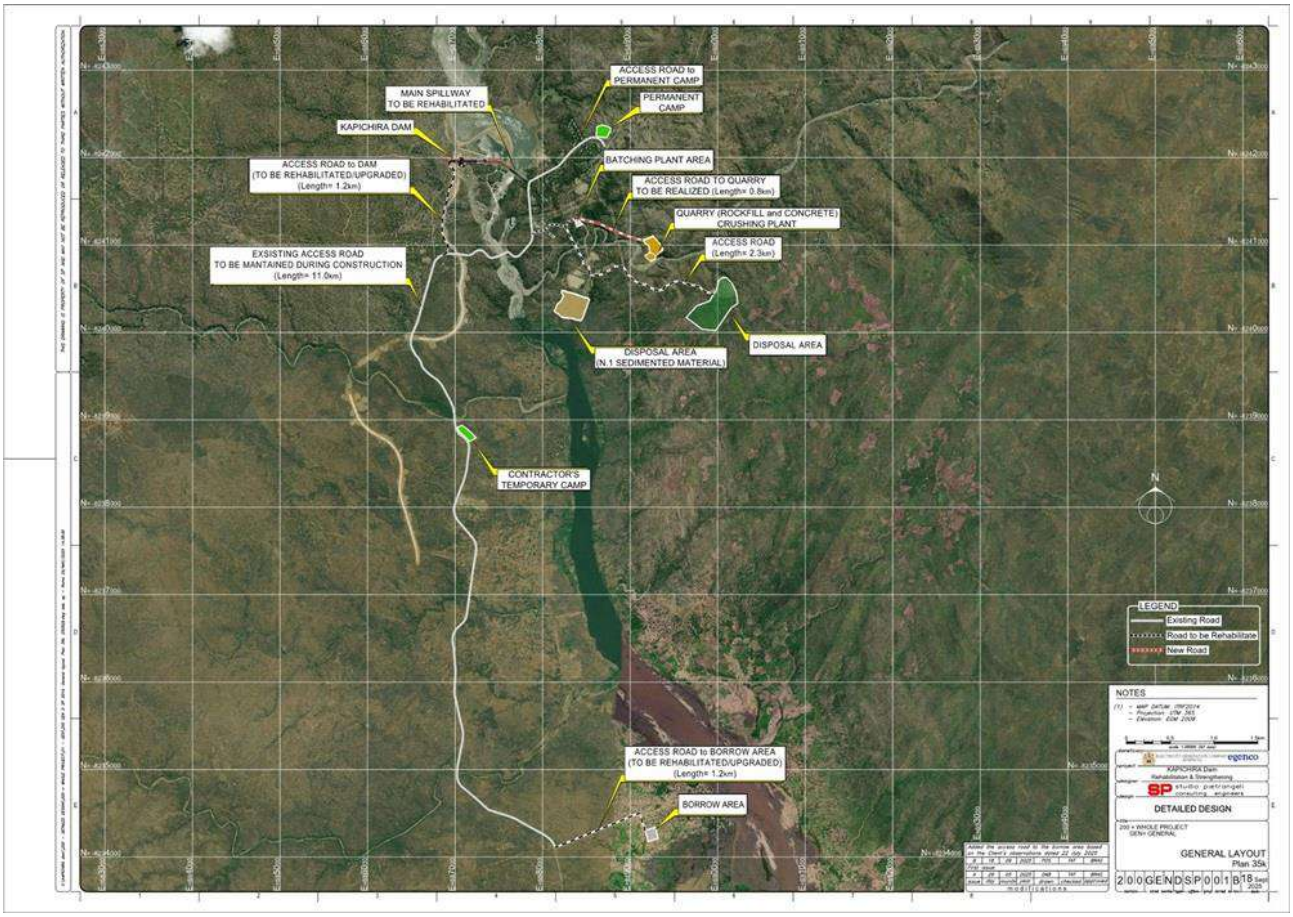
3.4. Description of construction facilities required for the dam rehabilitation

3.4.1. General layout plan for construction activities

In order to rehabilitate the dam as described in the previous sub-chapter, the project requires the following new construction facilities (see the figure 3-12) covered by this ESIA:

- New quarry site for the material of the main embankment and concrete works.
- New borrow site for the construction of the impervious core of the Kapichira Dam.
- New disposal area for the surplus of excavated material from the training dyke, close to the existing disposal area used for sediment deposition.
- New batching plant for the material to rehabilitate the dam.
- New temporary campsite for the Contractor's employees.
- New permanent camp for EGENCO staff within EGENCO residential area.
- Access roads between each construction area and the dam site.

As part of the existing Kapichira project, an area for sediment deposition exists and will be used for additional sediment material for the project.



Source: Studio Pietrangeli Consulting Engineers, 200GENRSP001A, Detailed Design Report, May 2025

Figure 3-12: General layout plan for construction activities

3.4.2. Quarry site

The new quarry site for the rehabilitation of Kapichira is situated around 2,5 km southeast of Kapichira dam, on the land of Maganga 2 village. The following quantities of material required for the works were estimated as follows:

- 55'000 m^3 for concrete aggregate,
- 43'000 m^3 for embankment shells, rip rap, drains and filters.

A total of about 98'000 m^3 of material will be needed. The chosen quarry can provide around twice more than the needs.

The quarry site covers an estimated area of 22,900 m^2.



Source: Studio Pietrangeli Consulting Engineers, 200GENRSP001A, Detailed Design Report, May 2025

Figure 3-13: Quarry Site, Aerial view

The geological substrate is a gneiss with excellent mechanical properties, making it suitable for use both as rockfill, filter and transition layers in the dam body and as aggregate for concrete.

The land must be acquired by the project (included in the Resettlement Action Plan for the project).

3.4.3. Borrow area

For the rehabilitation of the main embankment, a total of about 8'000 m^3 of clay material have to be supplied for the construction of the central core.

The new identified borrow site is located approximately 10 km downstream dam and cover an area of about 2 hectares. It is located closed to Njereza village, with 1km access road from the main Chikwawa-Kapichira road.

An average excavation depth of 2m will be required to provide the whole volume necessary for the construction of the main embankment.



Source: Studio Pietrangeli Consulting Engineers, 100GENRSP005A Borrow area assessment Report, July 2025

Figure 3-14: Location of the borrow site

The land must be acquired on a temporary basis by the project (included in the Resettlement Action Plan for the project).

3.4.4. Disposal area

Related to the dam construction, the location of the surplus of excavated material and waste disposal site has been identified on the left side of the Shire River, around 3,5 km

from the dam area, close to the quarry site. It is currently estimated by the Owner's Engineers that the mass balance of earthworks will result in a surplus of approximatively 60 000 m³ of excavated materials, which will be permanently deposited.

The disposal site covers an estimated area of 175,500 m^2. The land has been recently acquired from Maganga II by EGENGO through a long-term lease dated 12 December 2025.

3.4.5. Batching plant area

For the parts of dam to be rehabilitated, a batching plant must be installed by the contractor. The identified area is located between the quarry site and the dam site to minimize the transport between each site. This land belongs to EGENCO.

The batching plant site covers an estimated area of 3,900 m^2.

3.4.6. Contractor's temporary camp

The chosen location for the new temporary campsite for the contractor is within Maganga 1 village, located 4.3 km from Kapichira dam site along the main T416 road. The choice of the campsite location has taken into consideration nearby the villages to prevent the proximity between the campsite and residential area. The nearest village to the campsite (Mwembezi 1) is approximately 1km away, and it is located along the direct route between the campsite and the works.

The temporary camp is located on the right bank of the Mwembezi River, tributary of the Shire River, with an area of 16'700m^2.



Source: Studio Pietrangeli Consulting Engineers, 200GENRSP001A, Detailed design Report, May 2025

Figure 4 4: Campsite Area, Drone View in October 2024

The land must be acquired by the project (included in the Resettlement Action Plan for the project). Water will be supplied by borehole. Energy should be supplied by 33 kV line.

3.4.7. Permanent camp

There is an existing residential area for EGENCO staff. A permanent camp for this project will be added on land available in this area. The permanent camp (management camp) is located on the left side of the reservoir, upstream the dam in an area directly adjacent to the existing residential areas of the EGENCO staff. The area assigned to the permanent camp is equal to 18'600 m^2. The land belongs to EGENCO.

In the permanent camp, the following main structures have been foreseen:

- 4 two-bedrooms family houses
- 8 one-bedroom family houses
- 4 one-bedroom accommodation for Workers
- 1 Mess
- 1 Laundry building
- 1 office building
- 1 guard house.

All the structures of the additional permanent camp have been designed as reinforced concrete permanent structures to be handed over to the Client at the completion of the project. The buildings will be built with foundations and frames in reinforced concrete, lateral walls by concrete blocks, plastered and painted, and roofs in metallic structures.

The following figure shows the permanent camp layout.



Source: Studio Pietrangeli Consulting Engineers, 200GENRSP001A, Detailed Design Report, May 2025

Figure 3-15: Permanent camp layout

3.4.8. Access Roads

Access roads for the project construction activities will include:

- The M1 road, which is the main road between Blantyre and Chikwawa, approximately 50 km long, with bituminous surface.
- The T416 road between Chikwawa and the entrance of EGENCO Kapichira dam area, approximately 20 km long. This is a feeder road which has, after leaving Chikwawa town, an earth surface maintained in relatively good condition. The contractor's temporary camp site will be installed along this road.



Figure 3-16: T416 road from Chikwawa to Kapichira dam site – August 2024

- The roads passing through EGENCO property on the left bank. Access to the left bank areas is controlled by EGENCO-checkpoint at the right bank of the bridge. The roads to powerhouse, intake site and to the housing areas of EGENCO staff are with bituminous surface.



Figure 3-17: Bridge on the Shire River from the left bank in EGENCO property - August 2024

- The access road (1,2 km long and 6m wide) between African Parks Office and the west side (right bank) of the dam, which branches off from the existing T416 road: This is an existing track, constructed by SVTP for their access to the irrigation intake. After the construction, this area will come back to African Park. However, the road will stay permanently for the operational requirements of the SVTP irrigation water intake and for the maintenance of EGENCO dam equipment.



Figure 3-18: SVTP access road to intake – August 2024

- Earth roads on eastern side (left bank) of Kapichira dam, leading to the quarry site and to the disposal area. An existing earth road leads to the disposal areas and will be used for project access. Access to the quarry site will require construction of a new access road partly within EGENCO boundaries (no land acquisition required). However, the quarry site and the remaining part of the access road to be constructed will need to be acquired by the project, as the area is outside the boundary of EGENCO property.



Figure 3-19: Access road to the disposal area – August 2024

Based on the detailed design[8], the roads required for the project activities are as follows:

Table 3-8: Technical description of the access roads

Component	Description	Status	Length
Access road to the dam	This is the access road to the permanent construction site, which branches off from the existing road T416.	To be rehabilitated / upgraded	1.2 km
Stretch of road T416	This refers to the connection road between the borrow area, the dam access road, the permanent camp and the contractor's temporary camp.	To be maintained during construction	11 km
Access road to the disposal area	This is the access road to the disposal area and disposal area for sedimented material. It branches off from the existing road to the EGENCO camp.	To be rehabilitated / upgraded	2.3 km
Access road to the quarry	This is the access road to the quarry area. It branches off from the road used to access the quarries.	To be built	0.8 km

3.5. Project's areas of influence

3.5.1. General

The Project Area of Influence is defined as 'the geographical area in which impacts of a project will be felt' (IHA, 2021). This defines the geographical boundaries within which the impacts of the project are assessed.

The project area of influence – or study area - includes all areas with a direct or indirect impact of the Project. It therefore goes far beyond the "direct footprint area", which is defined as comprising mainly the dam site area. It also includes the construction influence area and the downstream area (including Chikwawa floodplain).

The Project Area of Influence varies depending on the type of impact and the project stage. This ESIA is for the rehabilitation of Kapichira dam, which has existed and operated since more than 20 years. Unless significant changes are made to the extent

[8] Studio Pietrangeli Consulting Engineers, 200GENRSP001A, Detailed Design Report, May 2025

of land required for Project structures or to the Project's operation, the main additional impacts are expected during the construction phase.

The following sections which describe the direct footprint area and the zones for studying impacts in the surroundings of these areas, are therefore mainly targeting to cover the construction phase impacts.

3.5.2. Direct footprint area

The projects' direct "footprint" area refers to all the areas with project components to be reconstructed or rehabilitated as described in the chapter 4.3. This area includes the dam area, and the reservoir area as described hereafter.

Dam area:

This area includes the existing spillway and embankment dam which will be rehabilitated, the new permanent structures (emergency spillway, permanent irrigation intake, right embankment) and the training dike. This area will be dedicated to the works activities for the contractor.

Reservoir area:

The reservoir is directly impacted by coffer dam construction and decommissioning, and by desilting and changes in operation and sediment management.

The reservoir area is delineated as the maximum water level at 148.5 m elevation.



Source: Studio Pietrangeli Consulting Engineers, 100GENRSP001A, Field investigations Report, October 2023

Figure 3-20: View of the direct footprint area with Kapichira reservoir and dam area from July 2023 drone aerial survey

The direct footprint area (in red on the following map) is the most sensitive area during the construction phase, and it still needs to be considered during the operation phase.

3.5.3. Construction influence area

The construction influence area is a wider area than the direct footprint area. It includes the direct footprint area as described above and the construction facilities with the quarry and borrow areas, the disposal site, the camps and the access roads as described in chapter 4.4. The construction influence area is the most sensitive during the construction phase.

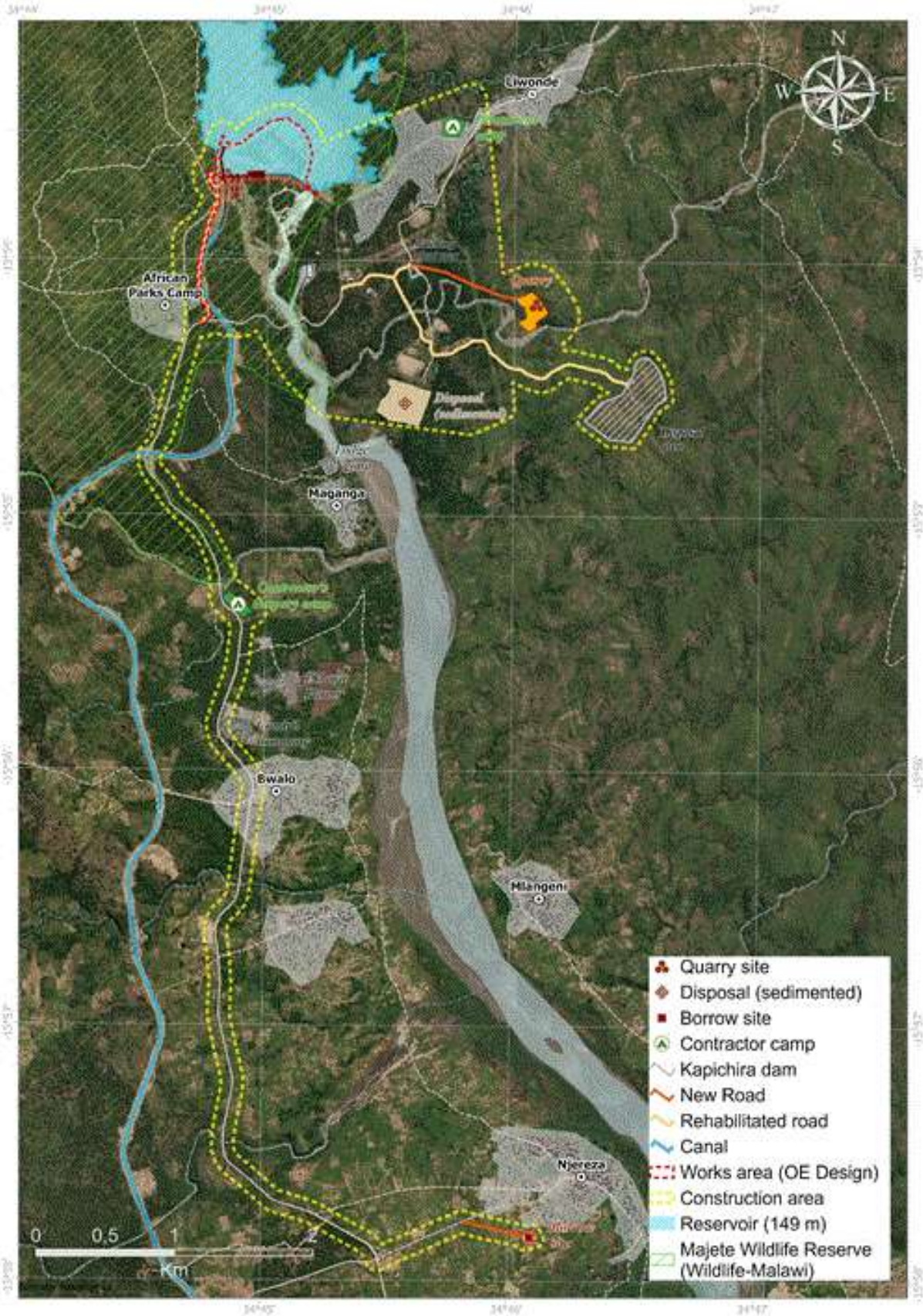


Figure 3-21: Construction influence area

The construction influence area is mainly targeting to cover the construction phase impacts such as noise, visual impact and air pollution, traffic and the interaction with the communities.

3.5.4. Downstream influence area

The downstream area is the zone where changes in the hydrology or water quality of river downstream of the infrastructures could have a significant impact on the receiving environment.

In the downstream of the dam, potentially influenced sections of the river and riparian areas are extended to cover the entire Kapichira falls (all flow channels) and the Shire River up to the tailrace channel outflow. This is the dewatered river section, i.e. the river section experiencing reduced flows due to diversion of flows into the SVTP irrigation intake and the Kapichira HPP. However, there are currently no flows into the SVTP intake.

Downstream areas (see the following figure) include the Shire River and riparian areas from downstream of Kapichira HPP tailrace upstream of the Elephant Marsh. This area includes the Shire River channel, the riparian areas and wetlands depending on Shire River flows, and the areas affected by floods and low flows of the Shire River such as Chikwawa floodplain. It extends down to the Chiromo bridge, i.e. downstream of the Elephant Marsh and just upstream of the confluence with Ruo River.

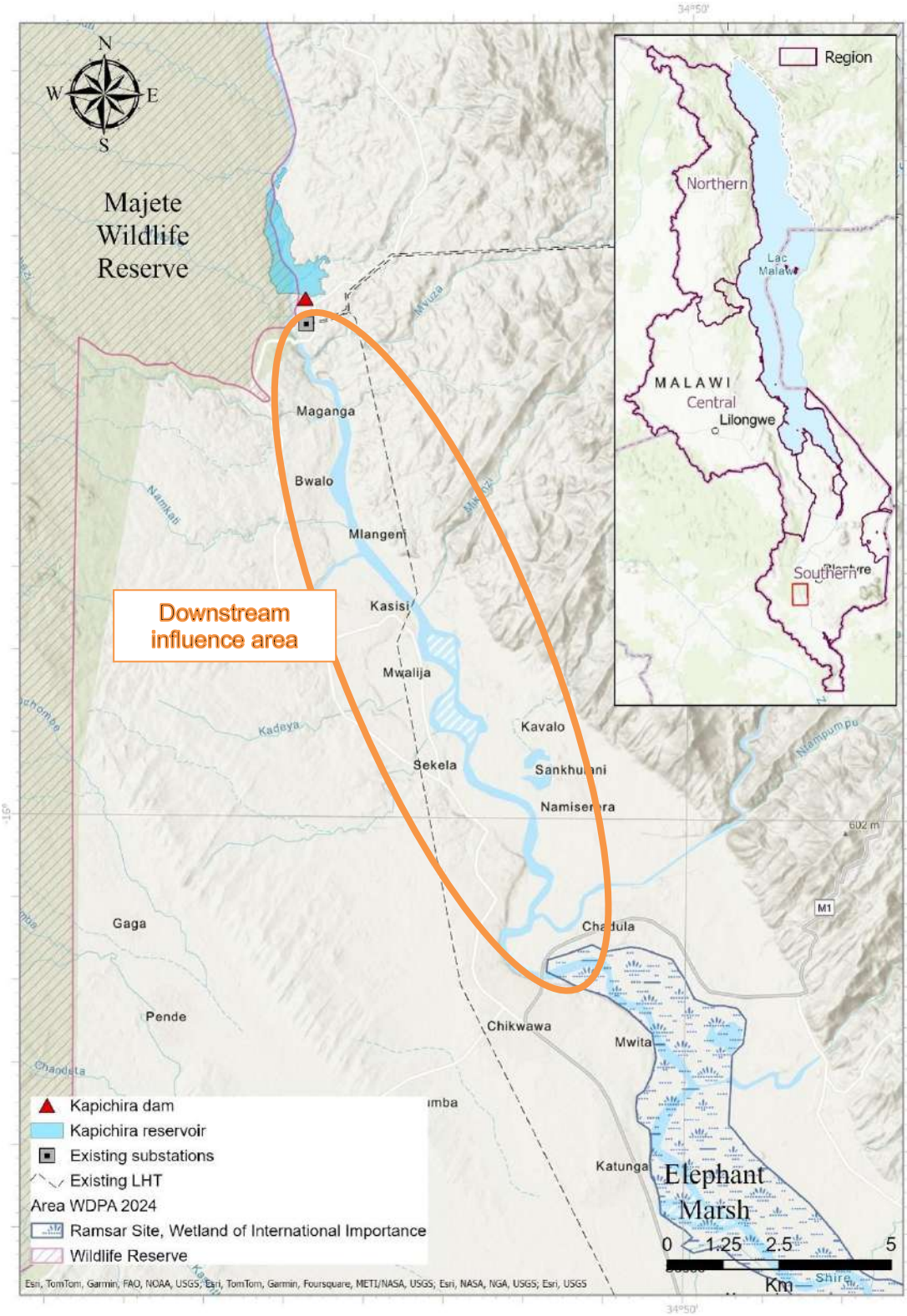


Figure 3-22: Downstream influence area

4. METHODOLOGY FOR THE BASELINE

4.1. Introduction

This chapter provides the methodology carried out to describe the baseline in the chapter 6 for the physical, biological and human environment.

Based on the area of influence as described in the previous chapter 4.5, the baseline relies on the review of the collected environmental and social data and reports before complementary field investigations. The design studies carried out by the Owner's Engineer were considered in parallel with this environmental and social study.

This chapter is structured as follows:

- The project's ESIA process, undertaken for this study,
- The scoping activities,
- The methodology for the assessment of the physical environment,
- The methodology for the assessment of the biological environment,
- The methodology for the assessment of the human environment.

4.2. Project's ESIA process

The Project ESIA process started in 2024 and was conducted as follows:

- April 2024:
  - Requirement of environmental and social impact assessment for the proposed Kapichira dam strengthening project from MEPA,
  - Kick off meeting with EGENCO and the Consultant Tractebel-Ruo for the ESIA,
  - Inception report.
- May 2024:
  - First stakeholders' consultation during scoping phase.
- June 2024:
  - Draft report of the scoping report.
- August 2024:
  - First physical and biological investigations
- September 2024:
  - Socio-economic survey.
- March - April 2025:
  - Second biological investigations on complementary areas (temporary camp site and quarry site).

- September 2025:
  - Complementary surveys at the new clay borrow site including access road.
- October 2025:
  - Social surveys relative to the resettlement action plan.
- November 2025:
  - Final stakeholders consultations.

4.3. Scoping phase

The following activities were carried out during the 2024 scoping phase to prepare the field activities for the ESIA baseline:

- Compilation of documents and data relative to the Kapichira Dam Project,
- Definition of the project's areas of influence,
- Initial alternative analysis,
- Description of the legal requirements in all environmental and social aspects,
- First stakeholders' consultations,
- Description of the initial version for the environmental and social baseline based on the available data,
- Identification of the potential impacts requiring further baseline data
- Description of the investigations for physical, biological and socioeconomical environment to be carried out for the needs of the ESIA considering to the above findings.

4.4. Methodology for the assessment of the physical environment

4.4.1. Introduction

The methodology was mainly based on existing data. However, the Consultant undertook complementary investigations about air and water quality as well as noise measurements.

4.4.2. Analysis of existing data

The initial conditions of the physical environment were characterized in a manner proportionate to the issues as follows:

- The existing hydrology (including climate change), hydrogeology, topography, and geomorphology studies as well as the geology and seismicity studies are considered from the existing survey reports mainly coming from the Owner's Engineer in charge of the design to describe the physical characteristics of the environment (see the bibliography in the Appendix B).

- The water quality and flooding risk study as well as the erosion and sedimentation studies provided by the Client was reviewed by the Consultant to ascertain the sampling and analysis.

4.4.3. Field activities

Based on the existing data and the preliminary field assessment, the Consultant undertook water samplings, noise level measurements and air quality assessment (see the locations on the following map):

- For water quality survey: upstream and downstream in the direct footprint area (mainly around the reservoir), as well as in the construction influence area (including the vicinity of the temporary camp site and the quarry site and disposal area) downstream until the Chikwawa floodplain. The water sampling campaign was conducted from the 7 to 15 August 2024 on Shire River with a total of eighteen (18) water samples collected.
- For air quality and noise level survey: a total of nine locations was surveyed in the direct footprint area (at three stations: dam area, water intake area and Kapichira bridge area) in November 2024 and in the construction influence area where potential nuisances could be felt: the quarry site, the batching plant area, on the access road close to African Parks Camp, at the Contractor's temporary camp site, at the borrow site and at Bwalo village in September 2025.

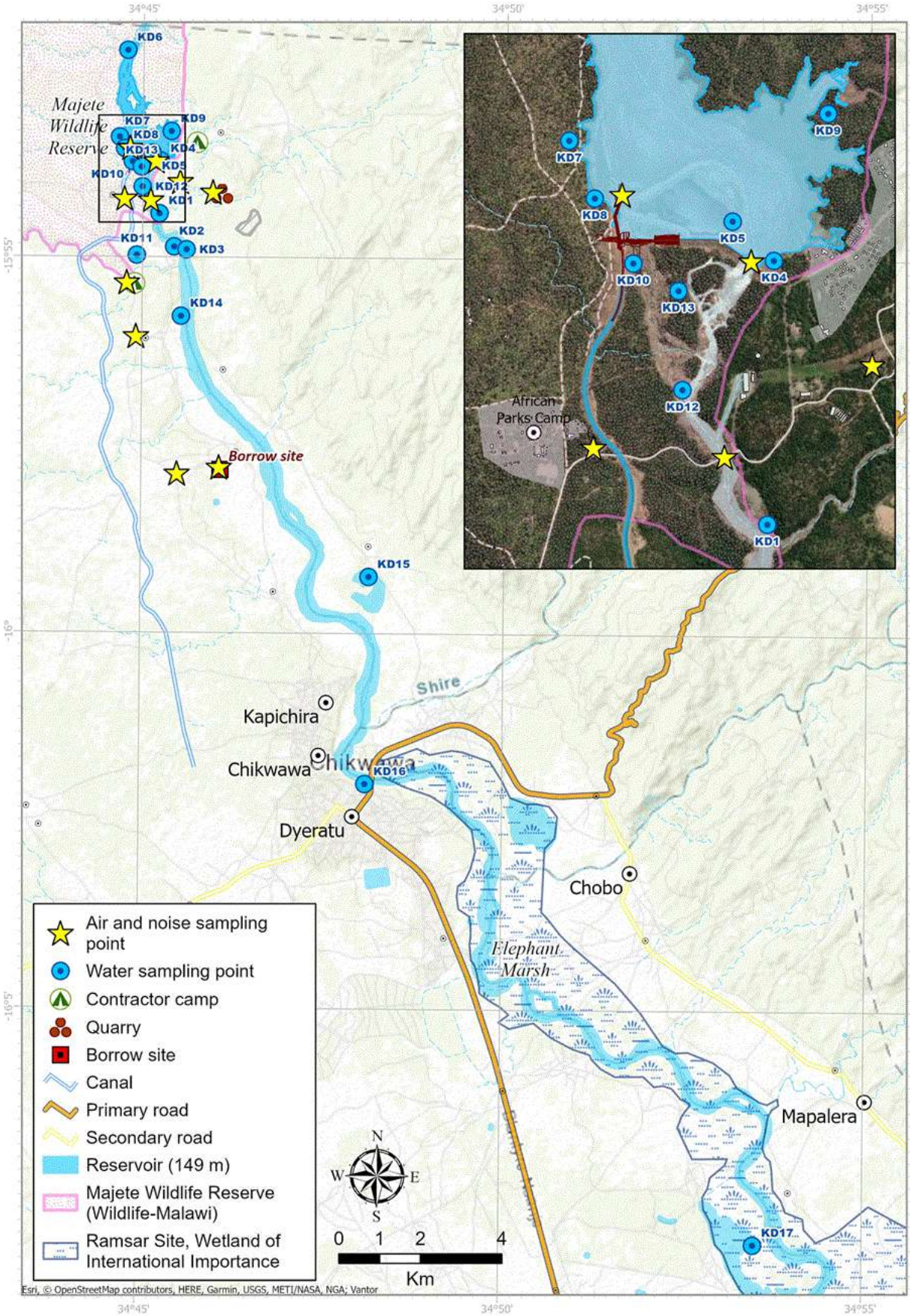


Figure 4-1: Location of samplings points for water, noise and air quality surveys

Water quality assessment

The analysis for the water quality includes the following parameters:

- Physical parameters: temperature (°C), turbidity (NTU), total suspended solids (mg/L).
- Chemical parameters: pH, Conductivity (µS/cm), Salinity (ppt), Dissolved Oxygen (DO - mg/L and %saturation), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Nutrients (Nitrogen and Phosphorus), Heavy Metals (e.g., Mercury, Lead, Arsenic), Chlorides and Sulphates.
- Biological Parameters: Microbial Contaminant indicators e.g., E. coli; Algal Counts (Chlorophyll a (µg/L)).
- Sediment Quality: Sediment Composition such as clay, silt, sand, etc; Benthic organisms.



Figure 4-2: Measuring physical properties using Hanna probe

The results were analysed considering the international guidelines such as the World Health Organisation, the American Society for Testing and Materials, the EU water framework directive and SEQ-EAU.

Air quality assessment

The assessment of air quality monitored the Total Suspended Particulate (TSP), the Particulate Matter PM_{10} and $PM_{2.5}$, the Carbon monoxide (CO), the Nitrogen dioxide (NO2) and the Sulphur dioxide (SO_2). Data was collected continuously for 24 hours.

Noise levels assessment

The noise assessment involved the use of a Brannan Sound Level meter without shielding to capture noise levels (dBA) at each site. The assessment was conducted during day and night.

4.5. Methodology for the assessment of the biological environment

4.5.1. Introduction

The methodology was based on the analysis of the existing studies (see the bibliography in the Appendix B) and data in the project area of influence.

Based on the results of the identified key issues, the Consultant undertook complementary fauna and flora investigations in two times, in August 2024 during the dry season and in April 2025 for the complementary components of the construction influence area.

4.5.2. Analysis of existing data

Biological data have been first collected from various projects around the Kapichira dam such as the Shire Valley Irrigation Project and the Mpatamanga Dam upstream of Kapichira Dam. The literature review helped to establish the baseline for the surveys such as the following projects:

- Shire Valley Transformation Program: The study area of SVTP spans from Majete Wildlife Reserve to the southernmost point at Bangula, covering most of Chikwawa district and part of Nsanje district. It lies within the Lower Shire River valley, including the confluence of the Ruo River with the Shire River and all rivers feeding into the Elephant Marsh from both its right and left banks.
- Mpatamanga Hydropower Project: Previous studies were analysed to classify and assess aquatic / terrestrial ecosystems and their ecological state.
    - Multiconsult Aquatic Biodiversity Field Report (2018) (for E-Flows study) Dry season: 16-26 July 2018. Predominantly aquatic ecological studies but included birds along river corridors at 15 E-Flow sites: (Mpatamanga Dam to bottom Elephant Marsh) Sampling confined to riparian zones. No assessment of potentially occurring priority species.
    - The 2024 ESIA surveys included:
        - July–August 2023: Fish and habitat integrity assessments in the Shire River, Elephant Marsh, and tributaries.
        - September 2023: Aquatic ecosystem surveys in the Shire River and lower Mkulumadzi River, including water quality, fish, flora, and macroinvertebrates.
        - Additional terrestrial 2023 surveys: The 2024 ESIA survey (26 April–11 May 2023) following Cyclone Freddy in mid-March updated descriptions of vegetation, flora, and fauna, focusing on priority habitats, threatened species (IUCN-listed), and nationally protected species. The late wet season conditions allowed for effective flora assessment, but amphibian surveys were limited due to drying streams. Sampling included vegetation reference points, transects, and incidental fauna surveys across project sites.
        - Survey data of the lower Shire River in the Elephant Marsh (Turpie, 2016).

The analysis of the key issues was also based on the associated biodiversity data from the international areas of conservation interest and national protected area as well as

the scientific literature on Malawi's biodiversity and threats. The main sources used for this study include the following sources:

- Key Biodiversity Areas (KBAs) based on the Integrated Biodiversity Assessment Tool (IBAT) extracted from the World Database of Key Biodiversity Areas.
- World Database Protected Areas (WDPA).
- Guidelines for applying management categories to protected areas. Gland, Switzerland: IUCN, Dudley, N. (Editor) (2008).
- IUCN Red Lists from the IUCN database, 2024.
- Integrated Biodiversity Assessment Tool (IBAT) database used to identify the theoretical ranges of species in relation to the project right-of-way.
- Malawi Environmental Law – Act No. 19 of 2017 published the 5th of May 2017.
- Malawi National Plant Red List, 2002.
- Malawi – List of fauna and flora species encountered in the Majete Wildlife Reserve in 2023, African Parks.

4.5.3. Field activities

The field surveys were conducted over two weeks, from August 6 to 16, 2024, to cover the direct footprint area and the downstream influence area:

- The first week included meetings with stakeholders, notably the Majete Reserve and the Ramsar site authorities downstream, as well as the initial surveys within the direct footprint area and its immediate downstream area.
- The second week focused on the construction influence area and the downstream area, particularly the Chikwawa floodplain.

Due to the new areas to consider for construction works, two additional weeks of inventories were carried out:

- at the temporary camp site and the quarry site from March 31 to April 4, 2025;
- at the borrow site and the disposal area from September 9 to 11, 2025.

In the direct footprint area, all surveys were conducted within the Majete Wildlife Reserve, targeting habitats near the Shire River and the future reservoir. All habitat types (aquatic, wetlands, forests, riparian areas, and cultivated lands) were surveyed, with georeferenced records collected. Interviews with local communities supplemented the observations by providing insights into wildlife encountered in their daily activities.

An area of influence has been inventoried to understand the insertion and conservation of species in their ecological niche around the direct footprint area, as well as those that may be indirectly affected by the project. The main objective is to integrate the project into a larger area to better understand the issues involved. The area of influence included:

- The downstream area of influence:
  - Upper and Lower Egenco Bridge, immediate downstream of the dam. In the downstream of the dam, potentially influenced sections of the river and riparian areas are extended to cover the entire Kapichira falls (all flow channels) and the Shire River up to the tailrace channel outflow.
  - Chikwawa flood plain, upstream of the Elephant Marsh Ramsar site.

- Elephant Marsh, upstream of the area.

- The Middle Shire River as part of the upstream area of influence.

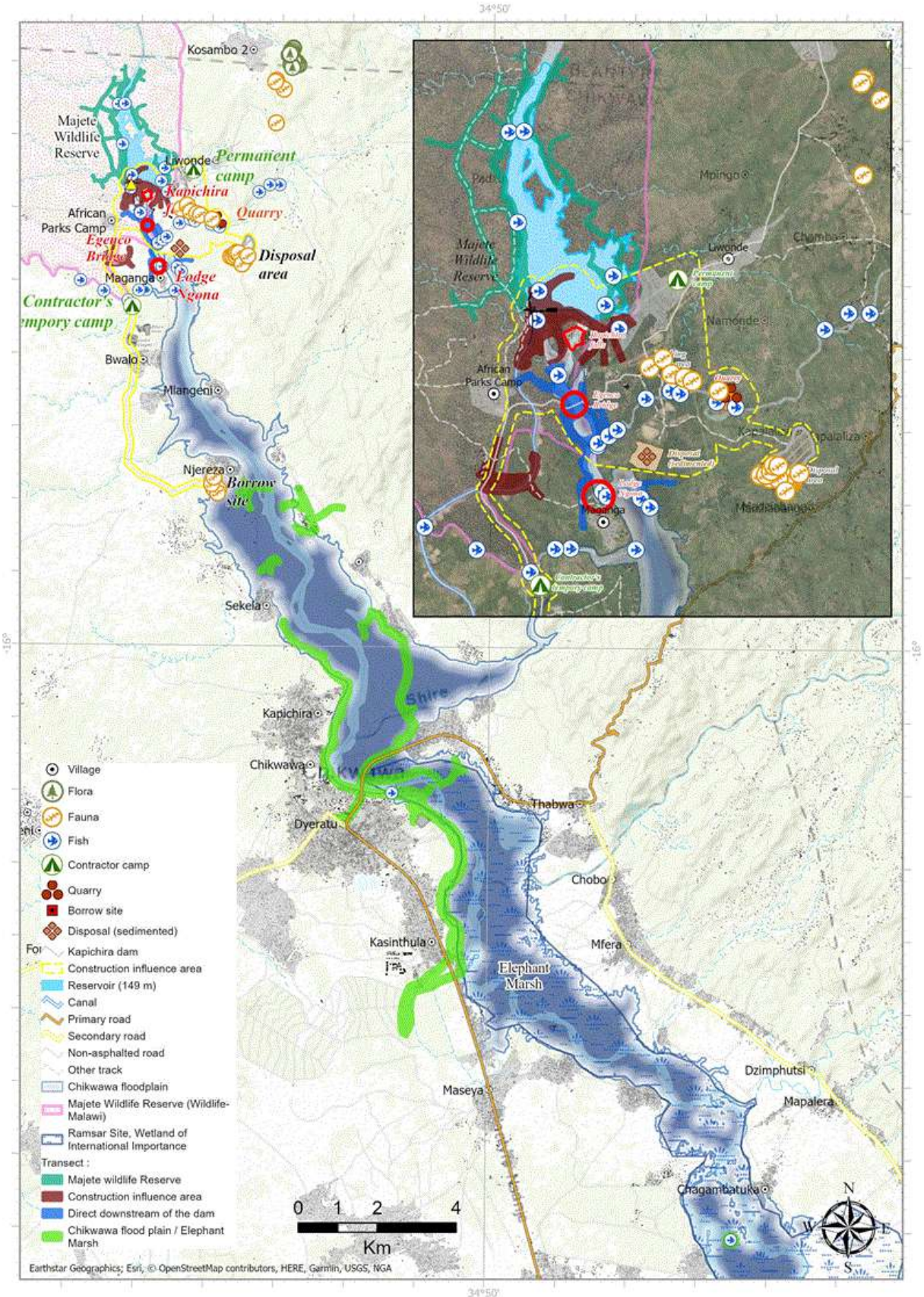


Figure 4-3: Location of flora and fauna investigations

The methodologies applied were as follows:

- Flora: Surveys conducted using transects and quadrats (10x10m), covering key habitat types. Unidentified species was determined later with the help of specialists.
- Fauna:
  - *Invertebrates*: Opportunistic sampling using various traps and capture methods, with partial identification postponed to the laboratory.
  - *Herpetofauna*: Active searches in different habitats (forests, wetlands, cultivated lands), using direct observations and interviews.
  - *Birds*: Transects and listening points, direct observations, and mist-netting within Majete Reserve.
  - *Mammals*: Search for presence indicators (tracks, droppings, burrows) and live trapping for small mammals.
  - *Aquatic fauna*: Sampling with nets and local catch assessments in collaboration with fishermen, along with monitoring fishing practices downstream of the project.
  - *Bats:* mist-netting strategy in suitable habitats for bats (including riverine and wooded areas).

The detailed field activities are presented in the biological assessment report in the Appendix F.



Figure 4-4: Example of a butterfly trap set during terrestrial invertebrate survey



Figure 4-5: Installation of traps for small mammals in the Majete Wildlife Reserve



Figure 4-6: Inspection of gillnet downstream the Kapichira bridge



Figure 4-7: Fisher using a scoop net for sampling in Mwembezi River

4.5.4. Limitations and constraints

The main constraints are the followings:

- Seasonal constraints: the surveys were conducted during the dry season (August to November), limiting the availability of water in rivers and affecting species behavior and habitat conditions. To take this constraint into account, the Consultant has considered the detailed survey carried out recently for Mpatamanga project and SVTP and has carried out a complementary survey in April 2025 at the end of the rainy season.
- Accessibility issues: rugged terrain, steep slopes, and poor road conditions restricted access to some sampling sites. Travel and data collection were delayed due to these physical barriers.
- Reduced sampling effort: Limited deployment time for equipment (e.g., butterfly traps, mist nets, and small mammal traps) reduced the chances of capturing diverse specimens, mainly due to logistical challenges.
- Reliance on opportunistic sampling: Across all groups (flora, invertebrates, birds, herpetofauna, and fishes), sampling relied heavily on opportunistic methods and observations due to constraints.
- Community collaboration challenges: Local consultations yielded general information, particularly for invertebrates and fishes, but lacked detailed or specific insights. Fishers were hesitant to cooperate due to recent enforcement activities related to fishing regulations.

Some limitations were group-specific observations:

- Flora: Most of the sampling sites were difficult to reach due to poor road conditions and difficult access to the river, with some significant challenges to access some proposed sampling sites. As a result, the experts took more time to access these areas during the data collection.
- Flora: The phenology of plants (changes in flowering, fruiting, and leafing) can vary significantly with changes in seasons. The floral assessments for this study were conducted during the dry season when most plant species had lost the flowers, leaves and fruits. This made plant identification difficult in some cases.
- Invertebrates: In the dry season, some rivers were dry. Most of the sampling sites were difficult to reach due to poor road conditions and difficult access to the river. The butterfly traps were set for a few hours or one night which reduced the chances of encountering more invertebrates. As a result, sampling focused mainly on opportunistic sampling, observations and some trapping. The local people consulted on invertebrates only knew general terms for invertebrate groups rather than specifics terms, although they were invited to do so.
- Birds and Herpetofauna: Sampling focused on bird calls, opportunistic sampling and sightings as well as few mist nets.
- Mammals: The small mammal traps were left for a maximum of two nights, which may have reduced the chances of capture. In most habitats, it was difficult to catch small mammals because the ground was too dry to provide them with food and water.
- Fishes: At some fish landing sites, local fishermen sometimes refused to allow their fish to be examined because, a few weeks earlier, the enforcement team had confiscated illegal gear.

- Bats: Acoustic sampling could not be conducted around Kapichira Dam. The museum lacked the necessary equipment, and borrowing from MUST University was not possible at the time since the devices were already in use elsewhere.

However, the existing recent studies from Mpatamanga and SVTP projects were used to supplement the field analysis.

4.6. Methodology for the assessment of the human environment

4.6.1. Analysis of existing data

The socioeconomic assessment was organized based first on the analysis of the existing data:

- An analysis of satellite images that aims to identify the areas to be studied and establish a first photograph of the study area (habitat density, diversity of spaces (land use, presence of infrastructure, etc.).
- A literature review of documents in the project area, national sectoral databases (demography, health, education, etc.) and international databases such as the World Health Organization (see the Appendix B).
- The socio-economic field investigations that take place at the district and village levels, in addition to detailed surveys that are conducted at the household level.

4.6.2. Field activities

The investigations at district scale, meaning Chikwawa District, consisted mainly of interviews with local administrative and traditional leaders. These interviews provide keys information to understand the following themes: administrative and customary division of the area, ethnic groups and possible conflicts, main activities of the population, land system, main public infrastructures, national standards, health issues, security aspects, vulnerability etc.

The investigations in the villages in the construction influence area provide an additional level of detail in the socio-economic analyses. Eight villages were surveyed from the 23 to 30 September 2024:

- The villages within 5 km from Kapichira Hydro Power Station downstream Shire River, along the T146 road: Bwalo, Njereza and Maganga 1.
- The villages within 3 km away from Kapichira Hydro Power Plant on the northeastern side of the power station: Liwonde and Kandeu.
- The villages 14 km south of Kapichira Hydro Power Plant, on the T146 road near Mwalija bridge: Sekela.
- The villages on the eastern bank of the Shire River, south of Kapichira Hydro Power Plant: Maganga 2 and Mlangeni.

The socioeconomic survey in these villages included the followings surveys:

- Interviews with village leaders: These interviews aim to understand the history of the village, the customary system (especially on land management), the access to basic services, the potential cultural and archaeological heritage of the village, the presence of associations, the existence of existing or past inter-community conflicts, etc.
- Focus groups with men, with women and with fishermen: These groups are developed to represent the relevant social categories within the framework of the project. These groups make it possible both to collect thematic information: on gender aspects, economic activities, conflicts, vulnerability, the uses of the resources and information on the concerns.
- Household survey: The survey in the villages was statistically established using the Cochran formula for sample determination from unknown or large population. On this basis, the minimum sample size would be 38 households in each village. In total, 213 household head were interviewed with 65% men and 35% women. The socioeconomic baseline considers gender aspects, the young people, the elderly, the disabled, and other vulnerable groups.

Table 4-1: Interviews and focus groups during the ESIA

Village	Focus group discussions	Key interviews
Kandeu	None	Group Village Kandeu
Liwonde	Men, women, fishermen	Village Head Liwonde
Maganga 1	Men, women, fishermen, young people	Village Head Maganga 1
Maganga 2	Men, women	Village Head Maganga 2
Mlangeni	Men, women, fishermen	Village Head Mlangeni
Njereza	Men, Women	Group Village Head Njereza, Traditional Authority Kasisi
Sekela	Men, women, fishermen	Village Head Sekela
Bwalo	Men, Women	Village Head Bwalo

5. ENVIRONMENTAL AND SOCIAL BASELINE DESCRIPTION

5.1. Introduction

This chapter describes the baseline for the physical, biological and human environment considering the project areas of influence (by distinguishing the area of direct influence from the area of indirect influence as described in the previous chapter 4.5.), before the construction activities for the proposed rehabilitation scheme.

This chapter is the results of the investigations for the physical, biological and human environment based on the methodology described in the chapter 5.

5.2. Description of the physical environment

5.2.1. Introduction

This chapter describes the relevant elements of physical environment for the project as follows:

- The overview of the Shire Basin
- The hydrology
- The sediment transport
- The hydrogeology
- The geological context
- The seismic context
- The pedology
- The geomorphology
- The climate
- The ambient air with air quality and noise nuisance
- The water quality

5.2.2. Overview of the Shire River Basin

The Shire River is the largest river in Malawi. The Shire River forms the only outlet of Lake Malawi. It is approximatively 700km long, runs through the southern part of Malawi and joins the Zambezi River more than 400 km further south in Mozambique. The Shire River watershed is represented in the following figure 5-1.

The Shire River can be divided into three sections, the upper, middle and lower sections.

- The upper Shire is the approx. 80 km long stretch from the outflow at Lake Malawi to the Liwonde (Kamuzu) Barrage. The landscape in this section is flat, the river flows slow and meanders, creating a network of pools and channels and flooding adjacent land in the rainy season.
- The middle Shire extends from Liwonde to Maganga (located just downstream of the Kapichira falls). The initially gentle river gradient gradually increases and beginning around Malope, the Shire River falls below the surrounding land and is flanked by alluvial terraces. The altitude in this stretch falls by approximately 384 m within approximately 75 km. This section includes a series of 10 rapids and 5 falls, the lowermost being the Kapichira falls on which the Kapichira HPP project site is located.
- The lower Shire valley below Maganga widens into a flat alluvial plain. For about 140 km the Shire meanders over this plain. The lower Shire valley is a continuation of the Great African Rift valley. The floor of the Rift Valley is flanked by escarpments associated with the major fault lines which follow a south-east to north-west trend. The relief is dominated by the Chikwawa-Thyolo Escarpment to the east, the Majete Escarpment to the north-west, the Nsanje Hills to the south-west and the Lower Shire uplands to the west. The altitudes in the lower Shire valley range from approx. 50 m to 200 m, while the escarpments rise to 1,000 m.

The size of Shire catchment from below Lake Malawi up to its confluence with the Zambezi is 22 530 km², of which approx. 84% (18 882 km²) lie within Malawi.

The flow of the Shire River is mainly determined by the outflow from Lake Malawi and the inflow from the drainage basin downstream of the Lake. Of these two components, the outflow from Lake Malawi is the dominant component. In the dry season, Lake Malawi outflow accounts for almost all water entering the Shire River. The Lake Malawi level fluctuates annually between a low level in the dry season and a high level at the end of the rainy season. In addition, the lake has in geological and historical times exhibited patterns of long-term fluctuation. During periods of low lake level, it has happened that the water level fell below the lake's natural outflow control (a sand bar across the mouth of the Shire, at elevation 471.5 m above sea level). During times of such low lake level, Shire River has entirely ceased to flow either during the dry season or for longer periods. At the beginning of the last century, low Lake Malawi water levels caused the discharge of water into the Shire River to be entirely shut off from 1915 to 1937.

The natural flow of the Shire River has been modified by the construction of four dams, namely Kamuzu, Nkula, Tedzani, and Kapichira dams. These dams were built in 1965, 1966, 1973, and 2000, respectively. The hydropower stations in the Middle Shire have a combined capacity of 342 MW. In the coming future, the new hydropower development should consider the development of Mpatamanga HPP upstream Kapichira HPP.

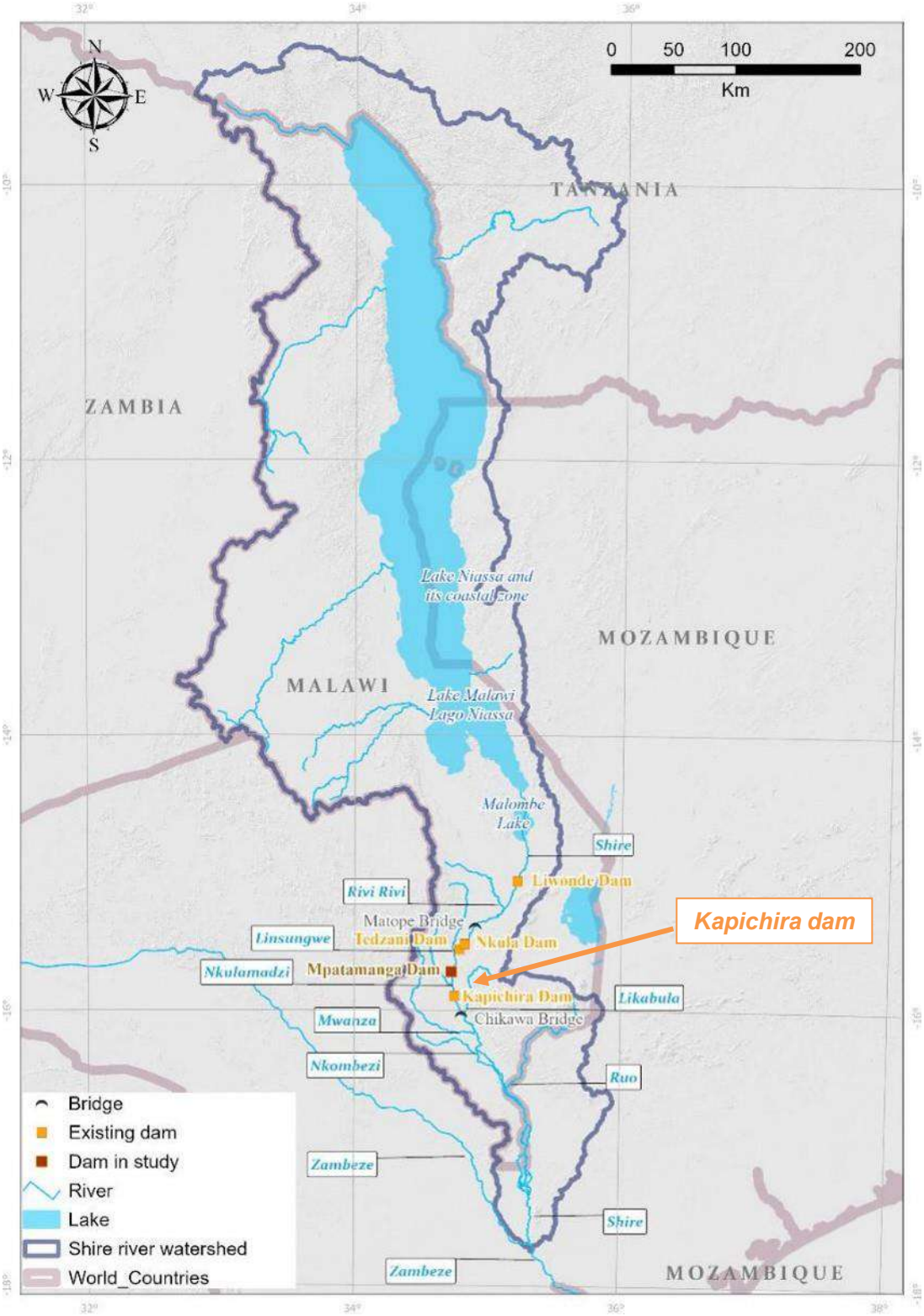


Figure 5-1: Shire River Basin

The Shire River main tributaries are presented below with their main characteristics based on the Mpatamanga HPP ESIA (SLR Consulting, 31 July 2024) and on the above map. They all have a large variation on daily average flows.

- Rivi Rivi River: The Rivi Rivi River is situated on the right bank of the Shire River and flows in the Shire River between the Kamuzu and the Nkula HPP. The Rivi Rivi River drains a catchment area of 1,482 km^2.

- Lisungwe: The Lisugnwe River is situated on the right bank of the Shire River and flows into the Shire River at a point a few kilometers downstream of Tedzani dam
- Mkulumazi: The Mkulumazi River is situated on the right bank, downstream the Regulating Reservoir of the Mpatamanga HPP. It flows into the Shire River at a point located between the proposed Mpatamanga Regulating Reservoir and Kapichira dam.
- Likhabula: The Likhabula River is situated on the left bank of the Shire and flows into the Shire River at a point between the Kapichira dam and Chikwawa Bridge.
- Mwanza: The Mwanza River is situated at the right bank of the Shire River and flows into the Shire on the upper part of the Elephant Marsh.
- Nkombezi: The Nkombezi River is situated at the right bank of the Shire River, downstream of Kapichira and flows into the Shire in the Middle part of Elephant Marsh.
- Ruo: The Ruo River is situated at the left bank of the Shire River, Downstream of Kapichira and flows into the Shire River in the lower part of Elephant Marsh.

Table 5-1: Characteristics of Shire River's main tributaries

River	Catchment area	Average annual flow	Monthly average low seasonal flows (April-November)	Monthly average high seasonal flows (January-February)
Rivi Rivi	1,482 km^2	7,3 m^3/s	0.6 – 2.7 m^3/s	24.3 – 27.1 m^3/s
Lisungwe	1,455 km^2	10 m^3/s	1.7 – 4.6 m^3/s	32.3 – 33.5 m^3/s
Mkulumazi	877 km^2	7.2 m^3/s	1.1 – 5.5 m^3/s	22.4 – 25.5 m^3/s
Likhabula	603 km2	4.4 m^3/s	0.2- 1.7 m^3/s	16.6 -19.4 m^3/s
Mwanza	1,836 km^2	9.7 m^3/s	0.4 – 3.9 m^3/s	35.9 – 46.9 m^3/s
Nkombezi	958 km^2	3.3 m^3/s	0.2 – 1.1 m^3/s	12.9 – 16.1 m^3/s
Ruo	4,788 km^2	62.4 m^3/s	2.0 – 9.8 m^3/s	207 – 279 m^3/s

5.2.3. Hydrology

The Hydrological Report (Studio Pietrangeli Consulting Engineers, October 2023), the Preliminary Design Report (Studio Pietrangeli Consulting Engineers, December 2024) and the Detailed Design Report (Studio Pietrangeli Consulting Engineers, May 2025) from the Owner's Engineer give an overview of the findings as described hereafter.

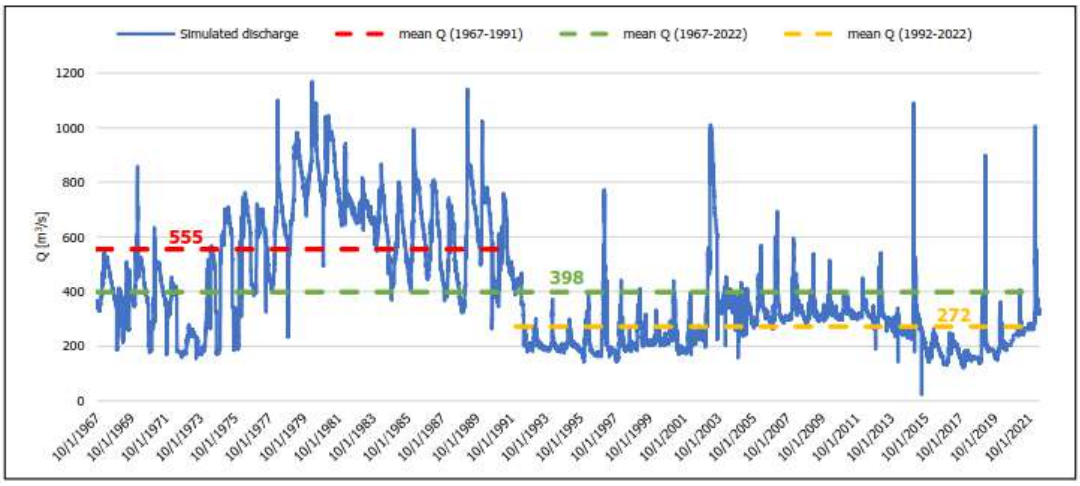
The hydrological analysis considers the intermediate basin between the Kamuzu barrage and the Kapichira dam axis.

The hydrological study initially considered five stations within the project area: Liwonde (1B1), Chiromo (1G1), Chikwawa (1L2), Matope (1P2), and Zalewa (1P6). After a detailed quality assessment, only Liwonde and Chiromo were retained for analysis. The Liwonde station (1B1) offers a long and generally reliable dataset, with corrections applied after the 2003 flood and flow regulation introduced in 1992, while Chiromo offers a shorter and fragmented record, with only the 1965–1971 period deemed reliable for model calibration. The remaining stations were excluded due to significant data gaps and inconsistencies, which compromised their reliability for robust hydrological modelling.

Table 5-2: Hydrometric stations and dataset features

Station name	East [m]	South [m]	Data period	No. Years	Resolution
CHIKWAWA (1L2)	692932	8226577	1977 – 2003	26	daily
CHIROMO (1G1)	729016	8168604	1953 – 1998	45	daily
LIWONDE (1B1)	738009	8333045	1948 – 2023	75	daily
MATOPE (1P2)	704274	8297624	1953 – 2002	49	daily
ZALEWA (1P6)	700037	8291666	1988 – 1998	10	daily

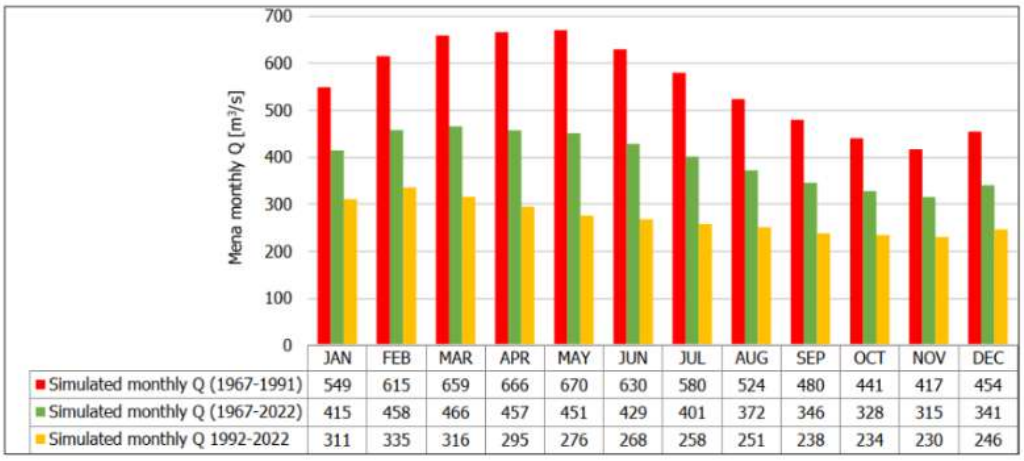
The average flow rate for the entire period (1967-2022) at Kapichira Dam was calculated to be approximately 400 m^3/s as shown in the following figure.



Source: Studio Pietrangeli Consulting Engineers. (2023). Hydrological report

Figure 5-2: Simulated discharges at Kapichira HPP (1967-2022)

The flow of the Shire River has been significantly regulated since the construction of the Kamuzu Barrage in 1965. In comparison, from 1992 onwards, the average simulated flow rate is about 270 m^3/s. Therefore, the flow regime since 1992 shall be considered as representative of the actual situation on site.



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Simulated monthly Q (1967-1991)	549	615	659	666	670	630	580	524	480	441	417	454
Simulated monthly Q (1967-2022)	415	458	466	457	451	429	401	372	346	328	315	341
Simulated monthly Q 1992-2022	311	335	316	295	276	268	258	251	238	234	230	246

Source: Studio Pietrangeli Consulting Engineers. (2023). Hydrological report

Figure 5-3: Average monthly inflow simulated at Kapichira HPP considering different periods

No excessive discharge differences are noted during the year, as the outflow released from the Kamuzu barrage (from Lake Malawi) is much more significant than the runoff of the Kapichira intermediate catchment.

Only small average monthly decreases in discharge are noted during the dry months. The highest monthly average flow occurs in the period January - March with the flow average values varying in the range of 311-316 m^3/s. The river flows slightly decrease to reach the minimum values in the period September-November with average flows in the range 238 – 230 m^3/s.

Peak flood assessment

The peak flood assessment was undertaken through a combination of statistical analysis and rainfall-runoff models (two different models were used). The peak floods at Kapichira dam site are estimated as shown in the following table.

Table 5-3: Peak flood assessment for Kapichira dam site

Return Period [years]	Kapichira Peak Floods [m^3/s]
20	945
100	1 712
1 000	3 209
10 000	5 095
PMF	11 171

Source: Studio Pietrangeli Consulting Engineers. (2023). Hydrological report

The Probable Maximum Flood (PMF) at the Kapichira Dam site is estimated as the maximum of the intermediate catchment PMF calculated by the HEC-HMS model plus the flood with a return period of 10 000 years from Liwonde station (1B1). As shown in the following table, the PMF estimated at the Kapichira Dam site is slightly higher than 11 000 m^3/s.

Table 5-4: Probable maximum flood estimated at the Kapichira dam site

Liwonde Q_{T10000} [m³/s]	Intermediate basin PMF [m³/s]	Kapichira PMF
1 753	9 418	11 171

Source: Studio Pietrangeli Consulting Engineers (2023), Hydrological report

For the 2022-flood caused by Cyclone Ana, it has been estimated that the Storm Ana has a return period of 3 000 years, when compared to the above table values, and the peak flow was estimated to be bigger than 4 082 m³/s.

5.2.4. Geomorphology

5.2.4.1. CONTEXT OF THE SHIRE RIVER

The landscape of the Shire River basin is formed by the Great Rift Valley as it passes through southeastern Africa. The morphology of the rift is a flat-bottomed trench through which the Shire River runs. The trench is surrounded by a mountainous area of fractured rocks.

The middle Shire River, where Kapichira HPP is located, extends from Liwonde to Maganga (located just downstream of the Kapichira falls). The initially gentle river gradient gradually increases and beginning around Malope, the Shire River falls below the surrounding land and is flanked by alluvial terraces.

The middle Shire valley forms the floor of the Great African Rift Valley. It is separated from the African surface by a scarp zone with an elevation difference of several hundred meters. The area is largely underlain by Precambrian metamorphic rocks (basement complex) consisting of gneisses and granulite. Soils in general are moderately deep, well drained, brown, and medium textured.

Further south, the lower Shire valley below Maganga widens into a flat alluvial plain. For about 140 km, the Shire meanders over this plain. The lower Shire valley is a continuation of the Great African Rift valley. The floor of the Rift Valley is flanked by escarpments associated with the major fault lines, which follow a south-east to north-west trend. The relief is dominated by the Chikwawa-Thyolo Escarpment to the east, the Majete Escarpment to the north-west, the Nsanje Hills to the south-west and the Lower Shire uplands to the west. The altitudes in the lower Shire valley range from approx. 50 m to 200 m, while the escarpments rise to 1,000 m. Some areas along the river are seasonally waterlogged. There are large areas of commercial agriculture in the upper parts of the valley, and the lower reaches are characterized by the seasonally flooded Elephant Marsh.

5.2.4.2. DOWNSTREAM KAPICHIRA DAM

The Mpatamanga HPP ESIA (SLC, 2024) reported that the Lower Shire downstream of Kapichira Reservoir is generally in a state of dynamic equilibrium in which river morphology and planform can be seen to have notably varied over the preceding decades. Meander migration and channel shifts of 40 m per decade at meander bends, and channel widening of 20 m per decade, are reported. Over the longer term, evidence such as the presence of oxbow lakes and meander scars suggest channel planform changes in the Lower Shire of 1 km to 2.3 km (EDF, 2024d).

A comparison of 2017 and 2023 surveyed cross-sections downstream of the regulating reservoir (that is, pre-Tropical Storm Ana in 2022 and post-Tropical Storm Freddy in

2023) illustrates example changes in riverbed elevation and planform. The Shire River is typically heterogenous in nature, and changes in deposition and erosion patterns, whether associated with infrequent large-scale events or with everyday flow conditions, may be expected to vary over short distances.

The following figure illustrates lateral movement of the Shire riverbank: 3 km downstream of Kapichira Reservoir the right bank of the river shifted laterally by approximately 100 m. The presented example of right bank lateral movement is given with reference to the 2023 surveyed cross-section (highlighted, shown as a white line). The selected Google Earth images show that, in 2017, the location of the 2023 surveyed cross-section is clearly located adjacent to the right bank of the river. In 2019, the development of a secondary channel on the right bank in this location is evident. In 2022, the right bank can be seen to be fully under water. Deposition upstream on the left bank becomes evident; a submerged sandbar towards the left bank is also visible. In 2023, the main channel is visibly wider with increased upstream deposition on the left bank.



Source: Mpatamanga HPP ESIA, SLC, July 2024

Figure 5-4: Example of lateral channel movement downstream Kapichira

5.2.5. Sedimentology

5.2.5.1. CONTEXT

Rivers have usually a natural balanced inflow and outflow of sediments. A dam construction dramatically alters this balance, creating a river divided by the dam and characterized by a different flow velocity and a trap for sediments. Upstream of the dam, there is a progressive accumulation of sediments in the dead and live storage and the reservoir loses storage capacity. The sediments that are situated in the dead storage

are not a threat to the project because they are stored in the zone below the level of the spillway. To achieve balance of sediments, a discharge of sediments and coarse material is needed.

A bathymetric survey of Kapichira reservoir in 2013 indicated that the reservoir had lost over 40 percent of its initial live storage and over half (59 percent) of its gross capacity after 13 years in operation. This is equivalent to a capacity loss at a rate of 4.3 percent per year. The loss of active storage has subsequently reduced the duration of the much-needed peaking to meet the country's energy needs. At Nkula dam, situated upstream of Kapichira dam, sediment loads were reported to contribute to a 10-12 percent reduction in power generation.

Sedimentation issues were identified at the design stage of the project, and it was recommended through the operational manual to flush sediment monthly. Between 2000 to 2011, flushing was done twice a month. The frequency of flushing decreased to only one to three times per year after 2011 as flows decreased in the river. Flushing operations were preferably carried out during the dry season to minimise losses in energy supply.

A new sediment management plan tailored for Kapichira was subsequently implemented from 2019. This included the use of a cutterhead suction dredge which was proven to provide an optimum environmental and economic solution specific for Kapichira reservoir. The replacement of flushing with dredging would ensure hydropower generation without the need to halt power generation to facilitate reservoir flushing by emptying and refilling of the reservoir. In addition, dredging would also support the operation of the irrigation intake on the right bank, which would otherwise be blocked by sedimentation.

The tropical storm Ana occurred when the new management plan to dredge the reservoir was implemented to restore the lost storage capacity. Following the storm Ana, the dam expert M. Lino wrote: "Sedimentation in the reservoir possibly accelerated by operating the plant at higher elevation than designed, appears as a root cause of the disaster: sedimentation in the reservoir led to progressive increase on the operating level which made the stoplogs unsuitable to be installed while producing energy".

5.2.5.2. BATHYMETRIC SURVEY

The Owner's Engineer has carried out a bathymetric survey of the Kapichira reservoir in July 2023 (Studio Pietrangeli Consulting Engineers, report 110GENRSP001A, Field Investigations Report) and established area – volume curves for the reservoir. The test was carried out using two cutting-edge instruments connected in real time to ensure high accuracy and minimize errors: an echo sonar probe for depth measurements and an RTK GPS for precise positioning.

Comparing the new area volume curves from the survey in 2023 to the original area-volume curve from a survey in 1993, the following conclusions have been drawn:

- According to the survey in 1993 before the Kapichira dam construction, the reservoir volume was 9.1 Mm^3 at elevation 147 m a.s.l. at full supply level. The live volume was 3.5 Mm^3.
- It was found that about 70% of the total storage at Kapichira was occupied by sediment and the total sediment deposit in the Kapichira reservoir over the 4-year period 2000-2004, estimated as a difference of the reservoir volume ante-operam and in 2004, was assessed to be about 6,4 Mm^3.

- The survey in 2023 found a total reservoir volume of 4.5 Mm³ at maximum operating level, out of which 2.7 Mm³ are live volume. The 2023 survey highlights a reduction of the live volume of 23% of the design live storage.
- The sediment yield estimated by means of the comparison of the volume curves ante-operam and current (2023) is 200,000 m^3/year corresponding to a sediment volume rate is approx. to 0.03 mm/y (22,030 m^3/km^2/year).

During the transition state, when the river is impounded, bed material (gravel and coarse sand) will begin to deposit in the upper end of the reservoir where a delta will form at the beginning of the backwater.

Suspended load (clay, silt and fine sand) is deposited in the deepest part of the reservoir, in the dead storage when flow velocities are low, and is re-eroded when critical flow velocities are exceeded, either by flushing or by natural flood events.

In the equilibrium state, the inflow of sediment (suspended and bed load) will coincide with the outflow of sediment through the spillway. As a result, a significant amount of the live storage and the entire dead storage will be lost.

5.2.5.3. SEDIMENT LOAD

Generally, the Shire River and its tributaries have a high sediment load due to the soil erosion caused by:

- The catchment degradation caused, for example, by continuous deforestation for charcoal production and poor cultivation practices such as on steep slopes,
- The land use change observed over the past forty years,
- The climatic condition,
- The Shire River HPP cascade.

Nkula dam is situated 50 km upstream of the Kapichira dam on the Shire River. It is considered that the sediment material at Nkula dam is similar to the material at Kapichira. Therefore, the Owner' Engineer (Studio Pietrangeli Consulting Engineers, Hydraulic and sedimentation study, July 2024) used the data presented in the sedimental survey[9] of Nkula dam for their own sedimental study and for their numerical modelling of sediment load at Kapichira. The sediment distribution at Kapichira is supposed to be 40% sand and 60 % clay as in the Nkula reservoir. Concerning the size of the particles, it is considered that 81% of the particles are smaller than 250 mm.

The concentration of the suspended sediment follows the trend of the discharge. It increases during the rainfall season and diminishes during the dry season. The average sediment concentration varies in the range of 15 to 60 mg/l in the rainy season, reaching the minimum value of 10 to 26 mg/l in the dry season.

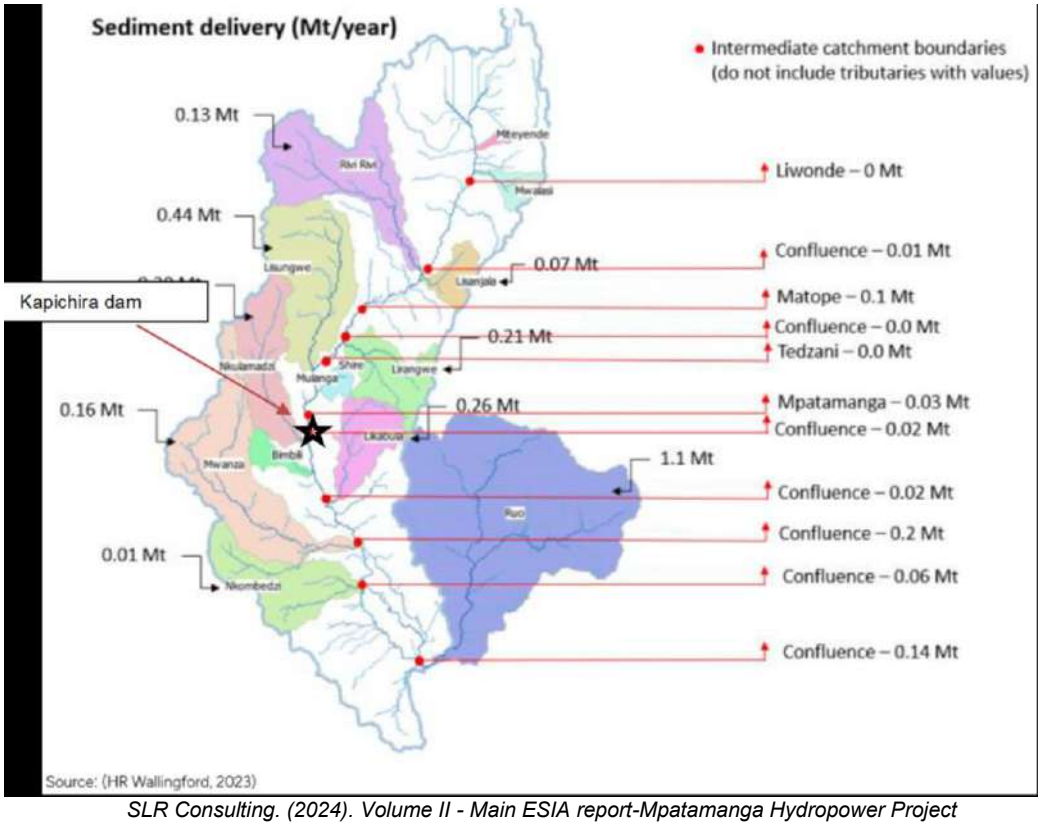
To determine the quantity of sediments transported by tributaries into the Shire River, modelling studies have been caried out in the context of Mpatamanga ESIA (SLR Consulting, 31 July 2024). Their results are used in the following paragraph.

An increase in sediment load was observed in the last 20 years. Under historic (2000) conditions, the annual average sediment load was 2.93 Mt/year. This number has increased in 20 years and now, the annual sediment load in the Shire River between Kamuzu Barrage and the confluence of the Shire River and Ruo river is 3.20 Mt/year.

[9] Determining sources of sediments at Nkula Dam in the Middle Shire River, using mineral magnetic approach - Mzuza et al. in 2016

This change in sediment input is mostly due to land-use changes that happened in the Shire Basin during the last years (agriculture, deforestation, charcoal production…).

The following figure shows the current annual sedimentation yield on the confluence of Shire River and its main affluents.



SLR Consulting. (2024). Volume II - Main ESIA report-Mpatamanga Hydropower Project

Figure 5-5: Current annual average sedimentation yield in the Shire River Basin

5.2.6. Hydrogeology

Seven types of aquifers could be found in Malawi with the following geological characteristics.

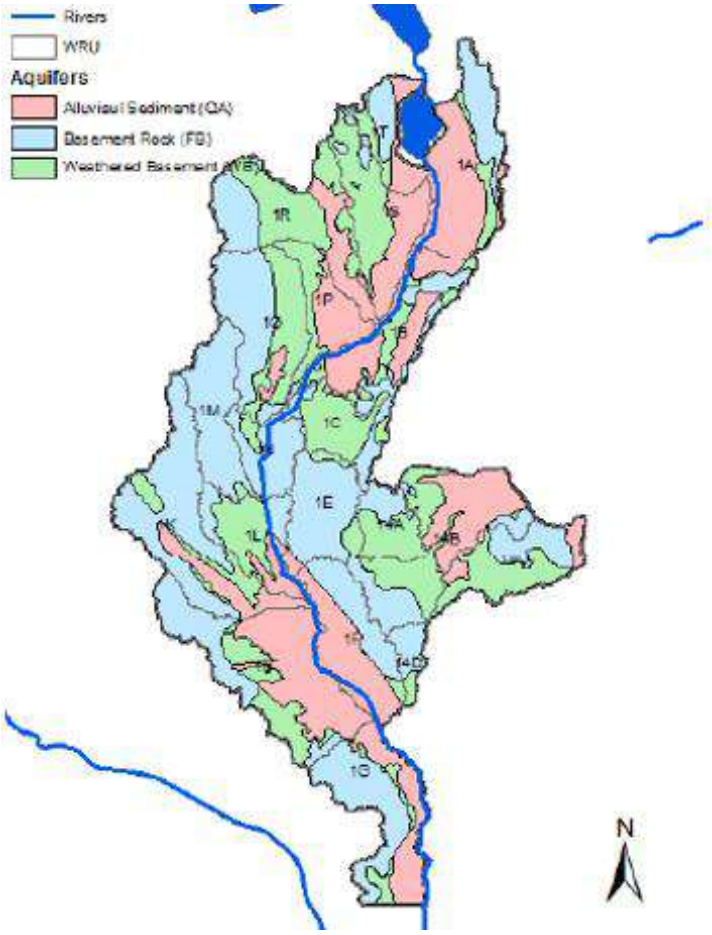
Table 5-5: Aquifers in Malawi

Aquifer Type	Designation	Geological age	Hydrogeological Characteristics
Quaternary alluvium	QA	Quaternary	Sediments include shallow lakeside and alluvial low permeability clays, silts and fine sands with low yield boreholes; with deep high permeability, sands, gravels and rift scarp fanglomerates with medium to high yield boreholes
Creataceous and Pleistocene sediments	CS	Cretaceous-Pleistocene	Sandstones, shales, marls, conglomerates with low primary permeability and limited high fracture permeability, low to moderate yield boreholes
Mesozoic Chilwa Alkaline	MA	Mesozoic	Massive Syenite-granite plutons with low permeability forming bornharts and inselbergs, few low-yielding boreholes
Karoo Volcanics	KV	Jurassic	Basalts with high permeability interflow and fracture zones, moderate yield boreholes
Karoo sediments	KS	Triassic	Sandstones, conglomerates, shales, minor coal seams, with low primary permeability and limited high fracture permeability, low to moderate yield boreholes
Fractured basement	FB	Archean	Gneisses, granulites, granite intrusions, thin weathered zone above fractured regolith, low yield boreholes
Weathered basement	WB	Archean	Gneisses, granulites, granite intrusions, thick weathered zone above fractured regolith, low yield boreholes and shallow wells

Source: WS Atkins International Ltd, 2011 - SLR Consulting. (2024). Volume II - Main ESIA report-Mpatamanga Hydropower Project

The distribution of the aquifer types in the Shire River Basin is shown in the following figure. Groundwater is the most dominant water supply source for the rural areas in the Shire River Basin where average yields vary between 1 and 2 l/s in the weathered zone of the basement complex. The dominant aquifer types are the extensive, but low yielding weathered basement aquifer in the plateau areas, and the high yielding alluvial aquifer of the lakeshore plains and the Lower Shire Valley.

Along the Shire River, from the area of the Kapichira dam to about 10 to 15 km downstream, the map shows Weathered Basement (WB) on the right bank and Basement Rock (FB) on the left bank. From there on the Shire River flows through Alluvial sediment (QA) aquifer. But also, in the area of the Archaean basement aquifer, it is possible that close to the Shire River, where alluvial thickness is greater than 5 m, a shallow alluvial aquifer is present and utilized by the local population through hand dug wells.



Source: Monjerezi, 2012 – cited in Final Feasibility Report (Shire Valley Irrigation Project, March 2017)

Figure 5-6: Aquifer types in the Shire River Basin

The main aquifer units beneath the dam and quarry are the decomposed and moderately weathered gneiss (overburden, up to 20 m thick), underlain by fractured fresh gneiss. The thickness of these units is variable, but the fractured gneiss zone—critical for groundwater flow—can extend up to 10–20 meters below the surface, depending on the location and degree of weathering.

Reservoir fluctuations are unlikely to significantly impact community boreholes due to depth separation.

5.2.7. Geological context

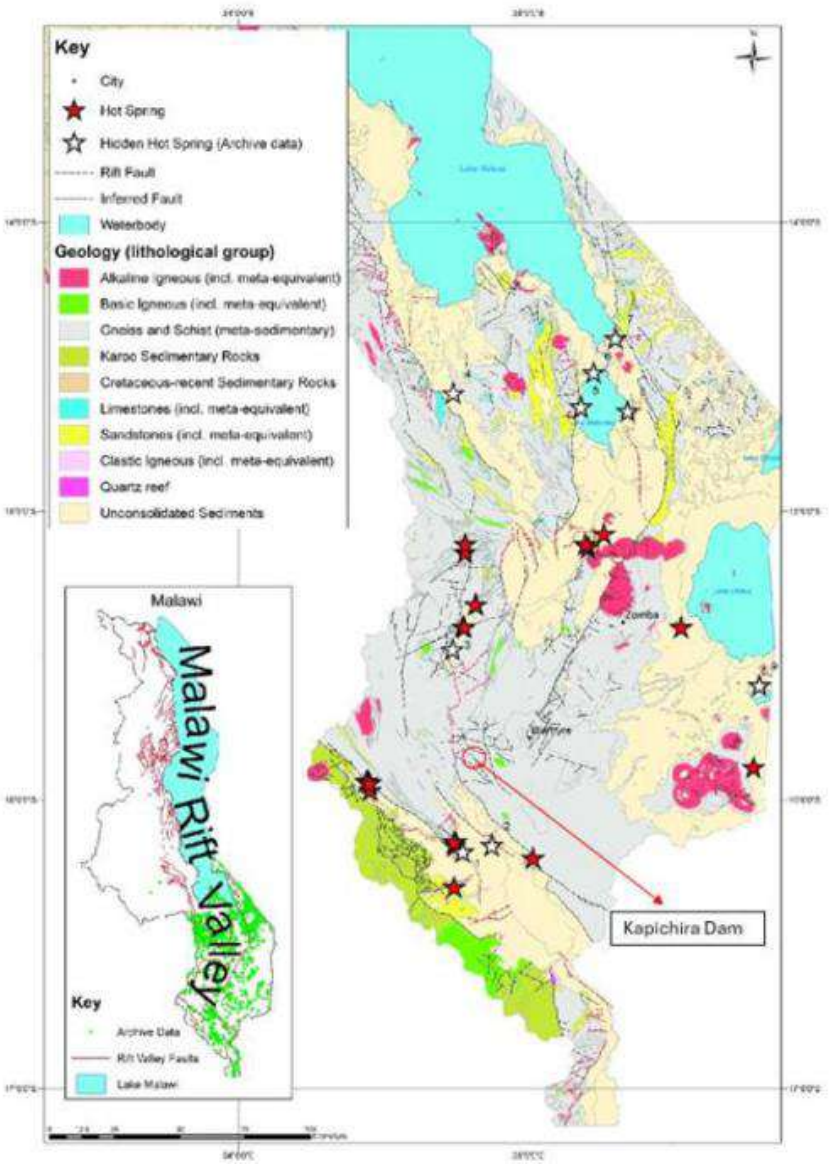
The geology at the direct footprint area was investigated by the Owner's Engineer (Preliminary Design Report, Studio Pietrangeli Consulting Engineers, December 2024).

The project area is situated in the southern section of the Cenozoic East African Rift System in the Malawi Rift Valley that is 40 to 90 km wide and extends in a N-S direction for approximately 800 km.

The Malawi Rift Valley is limited by a series of half-grabens and therefore is striped by normal and inferred faults where there is an intense seismic activity. The Cholo fault which trends north northwest - south southeast is one of the normal half graben boundary faults and lies to the east, north and south of the project site. Faulting and jointing are common, and the course of the Shire River is controlled by two dominant

directions. Dolerite dykes of the Karoo System (Lower Jurassic) are also common and generally have a northeast - southwest trend. They are sedimentary rocks found further south.

The following figure shows the geological context in the south of Malawi.



Source: Addison M. et al. 2021, cited in Preliminary Design Report (Studio Pietrangeli Consulting Engineers, December 2024)

Figure 5-7: Regional geological map of southern part of Malawi

The Kapichira direct footprint area lies in a series of Basement metamorphic gneisses with steeply inclined axes having a general axial trend of northwest – southeast.

The Preliminary Design Report (Studio Pietrangeli Consulting Engineers, December 2024) describes that permanent works at the dam site are planned within a valley where the banks are not very pronounced, in which gneiss emerges in the left bank, while in the right bank there is approximately 20 m of residual soil resulting from the alteration of the gneiss basement. At the right bank, the gneiss is well outcropping affected by one (1) main joint set.

The erosion of the embankment caused by the flood is evident along the planned new embankment section, especially in the right bank, where the weathered bedrock has been inferred directly to the actual ground surface. The erosion washed out all the loose and high weathered materials.

The Preliminary Design Report states that in general, in subtropical and tropical climates, gneiss is characterized by weathering grades often resulting in a complete decomposition of the rock material into soil. According to the geological survey carried out by the Owner's Engineer, two main classes of gneiss have been recognized around the proposed dam axis location. In general, a decomposed gneiss and a (highly) weathered gneiss were identified at the surface.

The following figure shows typical gneiss outcropping at the surface.



Source: Studio Pietrangeli Consulting Engineers (2024). Preliminary design report

Figure 5-8: Right bank - aerial view from drone

The Owner's Engineer has also investigated the geo-structural setting of the area through the execution of geo-structural measurements that have been carried out on typological rock outcrops to determine the local joint sets. Two joint sets have been recognized, which are transversal to the new dam axis. The Owner's Engineer notes that the geo-structural setting at the dam section must be considered both for stability analysis purposed during the excavation of the slopes and for the grouting works design.

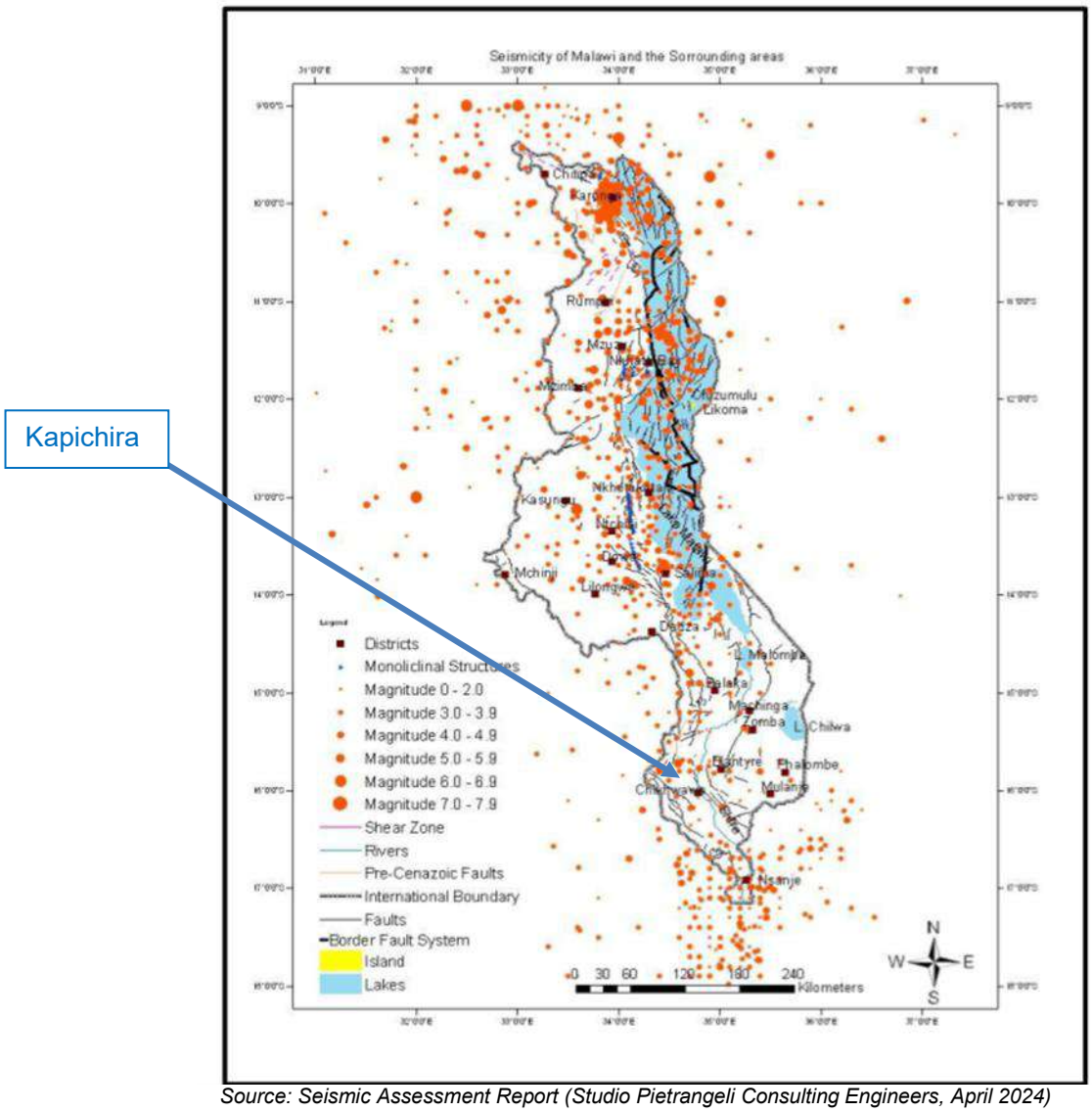
5.2.8. Seismic context

The Kapichira dam is situated on the African Plate, which is considered as one of the most tectonically stable areas in the world. The African continent can be divided into six seismotectonic provinces. Despite the general stable context of the African plate, the Kapichira dam is concerned by the East African Rift which is known for several large earthquakes.

The seismic risk in Malawi is considered moderate, meaning there is a 10% probability that a damaging earthquake could occur within the next 50 years.

Although no earthquakes with magnitudes greater than 7.0 have been instrumentally recorded in the project region, a 7.3 magnitude event occurred 200 km to the north-west of Lake Malawi at Rukwa in Tanzania on the 13 December 1910. The second-largest earthquake in the area occurred in Machaze, Mozambique, on 22 February 2006, with a moment magnitude of 7.0 M_w. Both events resulted in heavy damage and were felt in the country of origin and neighbouring countries.

The following map shows the seismic activity in Malawi.



Source: Seismic Assessment Report (Studio Pietrangeli Consulting Engineers, April 2024)

Figure 5-9: Seismicity of Malawi and the adjacent areas

The Seismic Hazard Assessment of the Kapichira site, based on the most recent state of the art and the updated regional earthquake database, has been performed by the Natural Hazard Assessment Consultancy (Pty) Ltd, appointed by the owner's Engineer for this project.

Considering the location of Kapichira Dam, the maximum acceleration amplitude measured (or expected) of an earthquake has been estimated at 0.106 g for the return period of 475 years, 0.139 g for the return period of 1,000 years and 0.285 g for the return period of 10,000 years, which is considered as a moderate seismic hazard.

Based on the classification from the International Commission on Large Dams (ICOLD), the total Risk Factor for Kapichira dam was estimated as follows:

Table 5-6: Risk factor for Kapichira dam

Risk Factor		Weighting points
Capacity	>120 hm^3	6
Height	30-15 m	2
Evacuation (persons)	>1000	12
Downstream damage	Low	12
TOTAL		**32**

Source: Studio Pietrangeli Consulting Engineers, 200GENRSP001A, Detailed Design Report, May 2025

The risk class of Kapichira dam is 32, which is in the middle of the "Extreme IV" class, the higest risk rating.

The owner's Engineer has considered these results for the design of the dam and other structures such as the emergency spillway.

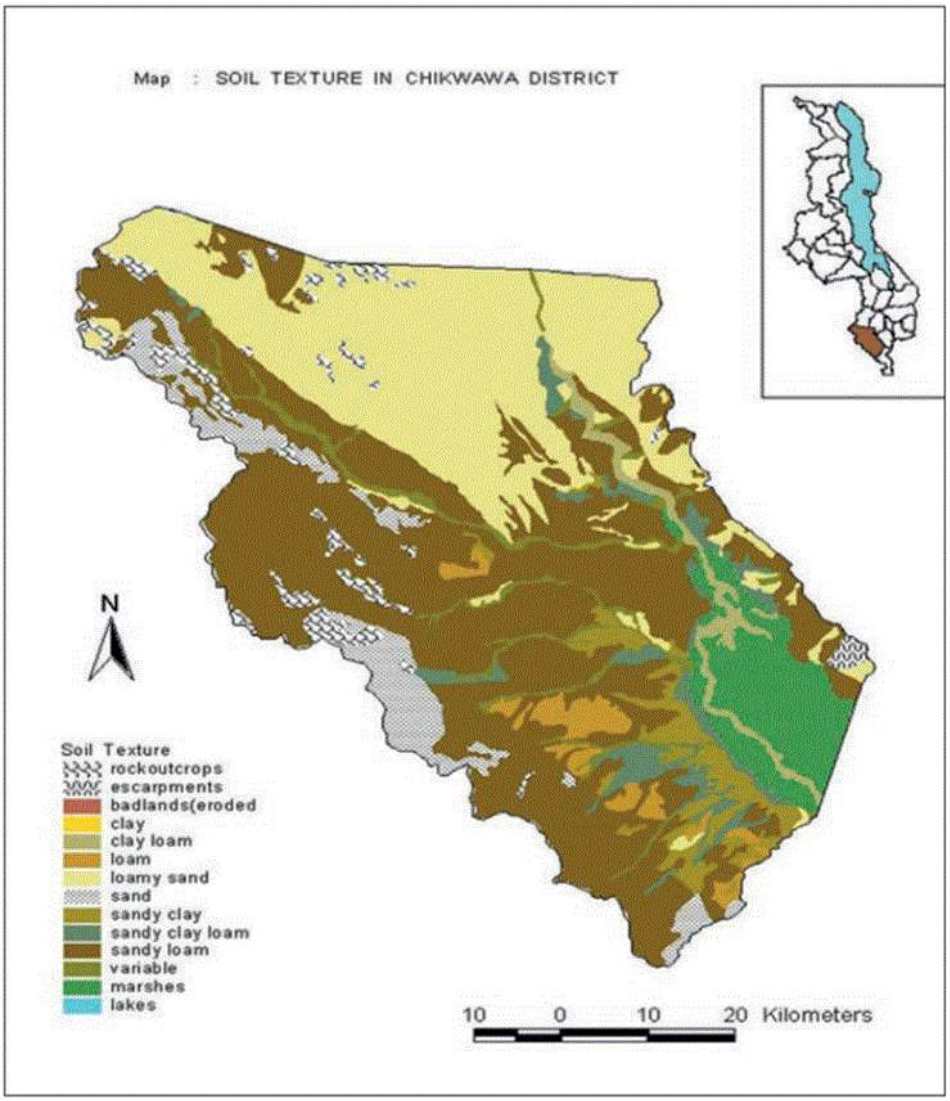
5.2.9. Pedology

On the Shire River, the soil constitution is defined as medium sand, with a size between 0.25 and 0.5 mm. On the Shire River tributaries, the bed-material sizes are medium and coarse sand (between 0.25 and 1.0 mm).

The Chikwawa district has ten soil groups out of a total of thirteen soil groups present in Malawi which indicate a great variety of soils in the district. The soils in Chikwawa District vary from area to area according to the different types of sediments and rocks from which they developed:

- In the area of the basement complex composed of gneisses, the soil texture tends to be loamy sand, while on the terrace alluvium, sandy loam and sandy clay soils are more frequent.
- Adjacent to the river channel, the soils have a clay loam texture.

The distribution of soils is illustrated in the following figure.



Source: National Atlas of Malawi cited in Chikwawa District Socio-Economic Profile 2017 – 2022 (Chikwawa District Council, September 2020)

Figure 5-10: Soil texture of Chikwawa District

At the Kapichira dam site, soils are deep with a medium to fine texture and their drainage vary from good to very poor. The alluvial material found on the site was deposed on the riverbank because of sediment transport. It is generally silty and clay like sands with subangular to rounded gravel, cobbles and boulders comprising granite, gneiss and quartz fragments.

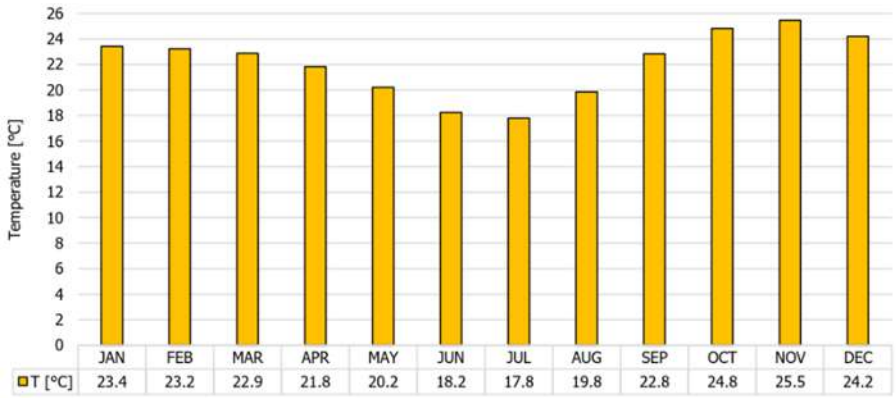
5.2.10. Climate

5.2.10.1. GENERAL CONTEXT

The Shire River Basin is characterized by a sub-tropical climate, which is relatively dry with clearly defined seasons. The climate of the catchment is influenced by the Inter Tropical Convergence Zone and its movement north to south with some influence from the Atlantic by systems moving south through the Congo Basin.

5.2.10.2. TEMPERATURE

The mean annual temperature is around 22.5°C. The mean monthly temperature can rise to 26°C during the warmer months, between October and December. The lowest temperature happens between June and July with temperatures around 18°C. The following figures show the mean monthly temperatures in the Shire River basin between 1965 and 2022.



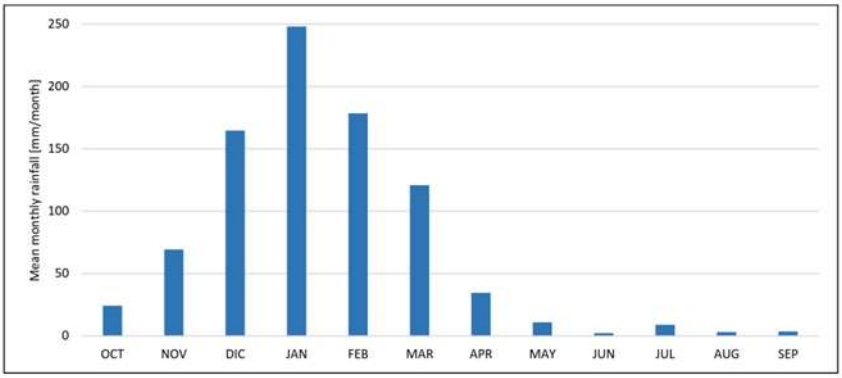
Source: Studio Pietrangeli Consulting Engineers, 130GENRSP001B, hydrological Report, December 2024

Figure 5-11: Trend in average monthly temperature between 1965 and 2022

5.2.10.3. RAINFALL

The rainfall is also seasonal. As shown in the following diagram, the dry season happens between June and October, whereas the wet season stretches from November to April. During this period, more than 90 % of the annual precipitation occurs with a peak of 1,000 mm can be reached. Generally, the mean annual rainfall varies between 760 and 1,140 mm. The precipitation diminishes from east to west, with increasing distance from the Indian Ocean.

The mean monthly rainfall, estimated for the period 1981-2022 from Climate Hazards Group InfraRed Precipitation website (CHIRPS), are summarized in the following figure.

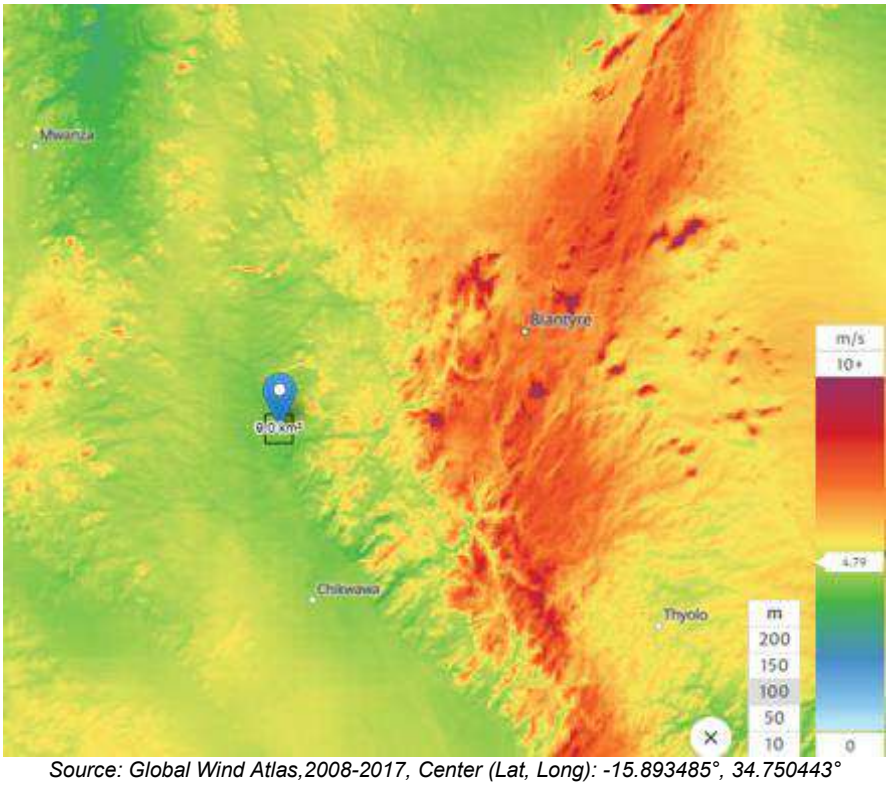


Source: Studio Pietrangeli Consulting Engineers, 130GENRSP001B, hydrological Report, December 2024

Figure 5-12: Trend in average monthly rainfall between 1981 and 2022

5.2.10.4. WIND

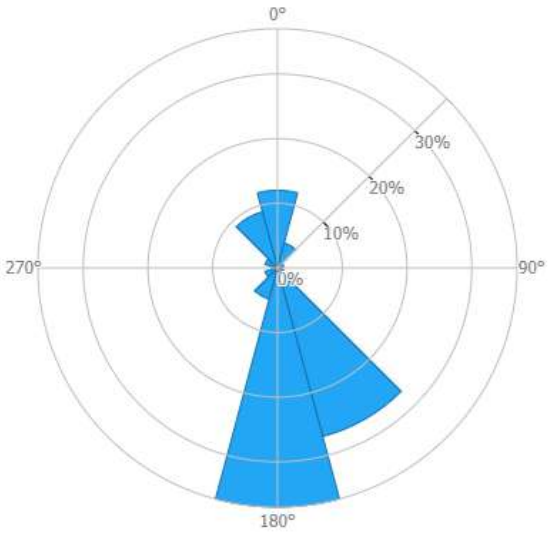
The project area is situated in a moderate continental wind velocity zone. The climate in the project area is also influenced by the Inter Tropical Convergence Zone and its movement north to south.



Source: Global Wind Atlas,2008-2017, Center (Lat, Long): -15.893485°, 34.750443°

Figure 5-13: Mean wind spead at Kapichira dam site

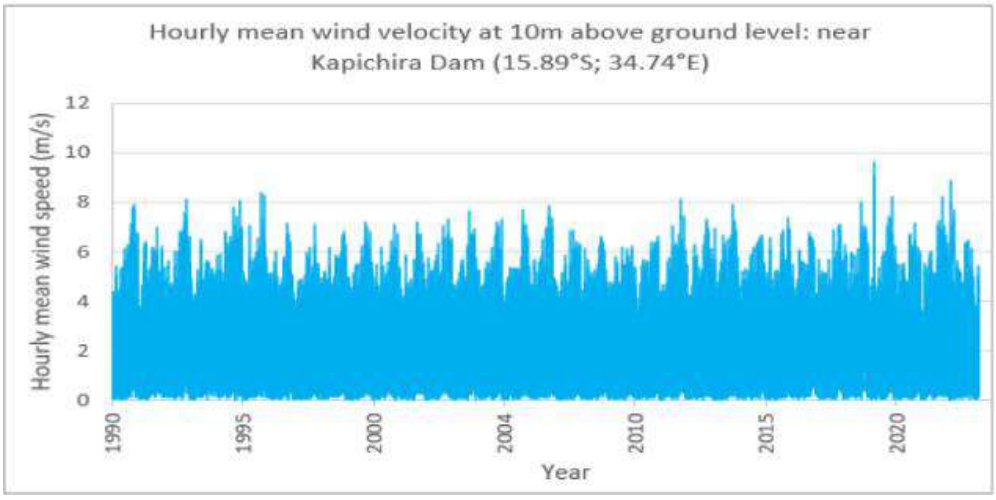
In the direct footprint area, the wind is coming from the South according to the following wind frequency rose (North= 0° - South=180°).



Source: Global Wind Atlas,2008-2017, Center (Lat, Long): -15.893485°, 34.750443°

Figure 5-14: Wind frequency rose at Kapichira dam site

The following diagram shows the hourly mean wind velocity near Kapichira dam recorded between 1990 and 2020.



Source: Memorandum on wind generated waves and currents impacting the Kapichira Dam for riprap protection design – 2023/08/03- EGENCO

Figure 5-15: Hourly analysed wind data obtained from ECMWF ERA5 at Kapichira dam site

Most of the time, the wind velocity ranges between 4 and 9 m/s which is characteristic of a moderate wind velocity zone. The maximum wind velocity recorded near Kapichira dam were during cyclone episodes: During the Cyclone Ana in January 2022, it passed near Kapichira with a wind velocity between 9.7 m/s and 23.6 m/s.

5.2.10.5. CLIMATE CHANGE

Global context

As mentioned in the hydrological report from the Owner's Engineer (Studio Pietrangeli Consulting Engineers, December 2024), the cyclonic events are the main cause of large floods in the project area. These intense events, which are characterized by heavy rainfall of 200-300mm/24h, usually occur during the rainy season over catchments that are already saturated with water. The frequency of cyclonic events has increased in the Shire River Basin since 2015 as shown in the following table.

Table 5-7: Major tropical storms in the Shire River Basin

Year	Event	Consequences
1946	Cyclone "Edith"	Major flooding. Changes in the extent of Lake Bangula, Lake Tomaninjobbi and other lakes in the Southern Elephant Marsh
2003	Tropical Storm "Delfina"	Major flooding
2015	Tropical Storm "Chedza"	Major flooding. Realignment of Ruo river into the Southern Elephant Marsh as a direct result of increased sediment into the Shire/Ruo embankment
2019	Cyclone "Desmond"	Major flooding
2021	Cyclone "Eloise"	Major flooding
2021	Cyclone "Guambe"	Major flooding
2022	Cyclone "Ana"	Major flooding, Kapichira dam break
2022	Cyclone "Gombe"	Major flooding
2023	Cyclone "Freddy"	Major flooding

Source: Multiconsult, Deltares, et al, 2023 - SLR Consulting. (2024). Volume II - Main ESIA report-Mpatamanga Hydropower Project.

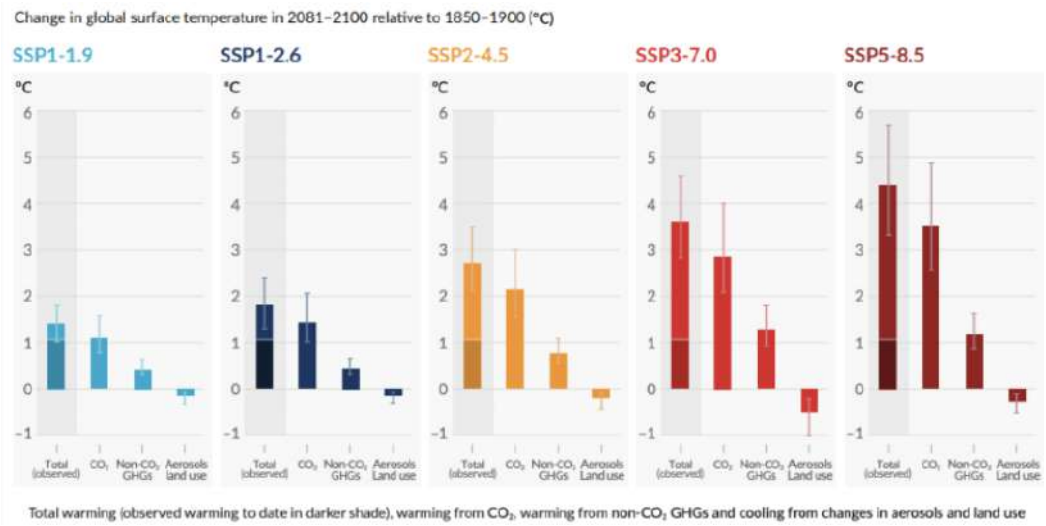
Tropical storm "Ana"

On Tuesday January 22nd, 2022, the tropical storm Ana formed over the Indian Ocean started moving westwards, passing over northern Madagascar and crossed over to Mozambique and subsequently reached Malawi, Zambia and Zimbabwe. This tropical storm was characterized by a wind varying between 63-83 km/h and a rainfall accumulation between 200 and 400 mm during the whole event.

The cyclone Ana flood assessment carried out by the Owner's Engineer estimated that the rainfall event corresponding to Storm Ana is an event having a return period of 3,000 years with a peak flow estimated to be bigger than 4,082 m^3/s.

Future climate change effect on temperature and floods

The Owner's Engineer assessed the range of probable effects of climate change on extreme floods at the Kapichira dam by using climate change scenarios.



Source: Studio Pietrangeli Consulting Engineers. (2023). Hydrological report

Figure 5-16: Predicted contribution of different climate change scenarios to the global surface temperature increase

For the assessment of future climate change impacts, the Owner's Engineer chooses the scenarios SSP2-4.5 and SSP5-8.5. These scenarios provide a range of possible future projections. SSP1 has been discarded, because it is currently too optimistic and probably already superseded.

For these two selected scenarios, the relevant anomalies (future deviations) in daily precipitations have been determined from the findings of the MMEW-model.

Finally, the assessed hyetograph for scenarios SP2-4.5 and SP2-8.5 have been used as input in the hydrological model of the whole watershed to model the process of formation of the flood at Kapichira dam site. The following table shows a summary of the peak floods evaluated by means of the rainfall-runoff models for the selected climate change scenarios.

Table 5-8: Rainfall-Runoff models, peak floods of residual catchments

Tr [yrs]	P(X) [-]	Scenario SPP2-4.5 (2080-2099)		Scenario SPP5-8.5 (2080-2099)	
		peak floods [m³/s]	Increase on current design floods [%]	peak floods [m³/s]	Increase on current design floods [%]
20	0.95	274	42	419	117
100	0.99	826	18	1044	49
1000	0.999	1978	8	2284	25
10000	0.9999	3476	4	3849	15

According to the performed analysis, peak floods increase more for a lower return period. For the 20-year return period flood, the percentage increase varies from 42% to 117% depending on the scenario. A minor increase (4-15%) was assessed for the higher return period of 10,000 years. Although the PMF is less sensitive to climate change than lower return-period floods, these findings highlight the importance of maintaining conservative design margins to ensure long-term resilience.

5.2.11. Ambient air

5.2.11.1. INTRODUCTION

The air quality and the noise levels were assessed in the construction influence area.

5.2.11.2. AIR QUALITY

Context

There is currently no industry in the project area. In addition, the absence of tarmac roads reduces motorised traffic, and therefore CO_2 emissions. In addition, there are no published reports on regional or local air quality within the District.

The main sources identified as generating pollutants and particles are currently bushfires, due to the presence of particles, especially during the dry season, characterised by high temperatures and low rainfall.

As for toxic gases such as NO_2 and SO_2, their concentration levels should be representative of a rural area unaffected by sources of contamination, and therefore not very present in the atmosphere.

Air quality analysis

The air quality was assessed by testing the following components:

- Particulate matter refers to any material, except pure water, that exists in the solid or liquid state in the atmosphere. They are minute and discrete particles capable of settling in gaseous medium. Such materials include dust, smoke, soot, fumes and ash. Particulate matter can range from 0.1µm to 30µm or greater in diameter. Of particular interest, however, are two sizes namely PM2.5 and PM10.
- Carbon monoxide (CO) is a poisonous, colourless, tasteless and odourless gaseous compound. It is usually formed from incomplete combustion of organic matter such as petroleum products. Incomplete combustion occurs where there is insufficient supply of air (Oxygen) for burning fuel.
- Nitrogen dioxide (NO_2) and Sulphur dioxide (SO_2) are both products of combustion of coal, oil and fossil fuel. Both NO_2 and SO_2 can cause lung disease, eye irritation and burning of the skin. They can both contribute towards formation of smog and acid rain which is harmful to plant and aquatic life.

Two surveys were conducted in the direct footprint area in November 2024 and in the construction influence area in September 2025 by the Malawi Bureau of Standards (see the locations in the following map). The results are included in the Appendix D.

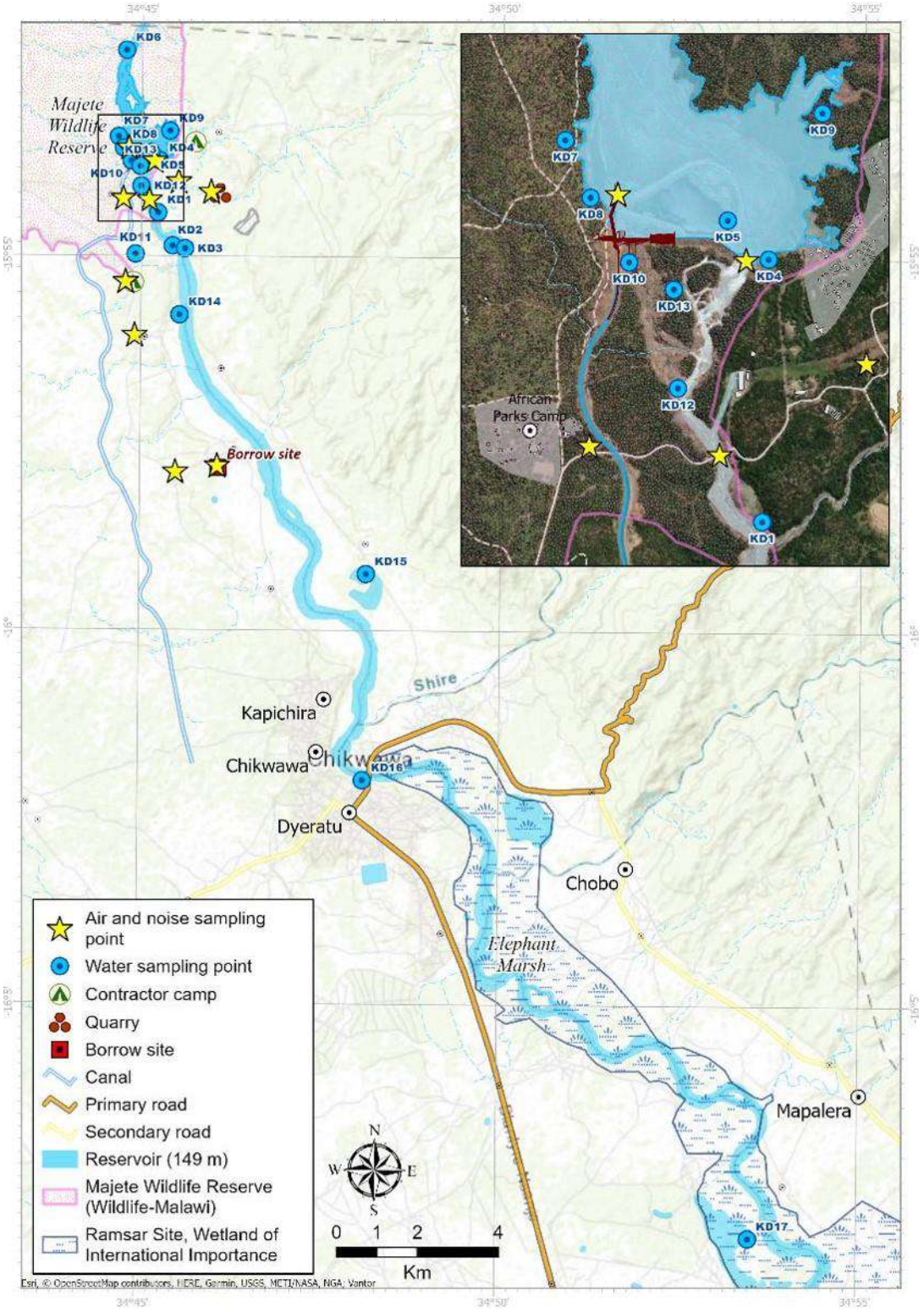


Figure 5-17: Locations of air quality and noise level samplings

The average results obtained at all surveyed sites in the direct footprint area were:

- 9 µg/m^3 for $PM_{2.5}$ (below the limit of 25 µg/m^3 in Malawi Standards MS737:2021),
- 12 µg/m^3 for PM_{10} (below the limit of 150µg/m^3 in Malawi Standards MS737:2021),
- 15.8 µg/m^3 for TSP (below the limit of 230 µg/m^3 in Malawi Standards MS737:2021),
- 0.3 mg/m^3 for CO (below the limit of 10 mg/m^3 in Malawi Standards MS737:2021),

- 1.9 µg/m^3 for NO_2 (below the limit of 110 µg/m^3 in Malawi Standards MS737:2021),
- 8 µg/m^3 for SO_2 (below the limit of 150 µg/m^3 in Malawi Standards MS737:2021).

The maximum limits obtained in the construction influence area were:

- 22 µg/m^3 for $PM_{2.5}$ (below the limit of 25 µg/m^3 in Malawi Standards MS737:2021),
- 43 µg/m^3 for PM_{10} (below the limit of 150 µg/m^3 in Malawi Standards MS737:2021),
- 49 µg/m^3 for TSP (below the limit of 230 µg/m^3 in Malawi Standards MS737:2021),
- 0.7 mg/m^3 for CO (below the limit of 10 mg/m^3 in Malawi Standards MS737:2021),
- 2 µg/m^3 for NO_2 (below the limit of 110 µg/m^3 in Malawi Standards MS737:2021),
- 10 µg/m^3 for SO_2 (below the limit of 150 µg/m^3 in Malawi Standards MS737:2021).

Therefore, the baseline air quality for Kapichira construction influence area comply with the national environmental requirements as well as the WHO ambient air quality guidelines.

5.2.11.3. NOISE NUISANCE

Context

The noise levels should be representative of a rural area unaffected by significant sources of noise.

Malawi Standard for Acoustics – Noise Pollution – Tolerance Limits (as well as WHO noise level guidelines) specifies 55 dBA and 45 dBA as maximum limits during daytime and nighttime respectively for residential areas.

Noise level assessment

The noise level was captured in the direct footprint area (around dam site) in November 2024 and in the construction influence area where potential noise nuisances could be felt such as the quarry site, the batching plant area, on the access road close to African Parks Camp, the Contractor's temporary camp site, the borrow site and villages such as Bwalo in September 2025 by the Malawi Bureau of Standards (see the locations in the Figure 5-17). The results are included in the Appendix E.

The noise level values were between 27 and 57 dBA, below the maximum of 85 dbA as acceptable limit, compliant to the national standard requirements based on MS 173 and IEC 60804. It should be noticed that the maximum of 57 dBA was captured at the water intake area considered as the noisiest area at the time of the survey.

5.2.12. Water quality

Context

The Shire River water has no salinity but has high silt content especially during the rainy season. The quality of water is treatable using the normal conventional Water Treatment technologies of sedimentation, clarification filtration and chlorination for it to be drinkable.

Water quality assessment

The results of the water sampling campaign with eighteen water samples collected from the 7th to 15th August 2024 on Shire River are presented hereafter. The details results are in the Appendix C.

The values of the following physical components are fitting within the acceptable values recommended by the WHO: pH, Temperature, Total Dissolved solids, Pressure and electric conductivity.

- **The pH** influences many components of biological and chemical processes in water body. It is therefore important to consider during a water quality assessment. The measured pH of the water was between 7.7 and 8.5 which falls within the acceptable range of 6.5 – 8.5 for water recommended by WHO. These values are in accordance with the values obtained during Mpatamanga survey ([7.99-8.74]).
- **The temperature** ranges from 22.1°C and 26.07°C. A temperature of 26.07°C is generally considered acceptable for concrete (according to ASTM C94) in most conditions, and it would not cause any significant issues or damage to the concrete as the ideal temperature for curing concrete is between 10 – 30°C. These values are in accordance with the Mpatamanga survey ([24.74-35.99] °C).
- **The Total Dissolved Solids** (TDS) corresponds to the filtrate phase after a filtration procedure. The measured TDS of the water is between 120 and 224 mg/L which falls within the acceptable range of ≤1000mg/L for water, as recommended by the WHO. These values are coherent with Mpatamanga survey laboratory analysis ([108-234] mg/L).
- **The Electric Conductivity** is the ability of the water to conduct electricity. It is an indicator of pollution and mineral content in the analysed water. The values are ranging between 248 and 470 µS/cm which fits in the acceptable range <1500µS/cm and is coherent with the Mpatamanga results. ([134-347] µS/cm)
- **The Oxidation Reduction Potential** (ORP) shows values ranging from 28.4 and 102.9 mV. This component defines the ability of the water course to cleanse itself. High values for ORP means that there is a lot of oxygen in the water: The higher the ORP value is, the healthier is the river. The ORP normally varies from + 100 mV to + 500 mV for surface and groundwaters containing DO. Therefore, the ORP values around Kapichira project imply a low oxygen concentration and a moderate polluted river. The results show lower values than for the water quality survey done for Mpatamanga ([42.90-219.30] mV) which can imply that the river is more degraded than at Mpatamanga.
- For **the percentage of saturation of dissolved oxygen** in the water, a percentage superior to 80% is an indicator for healthy water. The results show values that fits in the acceptable range >80% except for the downstream samplings which have values between 49 and 59 %. These percentage may indicate a stressful environment for aquatic wildlife.
- The **Dissolved Oxygen** (DO) concentration varies with temperature, salinity, turbulence, photosynthetic activity, and atmospheric pressure. The measurement of DO is used to determine the degree of pollution by organic matter, the destruction of organic substances and the level of self-purification of the water. The three samplings downstream falls under the acceptable range of 5 mg/L for water and could indicate a high nutrient load or sewage pollution. The other samples of water ranges between 6,46 mg/L and 9 mg/L and does fall within the acceptable range of 5 mg/L. These results are in accordance with the values obtained during Mpatamanga survey ([3.94-8.49] mg/L).

The chemical properties were analysed as follows:

- **Alkalinity** is controlled by the bases present in the water body. The values are ranging between 145,96 mg/L and 297,98 mg/L which fits in the acceptable range of <300 mg/L.
- **Biological Oxygen Demand** is defined by the amount of oxygen required for the micro-organisms to oxidize the organic matter to a stable inorganic form. High Biological Oxygen Demand Higher (BOD) indicates that more oxygen is required, signifying lower water quality. Low BOD means less oxygen is being removed from water, so the water is usually purer. The values are ranging between 0.39 mg/L and 2.47 mg/L which fits within the acceptable values of 0 to 20 mg/L for pure water. The results obtained during Mpatamanga survey showed similar values.
- **Chemical Oxygen Demand** permits to define the oxidation potential of organic and inorganic compounds in water body. The values are ranging between 2 and 25mg/L which fits in the acceptable limits <25 mg/L and does not indicate special pollution in the water.
- Metals like Mercury and Iron shows very low concentrations and does not indicate any sign of pollution.
- There are no specific standards that sets maximum concentrations for **Total Inorganic Carbon**. Nevertheless, it should generally be below 50 mg/L for drinking water. These values are fitting within these recommendations with values ranging between 7.04 mg/L and 49.28 mg/L.
- Major ions like Sulphate, Calcium, Magnesium, Carbonates and Bicarbonates shows typical concentrations for surface water
- Nitrates, Nitrites, Ammonium and Total Nitrogen show typical concentrations for surface water and do not indicate any type of pollution. Mpatamanga survey results are coherent with these observations but have detected high Nitrate and Nitrite concentrations at Lisungwe tributary. High values of Total Nitrogen were also recorded along the Mkulumadzi River. These pollutions may come from agricultural activities upstream.
- Values of Phosphate and Total Phosphor show typical concentrations for surface water.
- Total **Suspended Solids** shows typical concentrations for surface water and falls within the acceptable limit of 1,000 mg/L.
- The values of **Dissolved Organic Carbon** (DOC) are ranging between 3.69 mg/L and 30.93 mg/L. There are no specific standards that sets maximum concentrations of DOC. But in general, these values are above the desirable concentration which imply a low to moderate water pollution.
- The International standards do not set a specific Maximum Contaminant Level (MCL) for Total Organic Carbon (TOC) in drinking water. Nevertheless, the TOC is therefore a useful indication of the degree of pollution in surface waters. The TOC concentration is generally below 10 mg/L. These lab results ranging between 10.15 mg/L and 55.24 mg/L imply a polluted water and seems very high compared to the value obtained for Mpatamanga. The results are questionable and should be revised at the beginning of the project by the contractor.

The analysis of the water quality parameters shows typical values for surface water. Therefore, there is no major chemical pollution of the water in the Shire River which is coherent with the fact that there is no major industry or production in the vicinity of Kapichira dam.

5.2.13. Landscape and visual amenities

5.2.13.1. INTRODUCTION

Visual receptors are the people whose views may be affected by the proposals. They generally include:

- Visitors and tourists to the study area making use of recreational facilities and attractions.
- Travellers who may pass through the study area because they are visiting or living or working there.
- Residents living in the study area, either as individuals or, more often, as a community; and
- People at their place of work.

Viewpoints can be selected for a variety of reasons, but most commonly because they represent views experienced by relevant groups of people.

5.2.13.2. GENERAL CONTEXT

The landscape of the study area is formed by Great Rift Valley as it passes through southeastern Africa. This creates a wide, flat-bottomed trench through which the Shire River runs.

The edges of the trench are formed by mountainous upland areas of fractured rock with the base of the trench a mixed valley landform of undulating and flat topography. Historically woodland covered the lower valley landscape, but conversion to farmland and widespread resourcing of firewood and charcoal, has degraded the nature habitat. Most intact woodland survives in protected areas, here the Majete Wildlife Reserve which occupies the west part of the construction area.

5.2.13.3. PRESENT LANDSCAPTE IN THE DIRECY FOOTPRINT AREA

The proposed project is the rehabilitation of an existing structure: the Kapichira dam. It comes after the phase I works for the energy restoration including the construction of cofferdam sections. The dam construction works will be at the same area as the one for the phase I.

Visitors to the Majete Wildlife Reserve tend to be concentrated along the Shire River, touring the reserve on games drives, or experiencing nighttime activities on highpoints within Majete Wildlife Reserve.

The direct footprint area has been subject to successive phases of construction activities, leaving a visible legacy on the landscape. Phase I of the Kapichira dam rehabilitation introduced structures such as a coffer dam and a sand wall. Subsequently, the initiation of SVTP works has further transformed the area through extensive land clearing. As a result, the construction site is now highly degraded and clearly visible from tourist transects within the Majete Wildlife Reserve.

The following figure illustrates the SVTP construction activities as seen from Majete in November 2025. These works have visually altered natural habitats, converting them into land cleared construction areas. The cumulative succession of construction phases within the direct footprint has amplified the visual disturbance. From the tourist pathways in Majete, visitors can perceive the scale of these activities, which disrupts the visual

sensitivity of those seeking immersion in a pristine natural environment. The degradation of the scenic ambiance undermines the sense of tranquillity and belonging that is essential to the visitor experience in a conservation area, considering as well that there is now no access to Kapichira falls.



Figure 5-18 : View of the direct footprint area from Majete pathway

5.2.13.4. LIGHT EFFECTS

During the Mpatamanga ESIA in October 2023, a specific study was conducted on the effects of light pollution on the MWR's nocturnal conditions.

The study aimed to characterize the current nocturnal conditions and analyze their vulnerability to change. Several sources of light pollution are already present in the area, including the Kapichira dam operations, road traffic, a communication mast, and the *sky glow effect* due to the large city of Blantyre.

An aerial analysis confirms these sources (see the following figure). A highlight intensity is evident in Blantyre and its surroundings. The Kapichira dam is also a source of light pollution, which has a significant impact on the reserve's nocturnal atmosphere.

The results show that the *sky glow effect* is noticeable from most viewpoints. The northern part of the reserve is the most pristine because it is farthest from the source of light disturbance. In the southern part of the reserve, the effects of light pollution from the dam are more significant and meaningfully impact nocturnal visual quality. MWR is an important nocturnal landscape that should be conserved due to its strong sense of place. This area is generally sensitive to change and will be negatively affected if change is not managed appropriately.

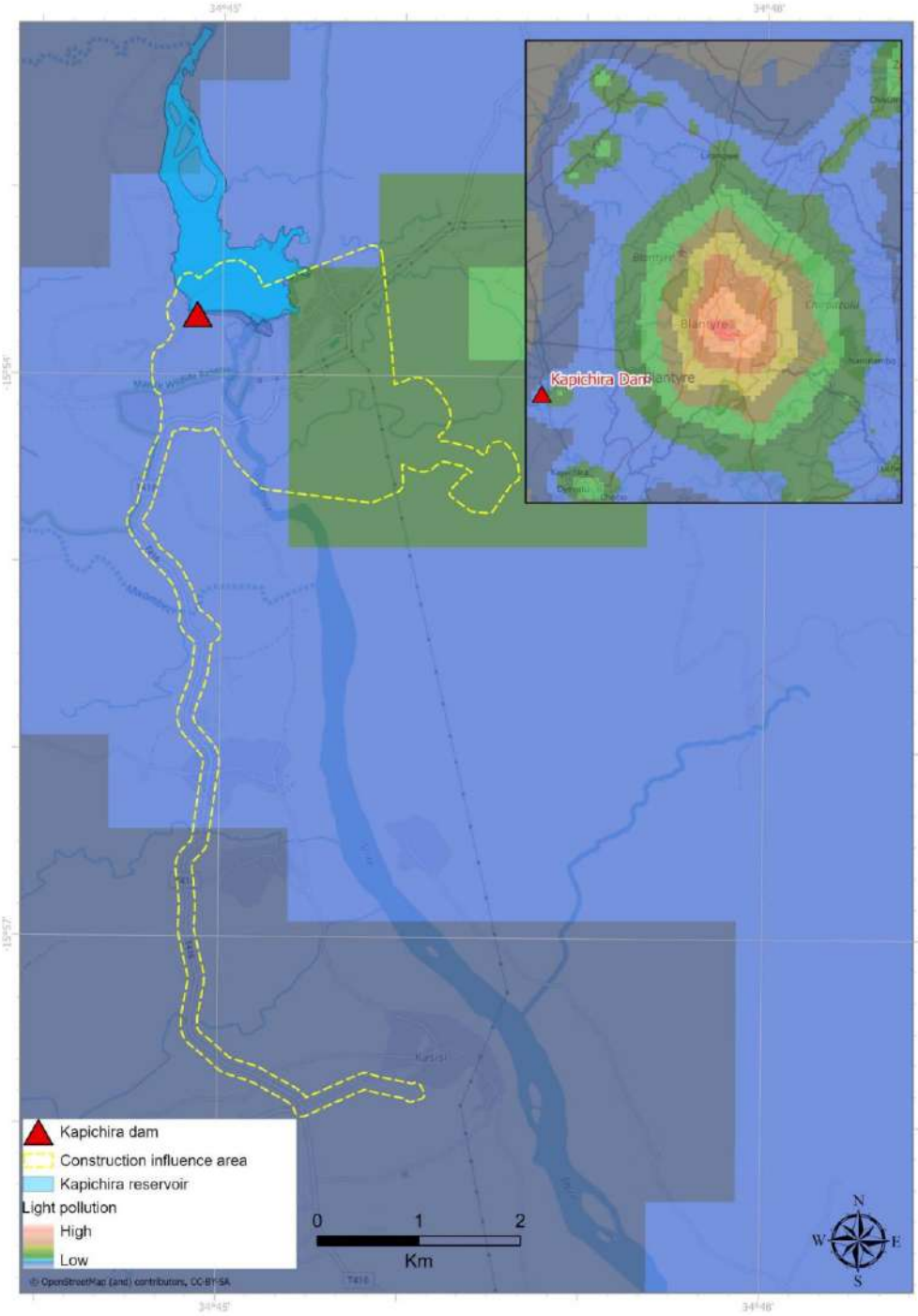
During consultations with African Parks, light pollution was identified as an existing issue primarily due to dam operations. Upward-facing lights around the dam infrastructure and in the EGENCO permanent camp are switched on all night long, impacting several key viewpoints in the reserve, including the Shire River Loop in the southern part.



Figure 5-19: Light around the dam area, seen from the Majete Wildlife Reserve

Furthermore, it has been noted that these lights directly impact biodiversity by attracting invertebrates. These lights act as ecological traps for nocturnal pollinators, attracting and disorienting them with these artificial light sources. This attraction leads to diminished pollination and mortality. Therefore, light pollution also has a knock-on effect on food chains by altering the interactions between vegetation, insects, and vertebrates that depend on these resources.

Due to the actual issue of night light effects, the lighting provided during operation should be reviewed, not to mention the impact of the upcoming construction project



Source: Light Pollution Atlas Information, 2023

Figure 5-20: Light pollution around Kapichira Dam

5.3. Description of the biological environment

5.3.1. General context

5.3.1.1. NATIONAL CONTEXT

Malawi is located within several "Global 200 Ecoregions" identified by the World Wildlife Fund (WWF):

- The terrestrial biome “Tropical and Subtropical Grasslands, Savannas, Shrublands ecoregion”.
- The terrestrial “Montane Grasslands and Shrublands”.
- The freshwater biome “East African Rift Valley's Great Lakes system”.
- The wet biome “Flooded Grassland and Savannah”

Ecoregions represent 238 terrestrial, freshwater, and marine areas considered the most representative of the planet's major habitat types. This selection is based on various criteria, including species richness, endemism, the uniqueness of advanced taxa, specific ecological conditions, unique evolutionary phenomena, and the rarity of associated habitat types[10].

The tropical and subtropical grasslands, savannas, and shrublands biome consists of ecosystems dominated by grasses, shrubs, and scattered trees, often adapted to periodic drought, fire, and grazing. These ecosystems are characterized by a warm climate and seasonal rainfall patterns that support a diversity of flora and fauna, including iconic species such as wildebeest, zebra, elephants, and lions.

This biome is particularly rich in large mammal assemblages, with the most intact examples found in African regions like the East African acacia savannas and Zambezian miombo woodlands. Despite this richness, large-scale migrations of herbivores such as wildebeest (*Connochaetes taurinus*) and zebra (*Equus zebra*) are in decline due to habitat modification and hunting pressure[11].

The biome “Tropical and Subtropical Grasslands, Savannas, and Shrublands ecoregion” in Malawi include predominant terrestrial biomes as follows[12]:

- Central Zambezian Miombo Woodlands cover large portions of the Western and Northern Malawi. The Miombo Woodlands are characterized by tall Miombo trees. This ecoregion is dominated by miombo tree species (*Brachystegia, Julbernardia,* and *Isoberlinia*), the woodlands support diverse wildlife, including large mammals like elephants and antelopes. Seasonal fires and grazing are essential processes that shape this ecosystem.
- Southern Miombo Woodlands: Found in southern Malawi, particularly around the Shire Highlands and adjacent areas. The eco region is similar to the Central Miombo Woodlands, dominated by *Brachystegia* and *Julbernardia* species and provides critical resources for wildlife and local communities, including timber and non-timber forest products.

[10] Olson, D. M., & Dinerstein, E. (2002). "The Global 200: Priority Ecoregions for Global Conservation." Annals of the Missouri Botanical Garden, 89(2), 199-224.

[11] McClanahan, T. R., & Young, T. P. (1996). "East African Ecosystems and Their Conservation." Oxford University Press

[12] Burgess, N. D., Hales, J. D., Underwood, E., & Dinerstein, E. (2004). Terrestrial Ecoregions of Africa and Madagascar: A Conservation Assessment

- Eastern Miombo Woodlands: Few patches are extending into southeastern Malawi. These woodlands feature rolling hills and valleys. This ecoregion features rolling hills, valleys, and *dambos* (seasonally waterlogged grasslands). The vegetation consists of miombo trees, shrubs, and grasses adapted to the region's seasonality.
- Zambezian and Mopane Woodlands: Found in the southernmost part of Malawi, particularly in the Shire River Valley. This ecoregion is dominated by *Colophospermum mopane*, which is well adapted to the region's drier conditions. It supports diverse fauna, including elephants and other herbivores, with fire and browsing shaping its vegetation structure.

In Malawi, the biome Montane Grasslands and Shrublands is represented by the Southern Rift Montane Forest-Grassland Mosaic, primarily located on the highlands and plateaus, such as the Mulanje Massif and Nyika Plateau. It consists of a mix of montane grasslands, shrublands, and patches of evergreen forest. The region supports diverse flora, including endemic orchids and proteas, and fauna like mountain reedbucks and rare bird species such as the blue swallow.

The freshwater biome East African Rift Valley's Great Lakes system in Malawi is dominated by Lake Malawi, part of one of the world's most biodiverse freshwater ecosystems, home to over 700 species of cichlid fish, many of which are endemic. The lake also supports species such as lake sardines, Nile crocodiles, and hippopotamuses. The surrounding wetlands and river systems, including the Shire River, provide crucial habitats for migratory birds, amphibians, and aquatic vegetation. This biome is vital for biodiversity conservation and sustains local livelihoods through fishing and tourism.

In Malawi, the biome Flooded Grasslands and Savannas is represented by Zambezian Flooded Savannas, including Elephant Marsh Ramsar Site (further details in the next session) and floodplain along the Shire valley. The Zambezian Flooded Savannas are an important ecoregion of the Flooded Grasslands and Savannas biome. They are defined by landscapes of seasonal floodplains, grassy savannas and permanent wetlands, which play a key role in the ecological and socio-economic dynamics of the regions they cover.

5.3.1.2. PROJECT AREA CONTEXT

The project area is located within the tropical and subtropical grasslands, savannas and shrublands biome. The ecoregions found in the project area are the Southern Miombo Woodlands and the Zambezian and Mopane Woodlands[12].

According to Burgess et al (2004), ecoregions can be classified according to their conservation priority and vulnerability. The conservation status is based on several factors including unique biodiversity or endemism, level of threat (deforestation, agriculture, fires, ...), ecological integrity of the ecoregion itself, protected areas... These statuses have different levels of priority (I is very high priority, II is high priority, III is moderate priority).

The Southern Miombo Woodlands occur in the vicinity of the Majete Game Reserve. This ecoregion is classified as Vulnerable (II, high priority) due to deforestation caused by subsistence agriculture, timber harvesting and charcoal production. The Majete Wildlife Reserve is an example of a well conserved habitat in this ecoregion.

The Zambezi and Mopane woodlands are located further south in the Shire Valley, downstream of the Kapichira Dam. Here the ecoregion becomes dominant. Its conservation status is fairly stable (III, moderate priority) but may be locally threatened. In general, this ecoregion is considered stable, but there are some pressures from urban areas, intensive grazing and agricultural development. Species characteristic of this biome, such as elephants and hippos, are particularly vulnerable to these changes.

The wetlands and Elephant Marsh Ramsar site, including the Zambezi Flooded Savannah, are a unique wetland ecosystem and their priority level is critical. This is discussed in more detail in the next section.

The Shire River, the main outlet from Lake Malawi, plays an important role in regulating hydrological flows and aquatic biodiversity in the region. The Shire River is divided into three distinct sections: the upper, middle and lower Shire River (see chapter 4.4.2). Due to physical barriers, these three sections have their own ecological characteristics and fish diversity.

The Kapichira dam and falls are an ecological and physical barrier that influences the migration dynamics of aquatic species between the sections of the river. The Kapichira Falls are the only real barrier between the lower and upper reaches of Lake Malawi. Some Upper Shire fish can cross the falls and the spillway but with difficulty and this migration is associated with injury and weakening.

Downstream in the lower Shire River, there are many floodplains including the flooded wetland and savannah and as the Elephant Marsh Ramsar site play a role in hydrological regulation. These floodplains are a refuge for many aquatic and terrestrial species, especially during the flood season, providing spawning, feeding and nursery areas. They provide many ecosystem services: regulation, as they are natural buffers as flood expansion fields and reduce the impact of floods and water storage. They are home to many migratory and endemic species. provisioning, as they play an important role for agriculture (fertilization of the soil, local fisheries, ...).

The direct footprint area is in the Middle Shire River including the reservoir dam and its area of influence is in the upper part of the Lower Shire River.



Figure 5-21: Middle Shire River on the west bank of the Majete Wildlife Reserve



Figure 5-22: Lower Shire River in the direct downstream influence area

5.3.2. Protected and internationally recognised areas

5.3.2.1. MAJETE WILDLIFE RESERVE

The Majete Wildlife Reserve (MWR) covers the direct footprint of the project including the dam infrastructure and the dam reservoir. The dam reservoir has become an essential resource for the local fauna.

The MWR covers an area of 77,754 ha. The reserve was created in 1955 and officially declared a protected area in 1975. Since 2003, the management has been entrusted to African Parks, a non-governmental conservation organisation which has signed a concession with the Department of National Parks and Wildlife (DNPW) of Malawi. This delegated management has marked the beginning of a significant transformation of the reserve.

Prior to Afrikan Parks' intervention, the MWR was little known and severely degraded by poaching and massive deforestation for charcoal. Most of the mammals had disappeared and the natural habitats were highly threatened. In 2003, African Parks initiated several programs of ecological restoration, including the reintroduction (5,000 individuals of 17 species) of elephants, black rhinos, lions, giraffes, African wild dogs... This effort aims to reconstitute the animal populations, which will be more than 12,000 in 2022 (an increase of 10% over 2020). The MWR provides local fauna to other parks in Malawi and is an example of successful ecological restoration.

The reserve is home to a wide variety of mammals, including large herbivores such as elephants, hippos and zebras, and carnivores such as lions, leopards and cheetahs. Nyala, kudu, Lichtenstien cob and porcupine are also present. The reserve is also home to more than 300 bird species, including birds of prey and four species of vulture, as well as a large population of bateleurs. During migration, between July and November, African skimmers and red-winged pratincole frequent the river areas, reinforcing the ecological importance of the site.

The reserve's vegetation is dominated by a mixture of miombo, a tree savannah typical of southern Africa. The western areas are characterized by dense woodland, while the eastern areas, closer to the Shire River, have landscapes of open woodland, scrub and rich riparian habitats. This diversity of habitats supports a wide range of wildlife and contributes to the reserve's ecological uniqueness.

Majete Wildlife Reserve plays an important role in the conservation and socio-economic development of the region. It is one of the main tourist attractions in the Lower Shire Valley, attracting visitors for its spectacular scenery, safaris and recreational activities. The income generated by tourism not only supports conservation efforts, but also local communities. Through educational programs and scholarships, the reserve helps to improve the livelihoods of local people.

The effectiveness of African Parks' management is demonstrated by the significant reduction in poaching. No black rhino has been poached since 2003 and no elephant since 2006. These remarkable results can be attributed to rigorous conservation measures and community initiatives aimed at reducing human-wildlife conflict.

However, the reserve continues to face challenges, including agricultural expansion and the exploitation of natural resources in the surrounding area. The effects of climate change, such as variations in rainfall, could also affect the habitats and hydrological cycles of the River Shire. Despite these threats, Majete Wildlife Reserve stands out as a model of conservation, ecological restoration and sustainable management, positioning Malawi as a key player in biodiversity conservation in southern Africa.

The project's direct footprint area is located within the Majete Wildlife Reserve including the dam reservoir area and the dam.

5.3.2.2. ELEPHANT MARSH RAMSAR SITE

Elephant Marsh, located on the floodplain of the Lower Shire River, is one of the key wetland ecosystems in the study area. It was officially designated as a Ramsar site in 2017, testifying to its ecological importance and its role in the conservation of wetlands of international importance. This remarkable ecosystem covers a vast area encompassing a mosaic of rooted aquatic vegetation, floating vegetation and open bodies of water bordered by meadows, reedbeds and islands where reeds, shrubs and palms grow.

The geography of the site is shaped by the complex interplay between the hydrological regime of the Shire River and seasonal flooding. Downstream of the Kapichira Falls, the floodplain is relatively narrow but widens after the confluence with the Mwanza River to form the Elephant Marsh. This marsh plays a key role in regulating hydrological flows, particularly for flood control and water storage, while also providing a supply of nutrient-rich sediments that help improve the fertility of the surrounding soils.

Although the outlying areas are largely cultivated, the heart of Elephant Marsh remains dominated by pristine wetland habitats. The ecological value of the site lies in the diversity of habitat types that change during the annual flood cycle, increasing the overall productivity of the system and its importance for resident and migratory wildlife.

The marsh is home to exceptional biodiversity. Some 110 species of waterbirds have been recorded, 26 of which breed in the area. The total population of these birds exceeds 20,000 individuals and three species meet or exceed the 1% threshold set by the Ramsar Convention for a site to be recognized as being of International Importance. Eight species of waterbirds found in the marsh are classified as globally threatened or near threatened: Madagascar Pon Heron (*Ardeola idae*), Lesser Flamingo (*Phoenicopterus minor*), Wattled Crane (*Bugeranus carunculatus*), Grey-Crowned Crane (*Balearica regulorum*), Great Snipe (*Gallinago media*), Bar-tailed Godwit (*Limosa lapponica*) and Curlew Sandpiper (*Calidris ferruginea*). Elephant Marsh is also an important site for the African Skimmer (*Rynchops flavirostris*).

In addition to birds, the site supports significant populations of hippopotamus, several species of fishes, aquatic invertebrates and a new subspecies of butterfly. These species are closely linked to the maintenance of the hydro-morphological processes that shape the habitats and ensure their long-term survival.

Elephant Marsh also plays an important role in the livelihoods of local communities. Human activities in the area include subsistence farming, livestock rearing and artisanal fishing. Approximately 1,500 small-scale fishermen depend directly on the marsh's aquatic resources. During the dry season, the marsh becomes an indispensable resource, providing soil moisture to support crops and pastures.

In terms of ecosystem services, Elephant Marsh helps to store water, regulate hydrological regimes and provide nutrient-rich sediments. These functions are vital to local agriculture, particularly in winter when water availability declines. However, the site is under increasing pressure, including agricultural expansion, overexploitation of natural resources and the effects of climate change. Preserving its ecological integrity remains essential to maintain the exceptional biodiversity it hosts and to support the local population.

The project's area of influence is located within the Elephant Marsh Ramsar site.

5.3.2.3. KEY BIODIVERSITY AREAS

Other areas of conservation interest are located between 50 and 130 km from the Kapichira HPP.

The following table describes the Key Biodiversity Areas (KBAs) within the regional context. **None of these KBA are part of the direct footprint area and area of influence.**

Table 5-9: Key Biodiversity Areas between 50 and 130 km from the Kapichira HPP

Key Biodiversity Areas	Description
Liwonde Hills Forest Reserve	13% of the Liwonde national park is considered as a KBA and an IBA. The Liwonde Highlands comprise a chain of four round hills on a 32 km ridge, rising from the Lake Shore plain and Lake Chilwa. Chikala Hill, the easternmost and highest at 1,626 meters, hosts one of Malawi's finest patches of mid-altitude rainforest, covering 285 hectares between 1,300- and 1,600-meters elevation. The area supports various bird species, including the IUCN vulnerable species Thyolo Alethe (*Chamaetylas choloensis*), which inhabits the ground stratum of mid-altitude forests.
Zomba Mountains	This area is also considered as an IBA. The Zomba Plateau, part of the Zomba Mountains, reaches elevations up to 2,087 meters. The plateau's unique montane forests and grasslands are crucial for biodiversity conservation. The area is home to several bird species, including the IUCN vulnerable species Thyolo Alethe (*Chamaetylas choloensis*).
Ruo River	The Ruo River, a tributary of the Shire River, forms part of the boundary of the South Malawi montane forest–grassland mosaic ecoregion. The riverine habitats support various bird species, though specific threatened species are not well-documented.
Thyolo tea estates	The Thyolo area, known for its tea estates, was once covered by montane forests. Deforestation for tea cultivation has led to habitat loss, threatening species like the Thyolo Alethe (*Chamaetylas choloensis*) which is native to this region.
Soche Mountain Forest Reserve	Soche Mountain, located near Blantyre, is part of the South Malawi montane forest–grassland mosaic ecoregion. The forest reserve protects montane forest habitats. The area supports various bird species, though specific threatened species are not well-documented.
Mountain Mulanje Forest Reserve	This area is also considered as an IBA. Established in 1927, the Mulanje Mountain Forest Reserve covers 56,317 hectares and was designated as a UNESCO Biosphere Reserve in 2000. The reserve protects unique montane ecosystems, including endemic species. The reserve is home to the Mulanje Cedar (*Widdringtonia whytei*), endemic to the area, and bird species like the Thyolo Alethe (*Chamaetylas choloensis*).
Malawi Hill Forest Reserve	The Malawi Hills, including areas like Matandwe Forest Reserve, have faced severe encroachment and deforestation, impacting biodiversity. The vulnerable Thyolo Alethe (*Chamaetylas choloensis*) is found in some forest reserves within this region.

The Figure 5-23 highlights the location of the protected and internationally recognized areas in the Southern region of the Shire River valley.

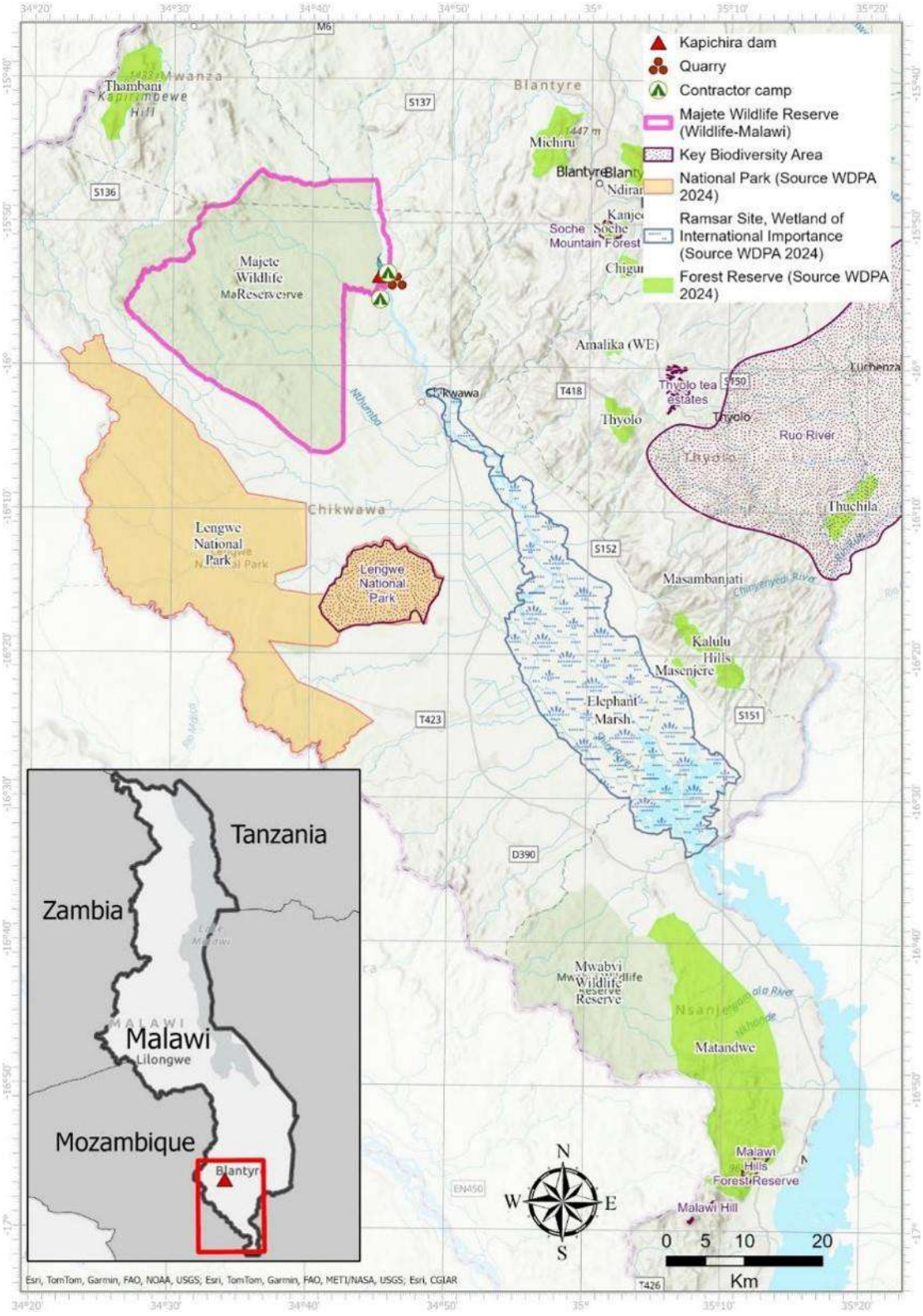


Figure 5-23: Protected and internationally recognized areas in the Southern region of the Shire River valley

5.3.3. Biological survey results

5.3.3.1. INTRODUCTION

This chapter presents the results of the surveys carried out upstream and downstream of the dam (including the Chikwawa floodplain and Elephant Marsh area) during the dry season, between 13 and 24 August 2024.

The survey was carried out (see the following map):

- in the direct footprint area (dam and reservoir area),
- in the construction influence area (including the quarry site and access road, the disposal area, the clay – borrow – site and its access road, the batching plant and the temporary camp site),

as well as in an area of influence to understand the insertion and conservation of species in their ecological niche around the direct footprint area, as well as those that may be indirectly affected by the project. The main objective is to integrate the project into a larger area to better understand the issues involved. Therefore, the surveys included as well:

- The downstream area of influence:
  - Upper and Lower Egenco Bridge: immediately downstream of the dam. Potentially influenced sections of the river and riparian areas are extended to cover the entire Kapichira falls (all flow channels) and the Shire River up to the tailrace channel outflow.
  - Chikwawa floodplain: upstream of the Elephant Marsh Ramsar site.
  - Elephant Marsh: inventoried upstream of the site.
- The Middle Shire River as part of the upstream area of influence.

A complementary survey was carried out in September 2025 to document the borrow site and the disposal area as new areas for the need of the construction works.

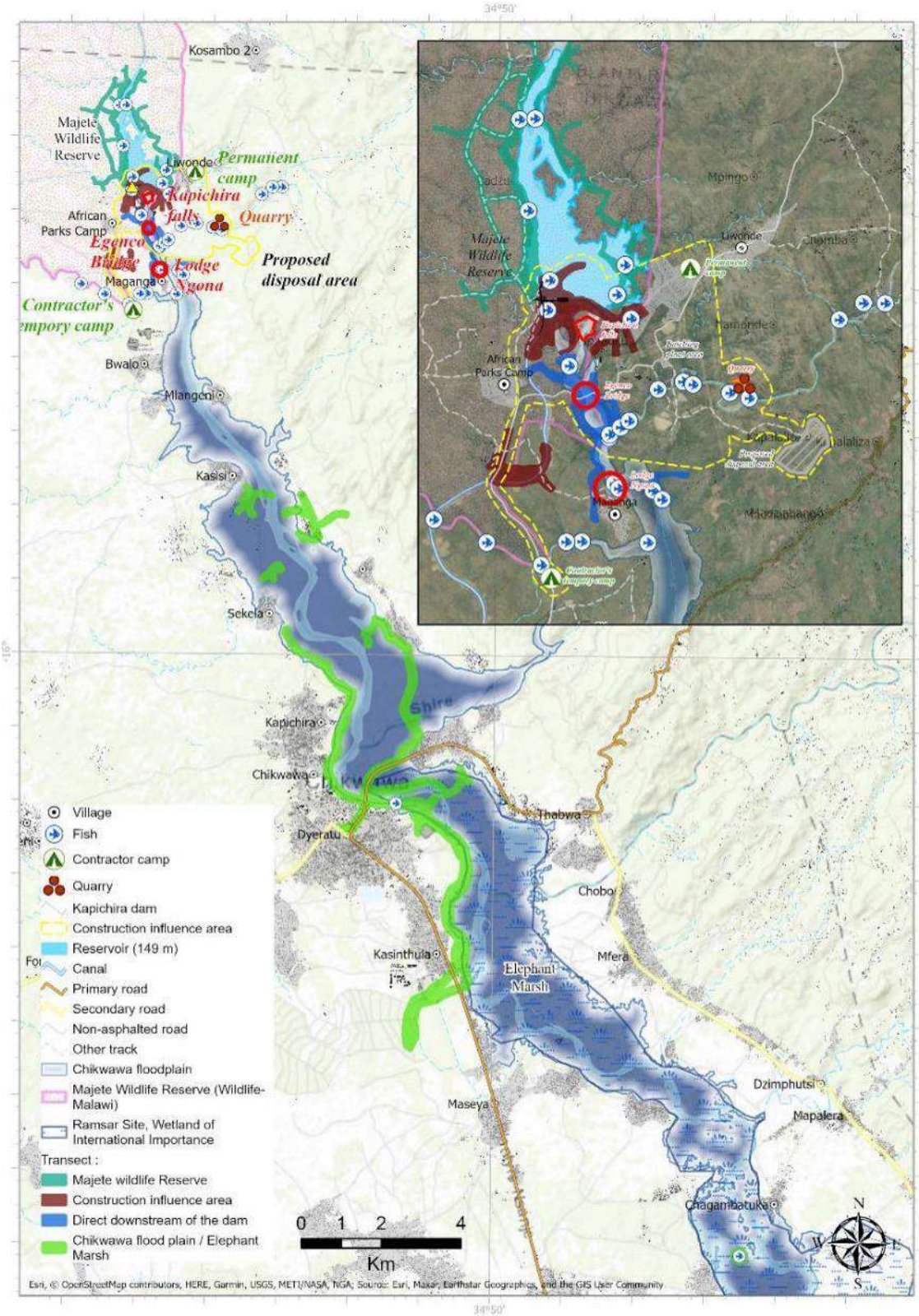


Figure 5-24: Localisation of 2024 and 2025 fauna and flora investigations

To complete these inventories, recent studies including several surveys in the area (especially in the wet season) were also analysed:

- Malawi – List of fauna and flora species encountered in the Majete Wildlife Reserve in 2023. This list was provided by the African Parks' conservation team of the Reserve during our meeting on 15 August 2024.
- Malawi – Shire Valley Transformation Program: environmental and social impact assessment, environmental and social management plan, and pest management plan - executive summary (English), World Bank Group, Washington, D.C., 25/08/2017.
- Malawi – Shire Valley Transformation Program - Updated environmental and social impact assessment for the Shire Valley Irrigation Project, 08/08/2017.
- Malawi – Mpatamanga Hydropower Project – Environmental & Social Impact Assessment Volume II – Main ESIA Report, 31/07/2024.

The baseline is therefore based on both survey results from the Kapichira rehabilitation project and a literature review of available data in the proposed project area.

5.3.3.2. HABITATS AND FLORA SURVEY

This chapter presents the results of the flora survey, presented in three sub-sections: one section about the habitats, one section about the results of flora inventories and one section about invasive aliens' species.

Habitats

The terrestrial habitats in the project area consist primarily of mixed deciduous forests, fragmented dry miombo woodlands, and dense dry savanna thickets (Wildlife Society of Malawi, 2005).

A notable vegetation type found in patches is the Miombo woodland, historically widespread, but now highly fragmented due to land conversion. It is dominated by semi-deciduous trees such as *Brachystegia* spp. and retains ecological importance despite its degradation (Mpatamanga HPP ESIA, 2024).

The following figure shows the main type of habitats in the project's area of influence.

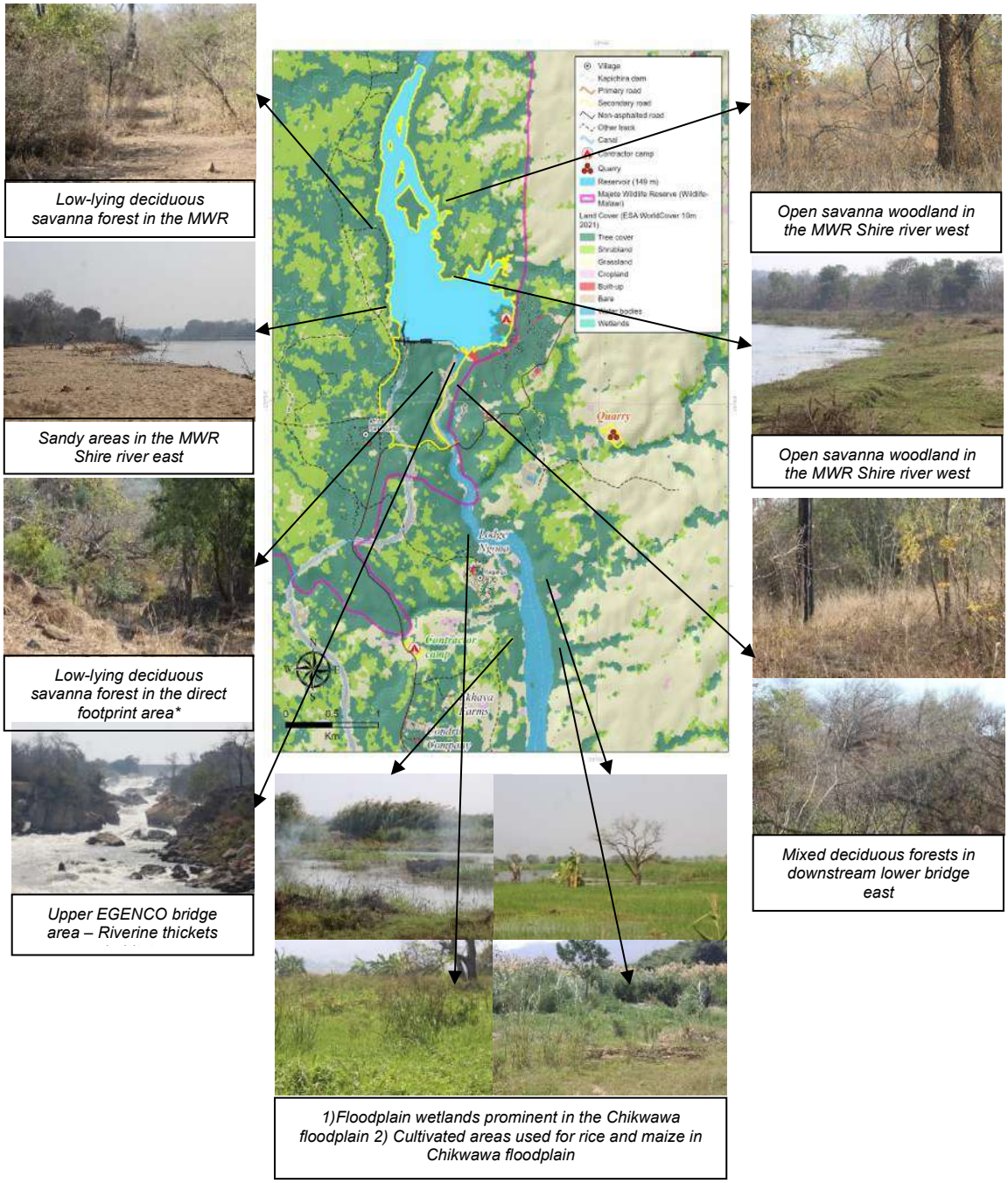


Figure 5-25: Type of habitats surveyed in the study area

The analysis of the survey has been divided into four main areas: the upstream Kapichira falls in the Majete Wildlife Reserve, the downstream areas of Kapichira falls along the Shire River, in the quarry site and access road, the disposal area, the clay – borrow – site and access road, the batching plant and the temporary camp site:

- **Upstream, In the Majete Wildlife Reserve:**

The Majete Wildlife Reserve features vegetation associations dominated by *Senegalia nigrescens*, *Sclerocarya birrea*, and *Brachystegia spp.*, while floodplains and riparian areas are shaped by seasonal flooding and sedimentation (*African Parks, 2016-2020*).

During the 2024 survey for this assessment, two distinct vegetation types have been identified in the Majete Wildlife Reserve:

- Low-lying deciduous savanna forest: Characterized by forest patches dominated by *Acacia nigrescens* and *Ziziphus mucronata*, with herbaceous cover representing around 50 to 60% of open areas.
- Open savanna woodland: Dominated by *Colophospermum mopane* and *Acacia nilotica*, with herbaceous cover ranging from 30-40%.



Figure 5-26: Dam reservoir on the left bank in the Majete Wildlife Reserve during the dry season (August 2024)



Figure 5-27: Riverbank vegetation in the direct footprint area

A detailed assessment of the habitat survey in the direct footprint area is provided in the Appendix F.

- **Downstream in the quarry site area:**

The natural vegetation at the quarry site is open canopy mixed savanna woodland dominated by dry savanna woodland vegetation type composed of *Acacia nigrescens*, *Terminalia sericea* and *combretum* species. Currently, the vegetation is human modified along the area chosen for the quarry site. Adjacent to the quarry site runs a river along the edge that is characterized by more-dense tree growth along the river edges.

Field observations of the vegetation cover along the proposed access route to the quarry site comprises of open dry deciduous forest type composed of mixed species with *Terminalia sericea, Bauhinia petersiana* and Acacia species as dominant species. On the western side, intact buffer forest on hilly slopes with canopy cover of 50–70% and species such as *Terminalia sericea*, *Pterocarpus angolensis*, *Dalbergia melanoxylon* and *Diospyros kirkii*; on the eastern side, mixed woodland dominated by *Diplorhincus condylocarpon*, *Combretum adenogonum* and *Terminalia sericea*, interspersed with open patches of grasses, aloes and isolated stands of *Dalbergia melanoxylon*. These well-conserved habitats are visually sensitive, and any disturbance will be significant.



Figure 5-28: Quarry site area with 1 - short and tall grass species including *Heteropongon contutus* and *Xerophyta trinerve*, and forest thickets patches of remnant *Dalbergia melanoxylon* and *Pteleopsis myrtifolia; 2 - Grasses poaceae (Hypharenia, Heteropogon) and trees shrubs*

- **Downstream in disposal area:**

The proposed dumping site is located within a mixed *Acacia–Combretum* woodland. To the east, the area transitions into a riparian zone that has been heavily degraded, leaving much of the riparian vegetation depleted and the ground exposed. Overall, the dumping site is predominantly open, dominated by tall grass species (see figure below) and shows extensive signs of degradation resulting from illegal activities such as charcoal production, timber harvesting, and firewood collection by surrounding communities.

Most of the original woodland forest cover has been lost, with only a few scattered natural regenerants remaining, many of which continue to be harvested for small-scale charcoal kilns. Evidence of past enrichment planting is visible through the presence of planted seedlings of *Gliricidia sepium*, *Albizia lebbeck*, *Azadirachta indica*, and *Senna siamea*. However, the survival rate of these species has been low, largely due to recurring fire damage and inadequate silvicultural tending operation such as weeding.



Figure 5-29: Habitats in the disposal site

A detailed assessment of the habitat survey at the quarry and the disposal area is provided in the Appendix G.

- **Downstream in the temporary camp site area:**

The temporary camp site is dominated by grass species. A forest thicket is also present onsite. Among the identified tree species, *Vachellia karoo*, *Diospyros squarrosa* and *Dichrostachys cinerea* are dominant. Forest thickets are widely used to provide firewood, building materials for kraals and fodder for livestock amongst other domestic uses.

A detailed assessment of the habitat survey at the camp site is provided in the Appendix H.



Figure 5-30: Area dominated by grass species and weeds on the temporay camp site with 1 and 2: low lying deciduous forest thickets dominated by *Vachelia karoo* and *Dichrostachys cinere*; 3 and 4: Disturbed forest from agriculture and left to fallow

- **Downstream in the (clay) borrow site area:**

The proposed clay borrow site is on dry deciduous woodland vegetation type is dominated by herbs and grasses with isolated pockets of tree/shrubs largely of *Diospyros squarrosa*. The canopy cover range between 0 to 10% as the area remain open due to anthropogenic pressure and human usage of the site for cattle ranching. Within the proposed clay site, notable forest thickets of bush/scrubland occur along the seasonal riparian zones. *Diospyros squarrosa* is the dominant tree species in this area. The vegetation type on the access road is similar with the clay site with 0-5% canopy cover.

A detailed assessment of the habitat survey at the borrow site is provided in the Appendix H.

- **Downstream area along the Shire River:**

Along the Shire River in the downstream area, habitats are influenced by seasonal flooding and human activities. Riparian and floodplain wetlands are prominent, supporting vegetation such as *Cyperus papyrus* and *Phragmites australis* (Mpatamanga HPP ESIA, 2024). They are often impacted by sediment deposition and invasive species such as *Calotropis procera* and *Lantana camara* (Mpatamanga HPP ESIA, 2024).



Figure 5-31: Mixed woodlands habitats along the Shire River in the downstream area



Figure 5-32: Samples sites in the downstream area: 1-Wetland present along the Shire River, 2-3-Mvuza River, a tributary of the Shire River, during the dry season

In wetland areas associated with Elephant Marsh, located downstream, but hydrologically connected to the project area, a 2015 flora survey identified 130 plant species, with dominance of grasses like *Vossia cuspidata*, reeds (*Phragmites australis*), sedges (*Cyperus spp.*), and emergent plants like *Typha spp*. Invasive aquatic plants,

including *Eichhornia crassipes* and *Pistia stratiotes*, are also present, along with floating ferns like *Azolla nilotica* and *Salvinia molesta* (MRAG Ltd., 2016; cited in Shire River Transformation Program ESIA). These areas have no extensive riparian forests but contain scattered palm trees and cultivated areas used for rice and maize as part of flood-recession agriculture.



Figure 5-33: Samples sites at the top of Elephant Marsh with crops present along the Shire River (1-2) and marshes (3-4)



Figure 5-34: Riverbank vegetation in the construction influence area

Both natural and modified habitats were sampled during the survey as follows:

- Natural habitats are environments which remain largely undisturbed by human activities, providing a home for native wildlife and supporting ecological processes without significant alteration.
- Modified habitats refer to environments which have been altered by various processes leading to changes in the natural landscape and potentially affecting the species that inhabit it[13].

The plant biodiversity assessment reveals notable variations in the level of habitat modifications across different locations within the project area as follows:

- Modified through flooding: habitats that were seen to be altered due to flooding events. This entailed changes in vegetation, sediment deposition, and water flow patterns.
- Modified by being cultivated area: Habitats that have been altered due to agricultural activities, including land clearing, planting of crops, soil tillage, and the application of fertilizers and pesticides. These modifications often lead to changes in native vegetation composition, soil structure, and hydrology.
- Modified through deposition: Habitats that have undergone changes due to the accumulation of sediments, organic matter, or other materials transported by water, wind, or human activities. This can result in altered soil composition, changes in drainage patterns, and shifts in plant communities, often favouring species adapted to sediment-rich environments.

The survey revealed that most of the upstream and downstream surveyed sites still contain natural habitats, such as forests, thickets, wetlands, and riparian zones, which provide environments for wildlife mainly represented in the MWR, along the Shire river, the quarry site and the access road and the disposal area.

However, several modified habitats were also identified, including areas altered by flooding, cultivation, and sediment deposition. These modified habitats are widespread across the downstream zone, where cultivation and charcoal production have led to significant changes in land cover. Similarly, the quarry site and the temporary campsite are partially covered due to intensive logging for firewood and charcoal.

A detailed assessment of natural and modified habitats is provided in section 5.3.5.

Results of flora survey

Flora species were inventoried in the construction influence area and downstream area to upstream of Elephant Marsh. The sampling areas were also carried out on the quarry, borrow site and the camp sites.

In all sites, the majority of species were listed (see Table 5-10) as Least Concern (LC) or as not evaluated (NE) regarding the global IUCN Red List except for one Near Threatened (NT), *Dalbergia melanoxylon*, a species recorded in several sampling areas. Indeed, this species was found in the Majete Wildlife Reserve, in the construction site and in the downstream area including the quarry site and the Chikwawa floodplain. *Dalbergia melanoxylon*, commonly known as African blackwood faces significant threats from overharvesting due to its valuable timber, which is highly sought after. Other valuable species like *Pterocarpus angolensis, Combretum molle* or *Burkea Africana* are

[13] Goslinga et al., A global mapping template for natural and modified habitat across terrestrial Earth, 2020.

present on the quarry site and heavily targeted for timber and charcoal, threatening their natural regeneration, especially due to the quarry's location on customary land.

Only three species (*Lannea schwenfurthii*, *Dalbergia melanoxylon*, and *Pterocarpus angolensis*) are nationally recognized on the IUCN Red List (Msekandiana & Mlangeni, 2002). They are present on the quarry site. Valuable species like *Dalbergia melanoxylon* and *Pterocarpus angolensis* are heavily targeted for timber and charcoal, threatening their natural regeneration, especially due to the quarry's location on customary land.

No conservation flora species were recorded in the camp site area and in the proposed clay borrow site.

The detailed assessment for each flora species survey is in the appendices F, G and H.

Table 5-10: IUCN conservation status of identified plant species

Location of flora investigations	Global IUCN conservation status: Number of times recorded for each species				Total species frequencies
	Data Deficient (DD)	Least Concern (LC)	Not evaluated (NE)	Near Threatened (NT)	
Downstream (Likhubula River)		5	10		**15**
Upper flood plain		41	41	7	**89**
Lower floodplain		22	65		**87**
Downstream (at the bridge, left bank)		35	49	1	**85**
Downstream (at the bridge, right bank)	1	19	16	1	**37**
Downstream, right bank		34	49	1	**84**
Dam area in the Majete wildlife reserve (left bank of the Shire River)		84	63		**147**
Dam area in the Majete wildlife reserve (right bank of the Shire River)		92	85	2	**179**
Quarry site		11	10	1	**137**
Disposal area	1	80	94	1	**104**
Borrow site		80	94		**54**
Access road to the borrow site				1	**107**
Temporary camp site					**85**
Direct footprint area		48	74	1	**123**

Eight (8) protected tree species (see Table 5-11) were confirmed to be present in the project area: *Terminalia sericea*, *Burkea Africana, Cordyla Africana*, *Dalbergia melanoxylon, Combretum molle, Sclerocarrya birrea, Afzelia quanzensis,* and *Pterocarpus angolensis*. All these species fall under Part II of the plant protected species schedule.

- *Terminalia sericea* was recorded within the dam area, in the access road to the quarry site, the disposal area, downstream area and in the upper Chikwawa flood plain.
- *Cordyla Africana* was recorded within dam area in Majete Wildlife Reserve.

- *Afzelia quanzensis* was recorded along the access road to the quarry site and in the disposal area.
- *Pterocarpus angolensis* was recorded within the dam area, in the quarry site and access road and upper Chikwawa flood plain.
- *Dalbergia melanoxylon* was observed within the downstream area, construction area, quarry site and access road, disposal area and in the flood plain.
- *Burkea Africana, Combretum molle* and *Sclerocarrya birrea* were recorded in the quarry site.
- *Burkea Africana* was also recorded in the disposal area.

These species are considered vulnerable or rare. Most of them seemed to thrive in Majete Wildlife Reserve's protected environment, but also on customary land (e.g. quarry site) where they are threatened by charcoal / timber production.

The preponderant of the protected species recorded is *Dalbergia melanoxylon* and *Terminalia sericea* in both the disposal site and access road to the quarry site.



Figure 5-35: *Karoma tettensis* (1) and *Dalbergia Melanoxylon* (2) in the construction influence area

Table 5-11: Protected species in the project area

Species	Common name	Local name	Protected status	Location					
				Dam area	Quarry site	Construction area	Chikwawa flood plain	Access road to the quarry	Disposal area
Terminalia sericea	Silver cluster-leaf	Naphini	Part II	+	+		+	+	+
Cordyla Africana	Wild mango	Mtondo	Part II	+					
Dalbergia melanoxylon	Zebrawood	Phingo	Part II		+	+	+	+	+
Pterocarpus angolensis	Bloodwood	Mlombwa	Part II	+	+		+	+	
Burkea Africana	Wild syringa		Part II		+				+
Combretum molle	Velvet bushwillow		Part II		+				
Sclerocarrya birrea	Marula		Part II		+			+	+
Afzelia quanzensis			Part II					+	+

Invasive Aliens Species

Invasive Alien Species (IAS) are exotic, non-native, non-indigenous or foreign plant or animal species that have been introduced into Malawi, both intentionally and accidentally, where they have established, and subsequently proliferated to the detriment of native biodiversity, local livelihoods, and economic activities (Witt et al. 2021). Invasive species can cause extinctions of native plants and animals, reducing biodiversity, competing with native organisms for limited resources, and altering habitats. Their management can only be possible once their occurrences and impacts are known.

The Global Register of Introduced and Invasive Species was used to assign identified species into their appropriate status (invasive and not invasive species) at global level while the 2021 Guide to the Naturalized and Invasive Plants of Malawi and Zambia and database on Invasive Alien Plant Species of Malawi-GBIF identifies key IAS at national level. Species were registered not invasive if they are not listed on the invasive species databases mentioned above.

The Figure 5-36 highlights the location of the invasive species.

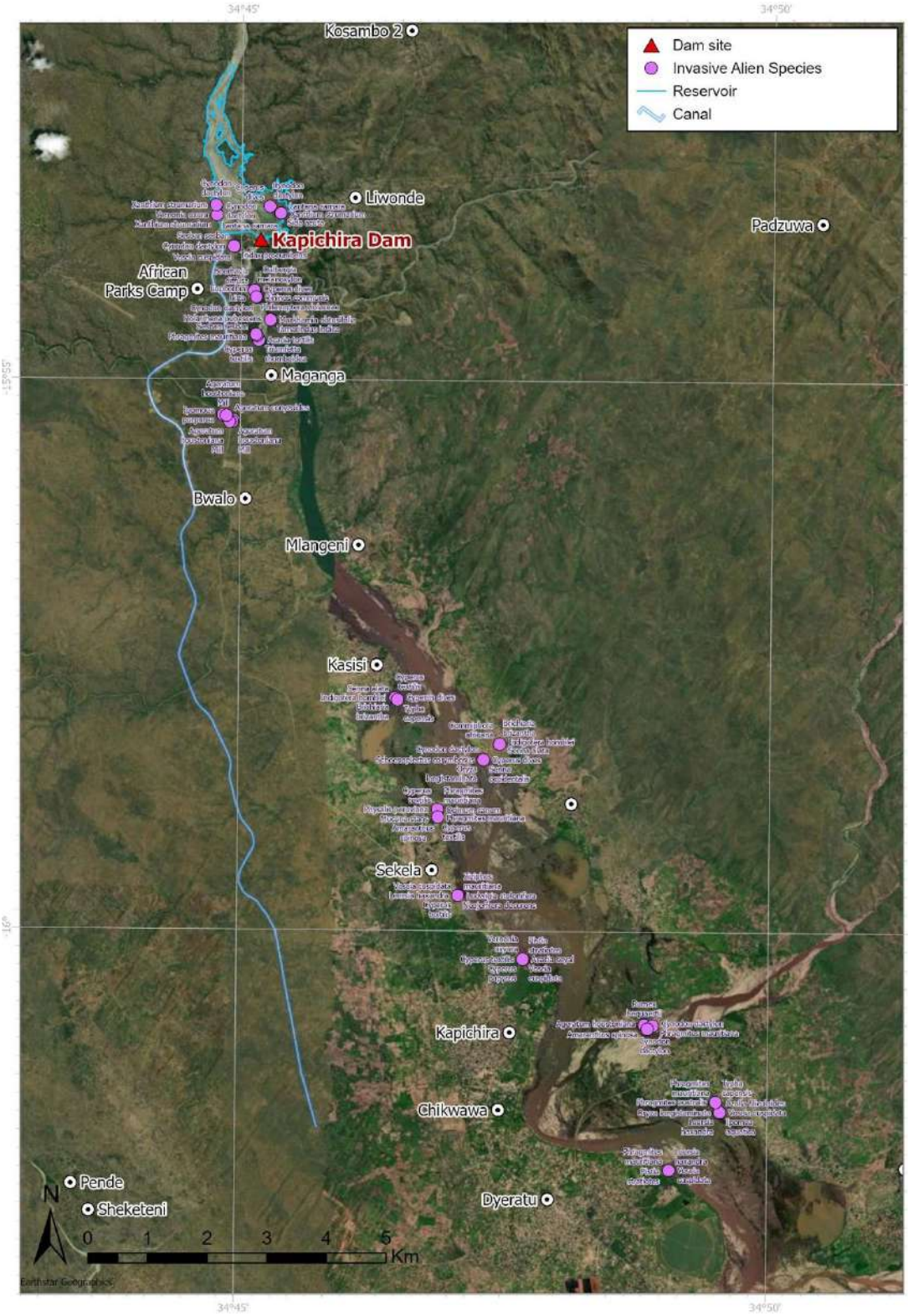


Figure 5-36: Location of invasives species recorded during the survey

The Table 5-12 provides data on invasive species encountered at various survey sites, categorizing the species into terrestrial and aquatic groups. The survey sites include areas along the Likhubula River, the Upper Floodplain, the Lower Bridge (east and west), the Western side of the river, the construction influence area, and both the eastern and western sides of the Majete Wildlife Reserve dam area. The data includes

both the number of specific invasive species found at each site, showing the prevalence of certain species in different environments.

Table 5-12: Number of invasives species recorded during the survey

Survey sites	Terrestrial species	Number	Aquatic species	Number
Downstream (Likhubula river)	*Argemone mexicana*	1	-	
	Ageratum houstoniana	1		
Upper flood plain	*Luffa cylindrica*	1	*Potederia crassipes*	**1**
	Lantana camara	3	*Eichhornia crassipes*	**1**
	Ricinus communis	1	*Azolla filiculoide*	**1**
	Ageratum houstoniana	1		
	Caelsalpinia bonduc	1		
	Datura stramonium	1		
	Calotropis procera	2		
Downstream (Lower bridge east)	*Ricinus communis*	1		
	Argemone mexicana	1		
Downstream (Lower bridge west)	*Trichodesma zeylanicum*	1		
Downstream (western side)	*Argemone mexicana*	1		
	Ageratum houstoniana	1		
	Xanthium strumarium	1		
	Heliotropium indicum	1		
	Lantana camara	1		
	Datura stramonium	1	-	
Construction site	*Lantana camara*	1		
Dam area (Eastern side)	*Xanthium strumarium*	5		
	Calotropis procera	2		
	Lantana camara	1		
	Datura stramonium	1		
	Opuntia vulgaris	1		
Dam area (Western side)	*Lantana camara*	1		
	Datura stramonium	1		
	Xanthium strumarium	1		
Camp site	*Ageratum conyzoides L.*	-		
	Ageratum houstonianum	-		
	Ipomoea purpurea	-		
	Senna occidentalis	-		
Access road to the quarry site	*Ageratum conyzoides*	-		
Disposal area	*Ricinus communis*	-	-	-
	Ageratum conyzoides	-	-	-
	Senna alata	-	-	-
	Luffa cylindrica	-	-	-
	Calotropis procera	-	-	-
Borrow site (clay site) and access road	*Opuntia stricta*	-	-	-
	Calotropis procera	-	-	-
	Xanthium strumonium	-	-	-
	Senna alata	-	-	-
	Agave sisalana	-	-	-

In this study, IAS were recorded both in terrestrial and aquatic habitats. Eighteen (18) species found were the invasive species. Out of the total invasive species found, 80% are terrestrial while 20% are aquatic species as follows:

- The aquatic species are: *Potederia crassipes* (Water hyacinth), *Pistia stratiotes*, and *Azolla filiculoides Lam*. The upper floodplain showed the highest presence of aquatic invasives, with species like *Potederia crassipes* and *Eichhornia crassipes* (water hyacinth), both known for their environmental impact. Aquatic invasive species were recorded also at some sites, although less frequently, such as the Likhubula River with *Ageratum houstoniana*.

- In terms of terrestrial species, the upper floodplain had the highest number of invasive species, with 10 species recorded including common invasive plants like *Lantana camara* (3 occurrences), *Ageratum houstoniana* (1), and *Calotropis procera* (2). Other sites with notable terrestrial invasives include the Downstream (Likhubula River) with *Argemone mexicana* and *Ageratum houstoniana* both appearing once, and the dam area (Shire East), where was found 5 times, along with other species like *Calotropis procera* and *Lantana camara.* Four (4) invasive plant species were recorded at the camp site and in the clay borrow site. Five (5) invasive plant species were recorded in the disposal area. These are *Ageratum conyzoides* L., *Ageratum houstonianum* Mill., *Ipomoea purpurea* (L.) Roth. *Senna occidentalis* (L.) Link. (Witt et al. 2024). The species however are not aggressive invaders as some are regarded as garden weeds.
- On the borrow site, and along the access road to the quarry site, the most common invasive plant was *Calotropis procera* and *Senna alata.* The observed high number of invasive alien species at the clay site, access to clay site as well as the disposal site may require proper management prescriptions to avoid spread and contamination of the invasive species to nearby unaffected surroundings.

  No invasive species were recorded at the quarry site.

In conclusion, the data reveals that invasive terrestrial species are more widespread than aquatic invasive species. The presence of aquatic invasives, while low during the field survey, is still notable in the project area. The aquatic species of greatest concern are those that may affect power generation such as *Potederia crassipes*.

5.3.3.3. AQUATIC FAUNA BASELINE

This chapter includes two sub-sections: one is relative to the fish survey, and one is relative to the macro invertebrates.

The aquatic ecology of the Shire River is highly fragmented due to the construction of several dams, including the Kapichira Dam. This has led to significant disruption to migratory species in the catchment area.

Fish survey

The Middle Shire River is characterized by relatively low fish diversity, which is primarily attributed to its geological history and the presence of natural barriers such as the Kapichira Falls. The species found are largely shared with the lakes Malawi and Malombe, including their tributaries. Only a few rheophilic species, such as *Labeo cylindricus* and *Labeobarbus johnstonii*, have adapted to the rapids between Matope and Kapichira Falls (Mpatamanga HPP ESIA, 2024).

Aquatic biodiversity surveys (see Table 5-13: Results of aquatic fauna field survey) were conducted in the dam reservoir and in the Shire River in August 2024, as well as in the Mwembezi River near the proposed campsite and in the Mimvunza River near the quarry site in April 2025. The list of species recorded during the surveys is reported in the Appendix F.

20 fish species from eight families (*Alestidae, Cichlidae, Clariidae, Cyprinidae, Distichodontidae, Mochokidae, Mormyridae*, and *Schilibeidae*) were recorded in the Shire River. The most abundant species were *Enteromius paludinosus* (28%) and *Labeo cylindricus* (26%), followed by *Oreochromis mossambicus* (9%) and *Oreochromis shiranus* (8%). Notably, the predatory tiger fish (*Hydrocynus vittatus*), known for its seasonal migration, was not recorded during the surveys, though local sources indicated its presence during the warm season from October to December.

Table 5-13: Results of aquatic fauna field survey

Location		Family	Genus	Scientific name	Local name	Number of species
Shire River	Upstream of the dam	Cichlidae	Astatotilapia	*Astatotilapia calliptera*	Kambuzi	3
			Oreochromis	*Oreochromis shiranus*	Makumba	9
			Otopharynx	*Otopharynx tetrastigma*	Kambuzi	2
		Clariidae	Clarias	*Clarias gariepinus*	Mlamba	1
		Cyprinidae	Labeobarbus	*Labeo congoro*	Nzizi	1
				Labeo cylindricus	Gundamwala/Nkhongolo	49
				Labeobarbus eurystomus	Gale	30
				Labeobarbus johnstonii	Gale	9
				Labeo altivelis	Manyame	1
Shire River	Dam area	Cichlidae	Oreochromis	*Oreochromis karongae*	Chambo	2
				Oreochromis mossambicus	Makakana	9
				Oreochromis shiranus	Makumba	16
		Clariidae	Clarias	*Clarias gariepinus*	Mlamba	1
		Cyprinidae	Labeobarbus	*Labeobarbus johnstonii*	Gale	7
Shire River	Direct downstream the dam	Alestidae	Brycinus	*Brachyalestes imberi*	Bwezele	18
		Cichlidae	Astatotilapia	*Astatotilapia calliptera*	Kambuzi	4
			Oreochromis	*Oreochromis mossambicus*	Makakana	4
				Oreochromis shiranus	Kambuzi	1
			Otopharynx	*Otopharynx tetrastigma*	Kambuzi	1
			Enteromius	*Enteromius paludinosus*	Matemba	33
		Cyprinidae	Labeobarbus	*Labeo congoro*	Nzizi	8
				Labeo cylindricus	Gundamwala/Nkhongolo	17
			Opsaridium	*Opsaridium tweddleorum*	Sanjika/Njole	8
		Distichodontidae	Distichodus	*Distichodus schenga*	Tchenga	1
		Mochokidae	Synodontis	*Synodontis zambezensis*	Nkholokolo	6
		Mormyridae	Marcusenius	*Marcusenius macrolepidotus*	Mphuta	20
			Mormyrus	*Mormyrus longirostris*	Nkholo	1
		Schilbeidae	Schilbe	*Schilbe intermedius*	Dande	6
Shire River	Chikwawa floodplain	Cichlidae Clariidae	Astatotilapia	*Astatotilapia calliptera*	Kambuzi	17
			Oreochromis	*Oreochromis mossambicus*	Makakana	24
			Clarias	*Clarias gariepinus*	Mlamba	1
		Cyprinidae	Enteromius	*Enteromius paludinosus*	Matemba	87
		Mochokidae Mormyridae Schilbeidae	Labeobarbus Synodontis Marcusenius Schilbe	*Enteromius radiatus*	Matemba	8
				Labeo cylindricus	Gundamwala/Nkhongolo	1
				Synodontis zambezensis	Nkholokolo	1
				Marcusenius macrolepidotus	Mphuta	1
				Schilbe intermedius	Dande	3
Mimvunza river	Quarry site, in the tributary of the Shire River, downstream of the dam	Alestidae	Brycinus	Brachyalestes imberi	Bwezele	206
		Cichlidae	Astatotilapia	Astatotilapia calliptera	Gong'o/Kambuzi	2
			Oreochromis	Oreochromis mossambicus	Makakana	5
		Clariidae	Clarias	Clarias gariepinus	Mlamba	2
		Cyprinidae	Enteromius	Enteromius atkinsoni	Kudwanga/Matemba	3
				Enteromius lineomaculatus	Kudwanga/Matemba	4
				Enteromius paludinosus	Kudwanga/Matemba	265

Location		Family	Genus	Scientific name	Local name	Number of species
				Enteromius trimaculatus	Kudwanga/Matemba	1
			Labeobarbus	Labeo altivelis	Njole	40
				Labeo cylindricus	Nkhongolo	1
		Malapteruridae	Malapterurus	Malapterurus electricus	Nyesi	2
		Mochokidae	Chiloglanis	Chiloglanis neumanni	Figo	5
			Synondontis	Synodontis zambezensis	Nkholokolo	1
		Mormyridae	Marcusenius	Marcusenius macrolepidotus	Mphuta	3
		Mormyrus	Mormyrus longirostris	Nkhoti/Samwamowa		1
		Schilbeidae	Schilbe	Schilbe intermedius	Dande	1
Mwembe	Temporary camp site, in the tributary of the Shire River, downstream of the dam	Alestidae	Brycinus	Brachyalestes imberi	Bwezele	200
		Cyprinidae	Enteromius	Enteromius paludinosus	Kudwanga/Matemba	11
			Labeobarbus	Labeo altivelis	Njole	1

The following analysis of the survey has been divided in three area, upstream and downstream of Kapichira falls and the tributaries of the Shire River.

- Upstream of Kapichira falls:

The surveys upstream of the dam registered 3 families with 9 fish species while the dam area also registered 3 families and 5 fish species.

Based on the IUCN red list, 2 threatened species were encountered in the Majete Reserve along the Shire River: *Oreochromis karongae* as critically endangered species (CR) and *Oreochromis mossambicus* (locally named *Makakana*) as vulnerable species (VU).

Oreochromis karongae is also a nationally protected and restricted-range species under World Bank Environmental and Social Standard 6 (ESS6)[14].

Six migratory species were recorded upstream the dam and the dam reservoir (see the following table).

Table 5-14: Migratory fishes species upstream of the dam

Local name	Scientific name	IUCN category
Makakana	*Oreochromis mossambicus*	Vulnerable VU
-	*Labeo cylindricus*	Least concern (LC)
Nzizi	*Labeobarbus congoro*	Least concern (LC)
Manyame	*Labeobarbus altiveris*	Least concern (LC)
Kambuzi	*Labeobarbus eurystomus*	Least concern (LC)
Gale	*Labeobarbus johnstonii*	Least concern (LC)

- Downstream of Kapichira falls:

No fish species were caught in the dead branch of the river, immediately downstream of Kapichira Falls.

[14] Restricted-range species are defined according to the guidance note 74 (GN 74) as a species with an extent of occurrence (EOO)1 of less than 50,000 km².

The highest species richness was recorded downstream of the dam, where fourteen (14) species from seven families were sampled, particularly in deep pools between the dam area and the Kapichira bridge. In contrast, the Chikwawa floodplain yielded nine (9) species from six families.

Downstream in the Lower Shire River, fish populations are more diverse, with over 60 species reportedly caught as part of the SVTP ESIA survey, although fishing activities are primarily dominated by three species: the African catfish (*Clarias gariepinus* and *Clarias ngamensis*, often grouped as a single species) and *Oreochromis mossambicus* (Shire River Transformation Program – Irrigation Project ESIA Report).

These three species account for 90% of the total fish catch, with *Oreochromis mossambicus* alone making up 51%. Despite its invasive status globally, *Oreochromis mossambicus* is native to the Lower Shire and Lower Zambezi River.

- Mwembezi and Mimvunza Rivers:

The temporary campsite is located alongside the Mwembezi River. The quarry site is located alongside the Mimvunza River, both tributaries of the Shire River, downstream of Kapichira falls.

542 fish specimens from 16 species, 8 families, and 12 genera were identified in total in these rivers. The majority belonged to the Cyprinidae (59.7%) and Alestidae (38%) families. Other families like Cichlidae, Mochokidae, and others contributed less than 2% in total.

Mimvunza River had greater fish diversity (13 species) than Mwembezi River (3 species). Most fish in Mimvunza were found downstream of a quarry site. Limited habitat features (deep pools, water levels) explain the lower diversity in Mwembezi River.

Most species are classified as Least Concern (LC), not endemic or protected. One species, *Oreochromis mossambicus*, is Vulnerable (VU), and *Chiloglanis neumanni* is Data Deficient (DD) according to the IUCN Red List. Furthermore, 81% of the species are migratory (13 species) and 40% inhabit localized environments.

- Ecological importance of key species and local consumption

The chambo (*Oreochromis karongae*), a critically endangered (CR) species, derives its importance from its role as a benthic regulator and its priority conservation status, which is essential for preserving the genetic diversity of cichlids (Turner, 2005). Alongside it, the *Oreochromis mossambicus* (Makakana) ensures trophic stability in fluctuating environments due to its high environmental tolerance (Skelton, 2001). Both species are pillars of local livelihoods, highly prized in markets for their nutritional quality and high market value.

The community structure is dominated by *Labeo cylindricus* (Agale) and *Labeo congoro* (Gundawala). Ecologically, these species facilitate energy transfer from primary producers (algae on substrates) to apex predators (Marshall, 2011). For Kapichira residents, their high abundance (exceeding 25% of catches) makes them the primary source of daily protein and cash income, particularly for the most vulnerable fishers using artisanal gear.

Biological integrity depends on the Tiger fish (*Hydrocynus vittatus*). As a native migratory apex predator, it prevents the overpopulation of opportunistic species like *Enteromius paludinosus*, thereby maintaining high species diversity (Winemiller & Kelso-Winemiller, 1994). Its social importance is twofold: it is consumed locally during seasonal migrations and serves as a major asset for ecotourism in the Majete Reserve. Finally, the Milamba (*Clarias gariepinus*) acts as a food "safety net." Its ability to survive

in low-oxygen waters ensures its availability during droughts, providing constant food resilience to local populations (Weyl, 1999).

Macro invertebrates and Ecological status

Assessing macroinvertebrate communities is essential for monitoring and managing project-related impacts, as these organisms serve as reliable bioindicators of long-term water quality and overall environmental health within the Shire River ecosystem.

A total of 13 aquatic and semi-aquatic invertebrate orders, 25 families, and 76 species were recorded during the aquatic survey in August 2024. Most of these taxa were classified as Least Concern or had not been assessed by the IUCN. However, *Hirudo medicinalis* (leech), reported by fishermen and villagers, is listed as Near Threatened on the IUCN Red List (Version 2024-1). Aquatic Coleoptera recorded in the Majete Wildlife Reserve Shire River included *Dineutes aereus* and *Aulonogyrus* sp.

Based on the inventory for the Mpatamanga HPP ESIA, snail populations were particularly abundant in the reservoir and downstream of the Kapichira Hydropower Project, with *Melanoides tuberculata* (a grazing snail) and *Corbicula fluminea sensu lato* (a bivalve) being the most dominant species (Mpatamanga HPP ESIA Report, 2024).

A Zambian Invertebrate Scoring System (ZISS1) was calculated during aquatic macroinvertebrate surveys in September 2023 (Mpatamanga HPP ESIA Report, 2024). The results revealed significant habitat degradation, particularly in the Majete Wildlife Reserve, Kapichira Reservoir, and downstream of the dam. The surveys used to assess biodiversity and habitat quality across different substrates, including cobbles, sands, and vegetation, with additional data collected via UV light traps.

Results indicate that the Majete Wildlife Reserve section of the Shire River is in a severely modified state (category E), with low species diversity due to poor habitat quality and mobile sands that hinder macroinvertebrate colonization. Only six taxa were recorded at one sample site in the Majete Wildlife Reserve, with a low ZISS1 score of 32, while another site in the Majete Wildlife Reserve had nine taxa and a slightly higher score of 60.

In the Kapichira Reservoir, high sedimentation levels prevented a formal ZISS1 evaluation. Only seven (7) taxa were recorded, predominantly Leptocerid caddisflies. Downstream of the dam at Ng'ona Lodge, suitable instream habitats were scarce, but light trap and woody debris sampling revealed eleven (11) taxa. Although oxygen availability was sufficient, ecological conditions remained unstable due to daily water level fluctuations, which disrupted habitat stability and favoured short-lived species.

5.3.3.4. AVIFAUNA BASELINE

A total 137 birds' species were encountered during the 2024 field survey. It was further noted that all the bird species recoded were of Least Concern (LC, IUCN red list) including 59 species within the areas of temporary facilities. The list of species recorded during the surveys is in Appendix J.

Ten (10) migratory species were encountered throughout the project area: African Open Bill - *Anastomus lamelligerus*, African Skimmer - *Rynchops flavirostris*, Black Heron - *Egretta ardesiaca*, Black-winged Stilt - *Himantopus Himantopus*, Common Squacco Heron - *Ardeola ralloides*, Grossy Ibis - *Plegadis falcinellus*, Openbill Stork-A*nastomus lamelligerus,* Whiskered Terns - *Chlidonias hybrida*, White-faced Tree Duck - *Dendrocygna viduata*, White-winged Black Tern - *Chlidonias leucopterus*. These species were found downstream of the dam between the EGENCO bridge and Elephant Marsh, except for the African skimmer, which was found in the Majete Wildlife Reserve.

- **Suitable habitats for species**

The Shire River includes as well natural habitats along its banks. Riverine ecosystems, characterized by dense vegetation, sandy banks and occasional rocky outcrops, serve as important habitats for resident and migratory birds. They use the Shire River corridor, to find refuge and feed opportunities during their seasonal movements.

The Shire Valley is an important wintering area for several Palearctic migrants, including the Steppe Eagle (*Aquila nipalensis*, EN) and Basra Reed Warbler (*Acrocephalus griseldis*, EN), as well as various raptors, rollers, bee-eaters, and passerines.

In contrast, areas more impacted by human activities (e.g. Chikwawa floodplain or clay site) show a loss of diversity and habitat fragmentation, limiting their ecological role and capacity to support sensitive species.

Indeed, the Majete Wildlife Reserve and the habitats in its vicinity encounter a higher abundance of species than the downstream influence area, especially for the Chikwawa floodplain impacted by human activities. These rich areas have a greater number of successful species and have more stable ecosystems due to the availability of ecological niches. The simplification of the landscape reduces ecological niches and food resources, limiting the capacity of these areas to support a wide range of species. However, a higher species diversity was inventoried in the quarry site and access road areas due to the well-conserved dry deciduous forest habitat.

The survey of the clay – borrow – site, disposal areas, and riparian zones around the dam recorded a variety of bird species making active use of local habitats. Ground-nesting species such as the Common Buttonquail (*Turnix sylvaticus*) and Bronze Manikin (*Spermestes cucullata*) were found in grass and shrub cover. Dominant species in the temporary facilities habitat including the Blue Cordon-bleu (*Uraeginthus angolensis*) and Yellow-fronted Canary (*Serinus mosambicus*) were observed feeding and breeding in open habitats. Riparian and wetland zones supported water-dependent species such as the African Openbill (*Anastomus lamelligerus*), Cattle Egret (*Bubulcus ibis*), and Grey Heron (*Ardea cinerea*). Sensitive raptors and nocturnal birds, including the Verreaux's Eagle Owl (*Bubo lacteus*) and long-crested Eagle (*Lophaetus accipitalis*), were also recorded, illustrating the diverse ways in which species utilize these habitats.



Figure 5-37: Bee-eater nests an the right bank of the Shire River

- **Focus on the Majete Wildlife Reserve**

The Majete Wildlife Reserve is home to many species of conservation concern, supported by a wide variety of natural habitats that provide suitable conditions for their life cycle. In fact, the reserve consists of well-preserved woodlands, riparian zones and thickets. Indeed, the widespread destruction of thicket habitats outside the reserve makes the remaining habitats critical for the survival of several rare thicket and forest birds endemic to southeastern Africa, such as the Gorgeous Bush Shrike (*Chlorophoneus viridis*), Rudd's Apalis (*Apalis ruddi*), and Grey Sunbird (*Cyanomitra veroxii*).

Moreover, threatened species not inventoried but known to be present in the Majete Wildlife Reserve are also identify: White-headed Vulture – *Trigonoceps occipitalis* (CR), White-backed Vulture – *Gyps africanus* (CR), Hooded Vulture – *Necrosyrtes monachus* (CR), Basra Reed Warble - *Acrocephalus griseldis* (EN), Lappet-faced Vulture - *Torgos tracheliotos* (EN), Secretary bird - *Sagittarius serpentarius* (EN), Steppe Eagle - *Aquila nipalensis* (EN), Madagascar Pond Heron – *Ardeola idea* (EN), Grey Crowned Crane – Balearica regulorum (EN), Bateleur – *Terathopius ecaudatus* (EN), Martial Eagle – *Polemaetus bellicosus* (EN).

Thus, the study results confirm the critical role of protected areas, especially Majete Wildlife Reserve, in conserving threatened and migratory birds.

5.3.3.5. TERRESTRIAL FAUNA BASELINE

This chapter presents the results of the fauna survey, presented in three sub-sections: Terrestrial invertebrates, mammals and herpetofauna.

Terrestrial Invertebrates

A total of twelve (12) terrestrial invertebrates orders, forty-nine (49) families and 157 species were recorded during the survey. The list of species recorded during the survey is in Appendix F.

The investigations showed a high level of diversity along the access road to the quarry site, with more than 82 species and a total abundance of 332 individuals recorded. The findings indicate that both biodiversity and ecosystem stability are particularly strong in this area.

The invertebrates sampled during this survey do not appear to be classified as threatened at national and international levels. Nevertheless, these invertebrates contribute to the balance of the ecosystem activities and are of nutritional and economic importance to local communities, hence the need to consider them as important in the future.

Hirudo medicinalis (Leech) which was not recorded during the survey but was mentioned by fishermen and villagers as being seen after being bitten by it when fishing is a near threatened species recoded under IUCN red data list.

Mammals

The mammal diversity during the Mpatamanga Hydropower Project ESIA has been extensively studied. Indeed, mammal inventories in and around Majete Wildlife Reserve are relatively well-documented, supported by long-term species monitoring and updated checklists from African Parks (2023). All species listed by African Parks are assumed to be present within the reserve. Notably, Majete Wildlife Reserve hosts iconic species

such as African elephant, lion, leopard, buffalo, giraffe, cheetah, and black rhino, many of which were reintroduced after local extinction.

The 2024 survey have identified a total of 61 species (see the Appendix I), including large herbivores, carnivores, and small mammals, many of which are classified as species of conservation concern as follows.

- **Within the Majete Wildlife Reserve**

Along the banks of the Shire River (including the reservoir), the most recorded species include large herbivores such as Eland (*Taurotragus oryx*), Impala (*Aepyceros melampus*), Nyala (*Tragelaphus angasii*), Waterbuck (*Kobus ellipsiprymnus*), Common wildebeest (*Connochaetes taurinus*) African buffalo (*Syncerus caffer*), African elephant (*Loxodonta africana*) and Hippopotamus (*Hippopotamus amphibius*). Large carnivores such as lion (*Panthera leo*) and leopard (*Panthera pardus*) are also present but were identified with indirect sightings (carcasses of herbivores and footprints).

- **Outside the Majete Wildlife Reserve**

Some indirect and direct sightings of species present in the Majete Wildlife Reserve have been recorded in the direct footprint area: footprint of Hippos; scatts of Bushbuck (*Tragelaphus scriptus*), Common warthog (*Phacocoerus aethiopicus*), Plains zebra (*Equas quagga*), Honeybadger (*Mellivora capensis*), Nyala (*Tragelaphus angasii*), Waterbuck (*Kobus ellipsiprymnus*), African wild cat (*Felis silvestris lybica*), Impala (*Aepyceros melampus*), Porcupine (*Hystrix africaeaustralis*) and Serval (*Laptailurus serval*); sight of Chacma baboon (*Papio hamadryas ursinus*). Indirect sightings of the Temminck's Pangolin (*Smutsia temminckii*) was inventoried along the Shire River on the left bank downstream of the dam.

Two small rodent species were trapped and released: the pouched mouse (*Saccostomus campestris*), recorded in multiple locations including in the direct footprint area, and the multimammate mouse (*Mastomys natalensis*), found along the downstream Shire Riverbank. Both species are classified as Least Concern (LC) by the IUCN.

In the direct footprint area, nine (9) species were documented along the access road to the dam, including the chacma baboon as the most frequent species.

In the downstream influence area, twenty-one (21) mammal species were recorded on the left bank of the Shire River, with chacma baboon and Bushveld gerbil (*Tatera leucogaster*) as the most frequent species. Eight (8) mammal species were recorded on the right bank of the Shire Rive, with the vervet monkey (*Cercopithecus aethiops*) as the most frequent species.

In the Chikwawa floodplain and the upper part of Elephant Marsh, twenty (20) mammal species were identified, with no threatened or near-threatened species.

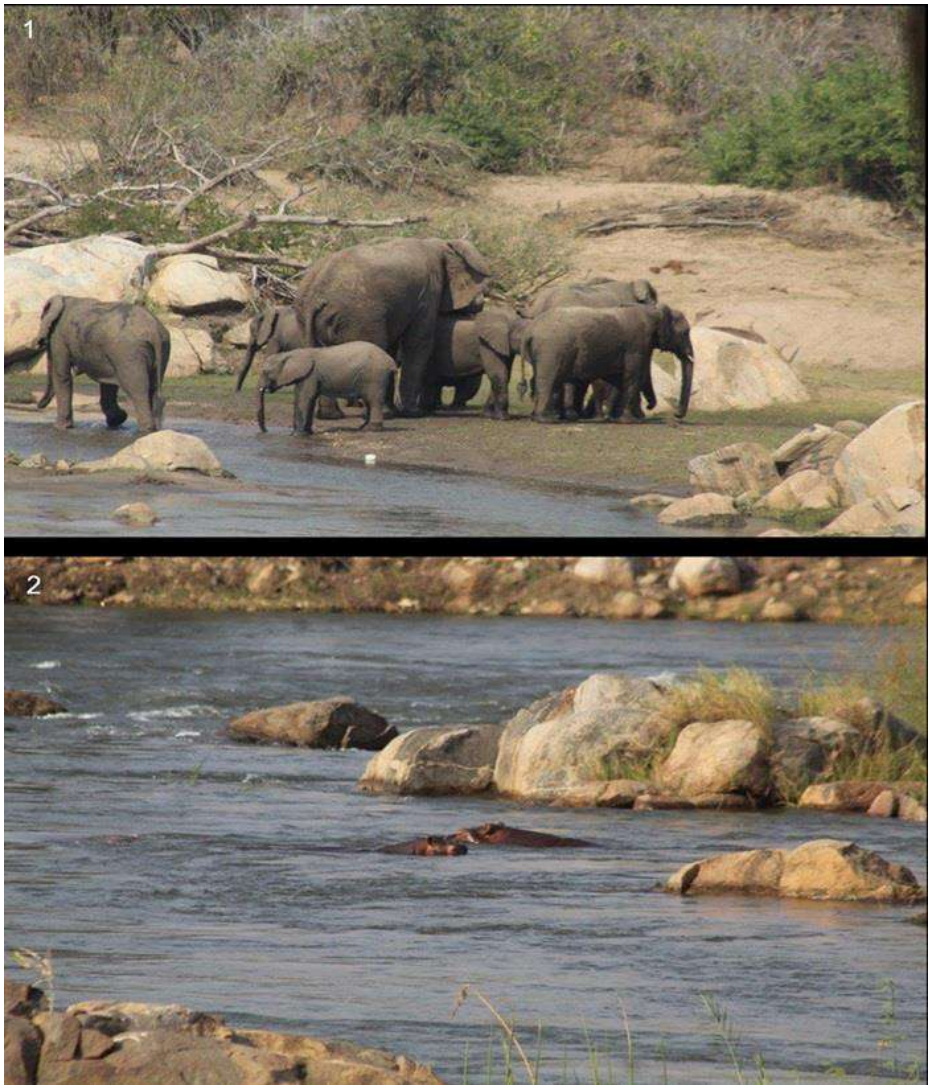


Figure 5-38: 1- Group of Elephant (*Loxondata Africana*) and 2- Group of Waterbuck (*Kobus ellipsiprymnus*) recorded on the banks of Kapichira reservoir

Regarding conservation status, five (5) threatened species were documented in Majete Wildlife Reserve along the Shire River, in line with IUCN Red List classifications and 2023 African Parks assessments as follows.

Table 5-15: Threatened and near-threatened mammals in the project area

Common Name	Scientific name	IUCN category	Identified during the 2024 survey	Present in the Majete Wildlife Reserve (Source: African Parks, 2023)
Black rhinoceros	*Diceros bicornis*	Critically Endangered CR	-	X
African Elephant	*Loxodonta africana*	Endangered EN	X	X
African Wild dog	*Lycaon pictus*	Endangered EN	-	X
Giraffe	*Giraffe camelopardalis*	Vulnerable VU	X	X
Hippopotamus	*Hippopotamus amphibius*	Vulnerable VU	X	X
Leopard	*Panthera pardus*	Vulnerable VU	X	X
Lion	*Panthera leo*	Vulnerable VU	X	X
Schreibers' long-fingered bat	*Miniopetrus shreibersii*	Vulnerable VU	-	X (very likely to be present)
Cheetah	*Acinonyx jubatus*	Vulnerable VU	-	X
Buffalo	*Cyncerus caffer*	Near-threatened NT	X	X
Plain zebra	*Equus quagga*	Near-threatened NT	X	X

Focus on bats

The well documented baseline of Mpatamanga reveals the presence of three Near Threatened species—African straw-colored fruit bat (*Eidolon helvum*), striped leaf-nosed bat (*Macronycteris vittatus*), and large-eared free-tailed bat (*Otomops martiensseni*)—which prefer intact woodland habitats, particularly within Majete Wildlife Reserve or near the regulating reservoir. Additionally, Melck's pipistrelle bat (*Neoromicia melckorum*), classified as Data Deficient, may be present but remains unconfirmed. Five migratory bat species have been noted in the Elephant Marsh area, though none qualify for critical habitat designation (Mpatamanga HPP ESIA Report, 2024). A bat species inventory was carried out in September 2025 in the construction influence area with no threatened species identified (see Appendix H).

During the additional surveys of September 2025, four species of bat were trapped in the nests: Whalberg's Epauletted Fruit-bat (*Epomophorous wahlbergi*), Little Epauletted Fruit-bat (*Epomophorous labiatus*), Egyptian free-tailed bat (*Tardarida aegyptiaca*) and Bushveld Horseshoe bat (*Rhinolophus simulator*). All the species are classified as Least Concern. They were inventoried in secondary forest habitats in the construction influence area of the access road to the quarry site, the clay site and the disposal area.

Herpetofauna

During the 2024 survey, a total of 4 herpetofauna orders, 19 families and 36 herpetofauna species (26 reptiles and 10 amphibians) were identified within the Kapichira Project area. One (1) species is near-threatened species: the African Python – *Python sebae*, which was identified in the Majete Wildlife Reserve, along the left bank of the Shire River and in the disposal area in the construction influence area. The other species are of least concern in terms of IUCN status.

Regarding the temporary facilities surveys, a higher diversity was recorded along the access road to the quarry site and disposal area (respectively eleven and thirteen species). This reflects relatively stable ecosystems, a wide range of ecological niches, and an overall favourable environment for biodiversity.

According to the literature review, large Nile crocodiles (>3 m) remain common in the Shire River and Elephant Marsh. Historical records suggest that the Zambezi flapshell turtle and the floodplain viper may now be regionally extinct in the Elephant Marsh area (Shire River Transformation Program – Irrigation Project ESIA Report). The amphibian populations appear relatively stable while the reptile populations show notable declines.

5.3.4. Main biodiversity challenges by area

5.3.4.1. INTRODUCTION

Due to the specificity of biodiversity challenges for this project, this chapter focuses on the main findings by area, such as the Shire River, the direct footprint area, the construction influence area and the downstream influence area.

5.3.4.2. THE SHIRE RIVER

This section presents the issues along the Shire River passing through the project area.

The presence of species of conservation concern was confirmed in the project area of influence during the surveys and in the literature review, including *Oreochromis mossambicus* and *Opsaridium microlepis*, (both classified as Vulnerable by the IUCN). These species are particularly sensitive to hydrological changes and anthropogenic pressures. *Oreochromis karongae* (classified Critically Endangered by the IUCN) identified in the dam reservoir but no viable populations are present due to the ecological state of the Middle Shire River.

Indeed, the studies performed for the Mpatamanga ESIA have revealed a progressive degradation of aquatic habitats. The observed siltation, particularly in the Kapichira Reservoir, is leading to a reduction in habitat diversity and negatively impacting benthic species. Water level fluctuations, exacerbated by dam operations, disrupt the biological cycles of fish and alter local ecological conditions. Downstream, in the Elephant Marsh, the proliferation of water hyacinth (*Eichhornia crassipes*) poses an additional threat, reshaping ecosystem structures and hindering fishing activities.

Finally, the analysis of aquatic macroinvertebrates, used as indicators of environmental quality, has highlighted significant degradation in several areas. In the Majete Wildlife Reserve, the ecological conditions are severely degraded due to low habitat diversity and siltation. The Kapichira Reservoir exhibits unfavourable conditions for biodiversity, with marked stagnation and high sedimentation. Downstream of the dam, hydrological instability directly affects the structure of aquatic communities, favouring species more tolerant to disturbances.

Surveys and consultations have highlighted a major concern regarding variations in water flow, which directly influence local biodiversity. Changes in downstream water flow can cause significant hydrological disturbances, exacerbating periodic wetland drying and altering sediment transport.

5.3.4.3. DIRECT FOOTPRINT AREA

The Kapichira dam is located within the Majete Wildlife Reserve, a protected area home to remarkable biodiversity, including numerous threatened species. The proximity of the reservoir is a major concern for species that rely on it as a source of water and food. The Majete Wildlife Reserve is protected by fences with the direct footprint area. However, the wildlife are very close to the direct footprint area including Elephant (*Loxondata Africana*), several species of aquatics birds, Warthog (*Phacohoerus aethiopicus*), Impala (*Aepyceros melampus*), African buffalo (*Syncerus caffer*), Waterbuck (*Kobus ellpsiprymnus*), Nile crocodile (*Crocodylus niloticus*), Hippopotamus (*Hippopotamus amphibius*), etc...

The presence of some species in the direct footprint area have been recorded: several intrusions during the SVTP works activities and indirect sightings during the surveys, increase the risk of impacts on these species during the construction activities.



Figure 5-39: Animals close to the Kapichira reservoir in each bank: 1- family of Elephants; 2- Impalas, Warthogs and Elephants; 3- Droppings of herbivores near the fences of the Majete Wildlife Reserve

The Majete Wildlife Reserve serves as a key habitat for several threatened species listed on the IUCN Red List, including the Black Rhino (*Diceros bicornis*), African elephant (*Loxodonta africana*), the African wild dog (*Lycaon pictus)* the lion (*Panthera leo*), *etc.* Their survival is closely linked to the integrity of local ecosystems.

The area also hosts a wide variety of bird species, including migratory species and raptors that are particularly sensitive to human disturbances. Notable species of concern include White-headed vulture (*Trigonoceps occipitalis*, CR), White-backed vulture

(*Gyps africanus*, CR), Basra reed warbler (*Acrocephalus griseldis*, EN), Steppe eagle (*Aquila nipalensis*, EN), Secretarybird (*Sagittarius serpentarius*, EN), Malagasy pond-heron (*Ardeola idea*, EN).

These species heavily depend on available natural habitats, which could be threatened by human activities related to dam rehabilitation.

The Majete Wildlife Reserve encompasses various natural habitats, including mixed deciduous forests and dry miombo savannas, dominated by *Acacia nigrescens*, *Ziziphus mucronata*, *Colophospermum mopane*, and *Acacia nilotica*, as well as thickets, riparian forests and wetlands. A near-threatened species, *Dalbergia melanoxylon* (NT), has been recorded in multiple areas, including within the construction site area.

5.3.4.4. CONSTRUCTION INFLUENCE AREA

Three species on the national IUCN Red List were recorded at the quarry site: *Lannea schwenifurthii., Dalbegia melanoxylon* and *Pterocarpus angolensis*. These trees are highly exploited for timber, wood curving and charcoal. Moreover, mature trees were observed along the river, and their clearance is the main issue of the site.

Although the vegetation on the future temporary camp site has been shaped by farming activities, some open deciduous forests interspersed with dry savannah woodland thickets are present.

Field inventories conducted along the access road to the quarry site have revealed the presence of well-conserved habitats located outside nationally protected areas. These habitats remain largely intact and have not yet been degraded by human activities, thereby representing a significant conservation concern. In addition, the surveys documented a high level of species richness, indicating that the ecosystems are more stable and that a greater diversity of ecological niches is available.

No conservation concern species regarding the IUCN Red list were surveyed in the quarry site, borrow site and in the temporary camp site. However, several tree species recorded on site, such as *Albizia harveyi* and *Adansonia digitata*, provide valuable ecosystem services and resources for local communities.

5.3.4.5. DOWNSTREAM INFLUENCE AREA

The Majete Wildlife Reserve and Habitats in its vicinity encountered a higher abundance of species and number of families than the downstream influence area, especially for the Chikwawa floodplain.

This instability is largely driven by a combination of anthropogenic activities and environmental pressures, including deforestation, the widespread conversion of natural habitats into agricultural land, and the intensive cultivation of crops such as sugarcane and rice. These activities significantly alter the landscape and reduce the availability of ecological niches for various species. The conversion of diverse floodplain habitats into monocultures simplifies the ecosystem, reducing the variety of microhabitats and food resources available for species.

Nevertheless, the project's area of influence extends downstream of the dam to the Ramsar site of Elephant Marsh, a wetland of international importance. Elephant Marsh supports numerous species that depend on floodplains and marshes for their life cycle, including migratory species (such as the Martial Eagle, classified as endangered on the IUCN Red List).

Despite significant habitat conversion downstream of Majete Wildlife Reserve, many natural habitats, particularly the Shire River riparian thickets, play a crucial ecological role by providing a transition between terrestrial and aquatic environments.

5.3.4.6. CONCLUSION

The ecological challenges of the Kapichira dam rehabilitation project are significant and can be seen at two levels:

- Within the direct footprint area (near the Majete Wildlife Reserve):
  - The proximity of threatened species and natural habitats is a top priority.
  - The significant aquatic habitat degradation in Kapichira reservoir is due to riverbank erosion, sediment accumulation, and fluctuating water levels.
- The construction influence area hosts natural habitats and rich biodiversity outside the reserve, representing a conservation concern.
- Within the area of influence (Lower Shire River – Elephant Marsh), issues related to water flow, sedimentation, and hydrological fluctuations require particular attention to minimize impacts on downstream ecosystems.

5.3.5. Critical habitat assessment

5.3.5.1. INTRODUCTION

This chapter presents a summary of the critical habitat assessment in the Appendix I as part of the Kapichira dam rehabilitation project ESIA. The presence of species of conservation concern, which may trigger the designation of critical habitat under established criteria, required this assessment.

5.3.5.2. CONTEXT OF THE CRITICAL HABITAT ASSESSMENT

As this project is a rehabilitation of the existing Kapichira HPP, siting is inherently constrained by the current facility location. However, avoidance was prioritized by locating construction camp, quarry, borrow site and spoil sites within previously modified habitats to avoid direct impacts on the Majete Wildlife Reserve's Critical Habitat. The minimization of impacts related in particular to siltation, noise and air pollution is incorporated into the ESMP (integrated in a Construction Biodiversity Management Plan and the Biodiversity Management Plan) and summarized in sections 6.3.4.8. and 6.4.4.7 (strict seasonal work windows and noise / light abatement, restoration activities, siltation management) of this document.

Regarding residual risks, the project acknowledges that minor impacts may persist on the hydrology of the Elephant Marsh and the tranquility of Majete's wildlife despite mitigation measures. To meet the requirements for ecological equivalence and Biodiversity Net Gain mandated by PS6, the project incorporates targeted conservation measures for key species both downstream in the Elephant Marsh and within the Majete Wildlife Reserve. These measures are formalized through specific net gain program (included measures related to Species Conservation Actions).

The main objective of this net gain program is to achieve a measurable biodiversity "Net Gain" by leveraging existing frameworks (Mpatamanga, SVTP) to protect conservation key species and restore already degraded riverine ecosystems.

The Majete Wildlife Reserve measures, implemented by African Parks, prioritize ecological restoration and the compensation of legacy impacts:

- Habitat restoration: stabilization of the Shire Riverbanks using removal of invasive species, and reforestation to restore aquatic and riparian biodiversity.
- Species-Specific Actions: GPS tagging and monitoring of vultures (White-headed and White-backed) to map corridors, and financial/technical support for African Wild Dog monitoring.
- Community Engagement: awareness programs to reduce human-wildlife conflict and prevent accidental vulture poisoning.

Simultaneously, the Elephant Marsh component targets wetland-dependent species, such as the Zambezi Flap shell Turtle and various migratory birds, that trigger Critical Habitat status:

- Mainstreaming monitoring: integrating specific critical habitat indicators into the existing Community Conservation Wetland Area (CCA) management plans.
- Capacity Building: strengthening local data collection on population status and breeding activity without duplicating existing institutional efforts.

The implementation and monitoring of these commitments are ensured through rigorous control protocols integrated into an Environmental and Social monitoring plan. These management tools include real-time monitoring of air and water quality, of erosion and stability of riverbanks of sediment transport, aquatic ecology and ichthyofauna of terrestrial fauna and revegetated areas.

Regular audits will be conducted to verify that restoration and offset measures deliver measurable gains for priority receptors. By using field data to validate seedling survival, canopy recovery, and the return of indicator species, these audits ensure that conservation progress is accurate, sustainable, and consistent with reported outcomes.

Table 5-16: Alignment and compliance with World Bank ESS6 requirements (paragraph 24)

ESS6 condition (Para. 24)	Project compliance & rationale
a) No other viable habitat exists in the region for the project to be implemented that would contain biodiversity of lesser value.	As a rehabilitation project, the location is fixed.
b) All required due diligence under national law or internationally contracted obligations, which are a prerequisite for a country to authorize the implementation of project activities within or in proximity to a critical habitat, has been conducted.	The project aligns with Malawi's legislation and international treaties. Collaboration with African Parks ensures all activities within the MWR buffer zone meet protected area standards.
c) Potential adverse effects or the likelihood of their occurrence on the habitat concerned will not result in a measurable net reduction or negative evolution of the biodiversity for which the critical habitat was designated as such	Through the mitigation hierarchy, the project ensures that essential ecological functions of the Shire River and Elephant Marsh remain intact, with no measurable loss to critical values.
d) The project is not expected to lead to a net reduction in the population of critically endangered, endangered, or restricted-range species within reasonable timeframes	Targeted measures against poaching and entrapment, combined with strictly controlled work schedules, ensure that populations of critical habitat species remain stable. This includes anti-poaching awareness, GPS tagging for vultures, and specific monitoring for the Zambezi Flapshell Turtle and African Wild Dog to ensure no net reduction occurs.
e) The project will not result in significant conversion or degradation of critical habitats. In cases where the project involves establishing or redeveloping forest or agricultural plantations, it will not convert or degrade any critical habitat	No conversion of critical habitat is planned. Temporary footprints will be strictly limited to modified habitats and fully restored with native vegetation post-construction. A Riparian Restoration Strategy (including invasive species control and bank stabilization) will be implemented to restore degraded habitats, ensuring no long-term loss or conversion of critical habitat.
f) The project's mitigation strategy will be designed to achieve a net gain in the value of the biodiversity for which the critical habitats were designated as such	The project achieves a Biodiversity Net Gain by funding a comprehensive package: restoration of the Shire riverbanks in MWR, GPS telemetry for endangered vultures, and the integration of species-specific monitoring into the Elephant Marsh Community Conservation Area (CCA).
g) A robust, well-designed, and sustainable biodiversity monitoring and evaluation program aimed at assessing the state of the critical habitat is integrated into the Borrower's management program	A long-term monitoring framework is integrated into the ESMP, featuring E-Flow real-time tracking, field-based biodiversity indicators (seedling survival, indicator species return), and biodiversity audits to verify that conservation actions deliver sustainable gains.

5.3.5.3. DEFINITION OF THE ECOLOGICAL AREA OF APPROPRIATE ANALYSIS

The Ecological Area of Appropriate Analysis (EAAA), as defined under IFC Performance Standard 6, is the spatial unit used to assess the presence of critical habitat. It is determined based on ecological relevance, considering the distribution of species, ecosystems, and the ecological processes that sustain them. The EAAA is tailored to each biodiversity value and may overlap across values when their ecological requirements coincide. It must extend beyond the project footprint or direct Area of Influence (AoI), encompassing broader natural features like catchments or rivers. The EAAA serves as the basis for applying critical habitat assessment.

5.3.5.3.1. Terrestrial EAAA

As part of the Kapichira HPP Rehabilitation project, three terrestrial threatened species—African savanna elephant (*Loxodonta africana*), black rhinoceros (*Diceros bicornis*), and African wild dog (*Lycaon pictus*)—have been identified within Majete Wildlife Reserve as likely to trigger critical habitat designation. These endangered species inhabit fenced, protected areas such as Majete Wildlife Reserve, Lengwe, and Liwonde National Parks.

The delineation of the EAAA was based on the ecological requirements and ranges of these species, the characteristics of their habitats within the Majete Wildlife Reserve, and potential threats associated with the rehabilitation project. Key threats include poaching, habitat fragmentation, and the indirect impacts of construction-related activities.

To ensure comprehensive coverage, the EAAA includes the full extent of the Majete Wildlife Reserve and a 10 km buffer zone around it. While the reserve's fencing restricts species movements beyond its borders, the buffer accounts for potential indirect impacts—such as disturbances from quarry sites, construction camps, and increased human presence near the perimeter. The buffer also anticipates external pressures that could influence wildlife behavior within the reserve, including water resource variability and human-wildlife conflict.

5.3.5.3.2. Aquatic EAAA

As part of the Kapichira HPP Rehabilitation project in the Middle and Lower Shire River in Malawi, several fish and aquatic species of conservation concern have been identified during field surveys. These include migratory species such as *Anguilla labiata* (African mottled eel), *Labeo cylindricus*, and *Labeobarbus congoro*, which require ecological connectivity between the Middle and Lower Shire for their life cycles.

The Zambezi Flapshell Turtle is also present and relies on marshes and large aquatic systems for its reproduction and adult habitat. In addition, the Elephant Marsh, located downstream of the project area, is a Ramsar site supporting significant populations of waterbirds, including migratory and threatened species such as *Ardeola idae*, *Egretta ardesiaca*, and *Balearica regulorum*.

The aquatic EAAA has been defined from the Nkula Dam in the Upper Shire to the Elephant Marsh in the Lower Shire. This corridor includes tributaries and river sections essential for maintaining habitat connectivity and the ecological integrity of the aquatic system. While critically endangered fish are not present in viable populations, the EAAA captures habitats for resident fish species, migratory pathways, and sensitive downstream wetlands.

5.3.5.3.3. Wide range EAAA

As part of the Kapichira HPP Rehabilitation project, several wide-ranging bird species, including migratory vultures, raptors, and waterbirds, were identified during field surveys. These species are sensitive to habitat fragmentation and human disturbance, especially along migratory routes. The list includes such as *Trigonoceps occipitalis* (White-headed Vulture), *Gyps africanus* (White-backed Vulture), *Necrosyrtes monachus* (Hooded Vulture), *Torgos tracheliotos* (Lappet-faced Vulture), *Acrocephalus griseldis* (Basra Reed-warbler), *Anastomus lamelligerus* (African Openbill), *Rynchops flavirostris* (African Skimmer), and *Chlidonias hybrida* (Whiskered Tern).

The EAAA for these species includes key habitats and migration corridors, particularly along the Shire River and around the Elephant Marsh, a critical site for staging and foraging. Species were considered under critical habitat criteria if they are listed as

Endangered or Critically Endangered, or if the site hosts more than 1% of their biogeographic population.

Recent tracking data confirm that White-backed Vultures use defined corridors between Lengwe National Park, Majete Wildlife Reserve, and Liwonde National Park. These corridors informed the delineation of the EAAA, which includes a 10 km buffer on either side of known migration routes to account for feeding, resting, and breeding areas. This buffer also includes areas used by waterbirds during migratory stopovers along the Shire River.

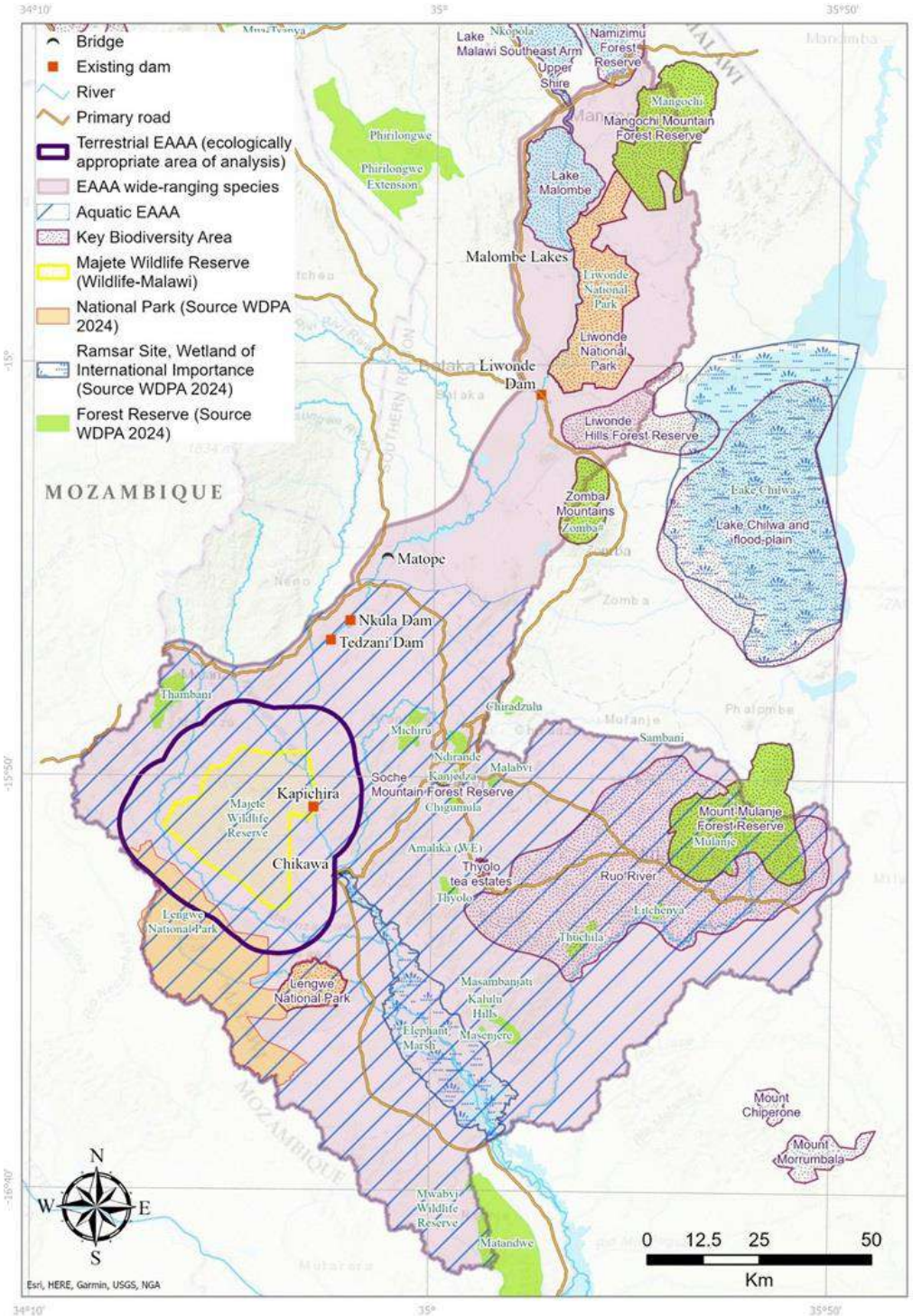


Figure 5-40: Terrestrial, Aquatic and Wide-ranging EAAAs defined for the Critical Habitat Assessment

5.3.5.4. NATURAL AND MODIFIED HABITATS

Terrestrial habitats

Terrestrial habitat includes natural and modified habitats across the upper, middle, and lower Shire Valley. It is largely shaped by the distribution of key vegetation types such as miombo and mopane woodlands, riparian forests, and thickets. The terrestrial EAAA included predominantly natural habitats concentrated in MWR although it shows signs of seasonal disturbance due to drought, fire, and wildlife browsing.

Regarding the wide-ranging EAAA these are mostly concentrated in protected areas such as Majete Wildlife Reserve, Lengwe National Park, and Liwonde National Park, as well as important forested landscapes along the Chikwawa-Thyolo escarpment. This escarpment (±21,000 ha) acts as a vital watershed and biodiversity corridor, especially within traditional lands under authorities such as Makhuwira and Katunga.

Aquatic habitats

The aquatic EAAA covers the middle and lower Shire River, including Elephant Marsh, a key wetland of international importance. Although affected by upstream hydropower infrastructure, agriculture, and deforestation, these aquatic systems retain significant ecological functionality. They continue to support diverse native fish populations, aquatic vegetation, and large populations of migratory waterbirds and wetland mammals like hippos. Elephant Marsh, in particular, serves as a migratory stopover and breeding ground, supporting high seasonal biodiversity.

The Mpatamanga HPP ESIA (SLR, July 2024) conducted an aquatic habitat mapping used the Index of Habitat Integrity (IHI), integrating data from recent E-Flows assessments and expert field studies. Habitat condition was classified according to IFC PS6 criteria, with Categories A–D considered natural, even if degraded, and E–F classified as modified. Most aquatic zones in the EAAA, including large portions of the Shire and Elephant Marsh, are defined as ‘degraded natural aquatic habitat’ due to sedimentation and hydrological changes but still retain ecological integrity.

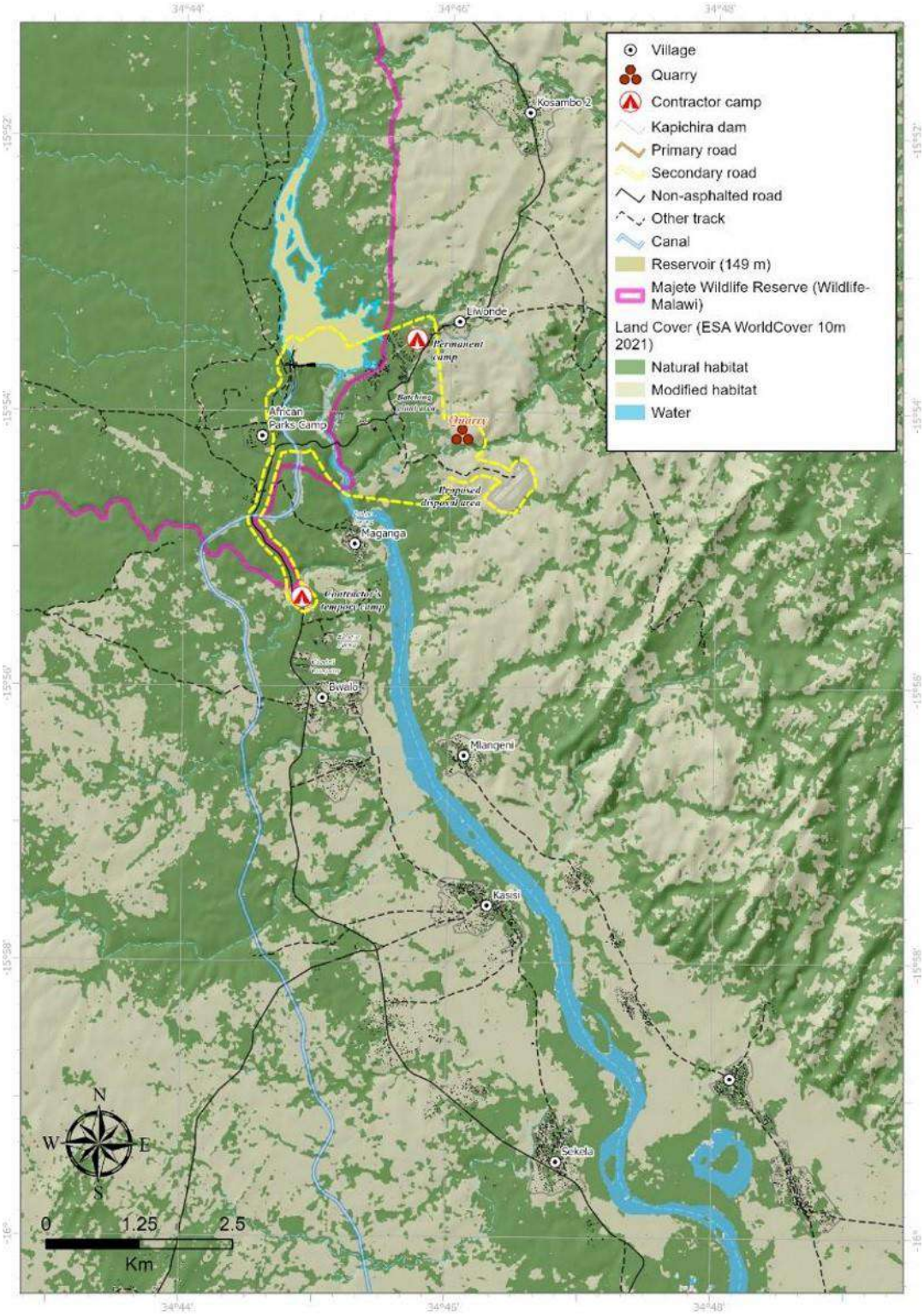
Table 5-17: Habitat and land use in EAAAs

Habitat/ Vegetation Community	Status	Rationale
Mixed Deciduous Forests	Modified/Natural in protected areas	Once extensive, these forests have been reduced due to logging, firewood collection, and land conversion. Some patches remain intact in protected areas, but fragmentation has affected connectivity for forest-dependent species.
Dry Miombo Woodlands	Modified/ Natural in protected areas	While still dominated by *Brachystegia* and *Julbernardia,* frequent fires and charcoal production have significantly degraded these woodlands. Regeneration is slow, leading to lower biodiversity and ecosystem function. Some patches remain intact in protected areas.
Dense Thickets of Dry Savanna Woodlands	Largely Natural	Thickets remain important refuge areas for fauna, particularly within protected zones (Lengwe, Majete). However, some areas have been affected by overgrazing, fire, and selective tree cutting.
Riparian Forests (Shire River, tributaries)	Modified/ Natural in protected areas	Hydrological changes from dam construction (Kapichira, Kamuzu Barrage) have altered seasonal flooding patterns, impacting forest structure and species composition. Still provides conservation concern habitat for birds, primates, and amphibians.
Elephant Marsh and Other Wetlands	Modified	Historically a dynamic floodplain wetland, now altered by sedimentation, agriculture, and reduced connectivity to the Shire River. Despite modifications, it remains a key site for migratory birds and fish spawning.
Hillslope Savanna & Woodland Mosaics	Natural Largely intact	Though increasing grazing pressure and fire frequency may shift species composition. Key habitat for ungulates and raptors.
Degraded Agricultural Land & Settlements	Highly Modified	Large portions of the valley have been converted for agriculture (maize, sorghum, rice) and settlements, leading to significant habitat loss and soil degradation

Key habitat modifications identified include:

- Cultivation-related modification: clearing of native floodplain vegetation and hydrological disruption from land conversion.
- Altered flooding regimes: shifts in seasonal flooding patterns due to upstream dam operations.
- Sediment deposition impacts: changes in sediment flow affecting plant communities and aquatic dynamics.

The following Figure 5-41 shows the natural and modified habitats in the Project area of influence.



Source: ESA World Cover 10m, 2021

Figure 5-41 : Natural and modified habitats in the Project area of influence

5.3.5.5. CRITICAL HABITAT ANALYSIS

The critical habitat (CH) designation is triggered in three distinct habitat units based on the qualifying species identified during the ESIA:

- The Majete Wildlife Reserve (Terrestrial CH): This area qualifies under Criterion 1 (CR/EN species). It serves as a strictly managed and fenced refuge for the Black Rhinoceros (*Diceros bicornis*) and African Wild Dog (*Lycaon pictus*). These populations are globally significant, and the reserve represents an essential habitat for their survival and recovery in Malawi.
- The Shire River and Elephant Marsh (Aquatic & Wetland CH): This corridor is triggered under two criteria. First, Criterion 1 is met by the presence of the Zambezi Flapshell Turtle (*Cycloderma frenatum*) and the Basra Reed-warbler (*Acrocephalus griseldis*), both of which rely on the Shire's specific hydrological conditions. Second, the Elephant Marsh Ramsar site qualifies under Criterion 3 (Migratory/Congregatory species) as it hosts over 1% of the global or biogeographic populations of six waterbird species (e.g., African Skimmer, Black Heron), making it a site of international importance for avian life cycles.
- The Regional Avian Corridors (Wide-ranging CH): This habitat is defined by the movement patterns of White-headed and White-backed Vultures. It qualifies under Criterion 1 because it encompasses vital flight and foraging corridors connecting Liwonde, Majete, and Lengwe, which are necessary for the persistence of these Critically Endangered raptors.

Critical habitat qualifying species

Eleven (11) species have been confirmed to meet the criteria for critical habitat and are present across all three Ecological Areas of Analysis (EAAAs) defined for the Critical Habitat Assessment: a terrestrial area, an aquatic area, and an area for wide-ranging species. These species include the Black rhinoceros, two vulture species (White headed vulture and White-backed vulture), six waterbirds, and one turtle species. The Black rhinoceros, vultures, and turtle qualify under Criterion 1 (Critically Endangered or Endangered species), while the six waterbird species qualify under Criterion 3 (migratory or congregatory species). No species were identified that meet Criterion 2 (endemic or restricted-range species). A more detailed description is included in Appendix I.

Table 5-18: Critical habitat qualifying species

Feature	CH qualifying feature	Presence in EAAAs	Criteria
Mammals	Black rhinoceros – *Diceros bicornis*	Confined to Majete Wildlife Reserve	1c
	African Wild Dog – *Lycaon pictus*	Confined to Majete Wildlife Reserve	1c
Birds	Black Heron – *Egretta ardesiaca*	Primarily associated with Elephant Marsh	3a
	African Openbill – *Anastomus lamelligerus*	Primarily associated with Elephant Marsh	3a
	African Skimmer – *Rynchops flavirostris*	Primarily associated with Elephant Marsh	3a
	Whiskered Tern – *Chlidonias hybrida*	Primarily associated with Elephant Marsh	3a
	Collared Pratincole – *Glareola pratincola*	Primarily associated with Elephant Marsh	3a
	Basra Reed-warbler – *Acrocephalus griseldis*	Primarily associated with Elephant Marsh	1a
	White headed vulture – *Trigonoceps occipitalis*	Movement between Liwonde, MWR and Lengwe National Park.	1c
	White-backed vulture – *Gyps africanus*	Movement between Liwonde, MWR and Lengwe National Park.	1c
Reptiles	Zambezi Flapshell Turtle – *Cycloderma frenatum*	Primarily associated with lake and floodplain habitats (e.g. Liwonde and Elephant Marsh). Recent surveys (2023) in MWR	1a

Species of stakeholder concern

Twenty (20) species (see Table 5-19) were identified as species of conservation and/or stakeholder concern. These species are also known to be present within the EAAAs, but do not qualify as critical habitat.

These species have been identified as species of concern due to international/national stakeholder interest and existing threats (including the proximity with the Majete), which may be exacerbated by the Project.

Indeed, during the construction activities of the SVTP, some species were reported to have entered the site — for example, a lion was observed, and crocodiles are known to be present. In addition, during the biodiversity surveys, numerous monkeys were observed both on the site and along the access roads. Pangolin tracks were also recorded downstream of the dam along the banks of the Shire River.

Table 5-19: Species of conservation and/or stakeholder concern

Feature	N°	Conservation species	Presence in EAAAs
Mammals	1	Hippopotamus – *Hippopotamus amphibius*	Majete WR and the surrounding area
	2	Leopard - *Panthera pardus*	Confined to Majete Wildlife Reserve
	3	Giraffe – *Giraffe camelopardalis*	Confined to Majete Wildlife Reserve
	4	Lion – *Panthera leo*	Confined to Majete Wildlife Reserve
	5	African savannah elephant – *Loxodonta africana*	Confined to Majete Wildlife Reserve
	6	Temminck's pangolin – *Smutsia temminckii*	Majete WR and the surrounding area
	7	Chacma baboon – *Papio ursinus*	Majete WR and the surrounding area
	8	Vervet monkey - *Cercopithecus pygerythrus*	Majete WR and the surrounding area
	9	Yellow baboon – *Papio cynocephalus*	Majete WR and the surrounding area
	10	Blue Monkey – *Cercopithecus albogularis*	Majete WR and the surrounding area
Birds	11	Martial eagle – Polemaetus bellicosus	Primarily associated with Elephant Marsh
	12	Bateleur – *Terathopius ecaudatus*	Primarily associated with Elephant Marsh
	13	Malagasy Pond Heron - *Ardeola idae*	Primarily associated with Elephant Marsh
	14	Grey Crowned Crane - *Balearica regulorum*	Primarily associated with Elephant Marsh
	15	Hooded vulture - *Necrosyrtes monachus*	Movement between Liwonde, MWR and Lengwe National Park.
	16	Lappet-faced vulture - *Torgos tracheliotos*	Movement between Liwonde, MWR and Lengwe National Park.
Reptiles	17	Nile crocodile - *Crocodylus niloticus*	Majete WR and the surrounding downstream areas
Fishes	*18*	*Labeobarbus congoro*	Migratory species present in the Shire river
	19	African mottled Eel - *Anguilla labiate*	Migratory species present in the Shire river
	20	Oreochromis Karongae	CR species found in the dam reservoir during the surveys

5.4. Description of the human environment

5.4.1. Administrative and territorial organisation

Malawi is divided into three (3) regions: the Northern region, the Central region and the Southern region. Kapichira Project is situated in the Southern Region.

These regions are subdivided into 28 districts. The Project area is located into Chikwawa district, in the traditional Authority Kasisi (see the following figure).

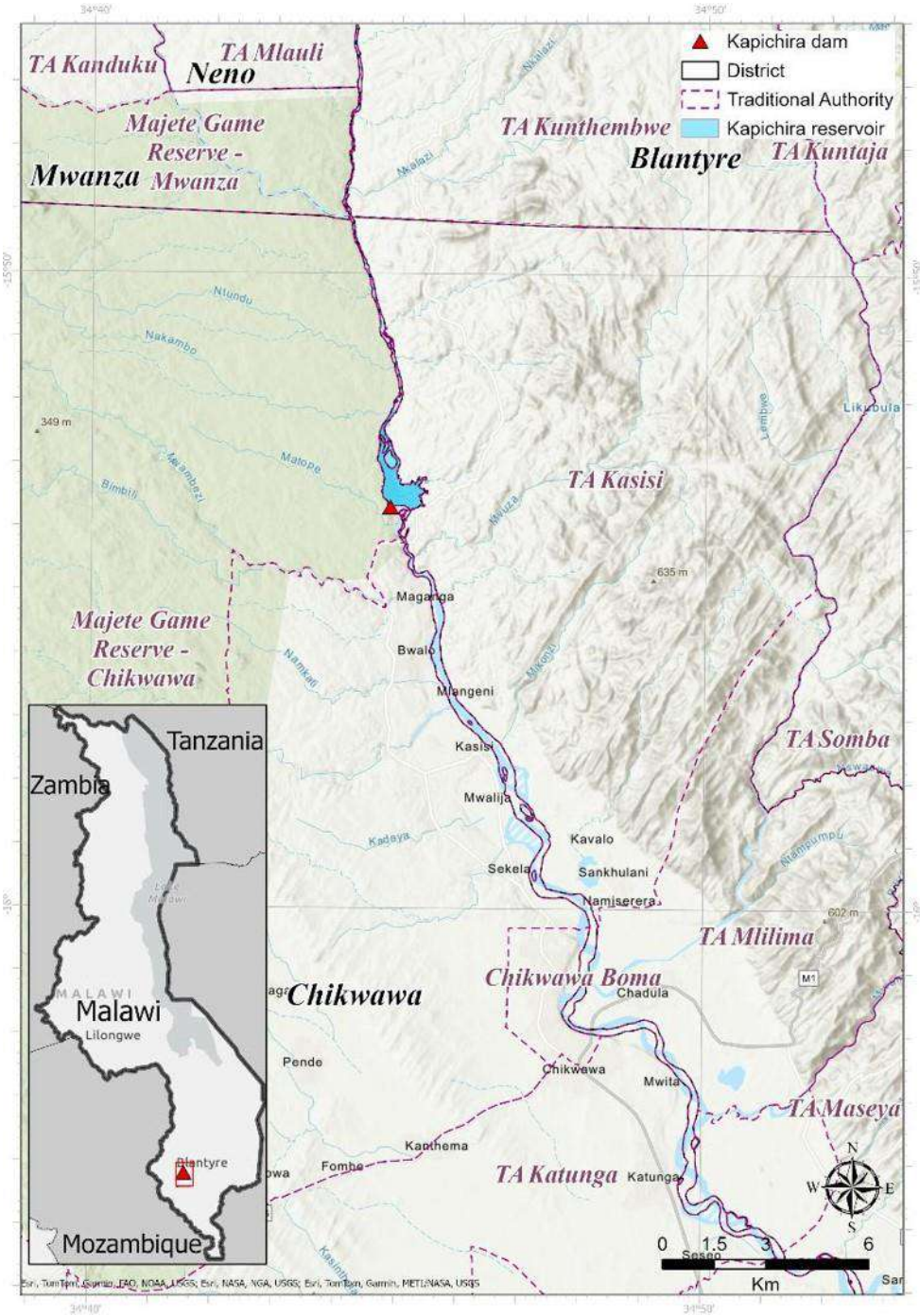


Figure 5-42: Location of the project area in Chikwawa district

Local government in Malawi is decentralized into urban authorities and municipalities, District Council and Traditional Authority Council.

Local councils are responsible for raising and collecting local taxes, user fees, and charges. However, most of their revenue comes from national government grants, both conditional (sectoral funds) and unconditional (general resource funds). All councils have the same responsibilities, including primary education, primary health, forestry, natural resources, and community services.

The administrative structure of the districts in the study area is a blend of formal and informal mechanisms characterised by a top-down/bottom-up approach. The highest political body at the district level is the District Council. Each District Council is subdivided into several Traditional Authorities, each with its own Area Development Committees.

5.4.2. Land tenure

There are three main categories of land tenure in the district as reflected in the Land (Amendment) Act of 2022: Customary, Public and Private land.

Public land includes government owned land in the form of establishments like schools, markets, hospitals, government offices, other infrastructural establishments, forest and nature reserves, rivers, lakes and other public areas. This land constitutes 45% of the total land in Chikwawa.

Private land covers 20% of the land in the district. This has mostly been occupied by expansive agricultural estates in the Shire Valley, notably Illovo, Presscane, Ekhaya Farms, Agricane and other individual persons owning livestock ranches.

Customary land, which has been distributed to current occupants through a traditional authority and passed down from generation to generation. Non-individual lands are considered to belong to traditional chiefs. They may include pastures, wetlands, cemeteries, open areas and markets. It is this land that, under customary law, can be shared with other occupants of the village. However, this phenomenon is disappearing due to the increase in population, as most of the land was shared between clans and families years ago. At present, it is estimated that customary land covers 35% of all land in the Chikwawa district. Customary land also covers two-thirds of the Shire Valley Agricultural Development Division, which is controlled by the traditional authorities. Any compensation for access to land must involve the District Council Land Department.

EGENCO owns the entire site of the hydropower plant, which covers 239,663 hectares of leased land with title number 87923. According to EGENCO's site boundaries (see sketch map in the Appendix N), part of the reservoir, including the training dyke, lies within the Majete wildlife reserve as shown in the following map.

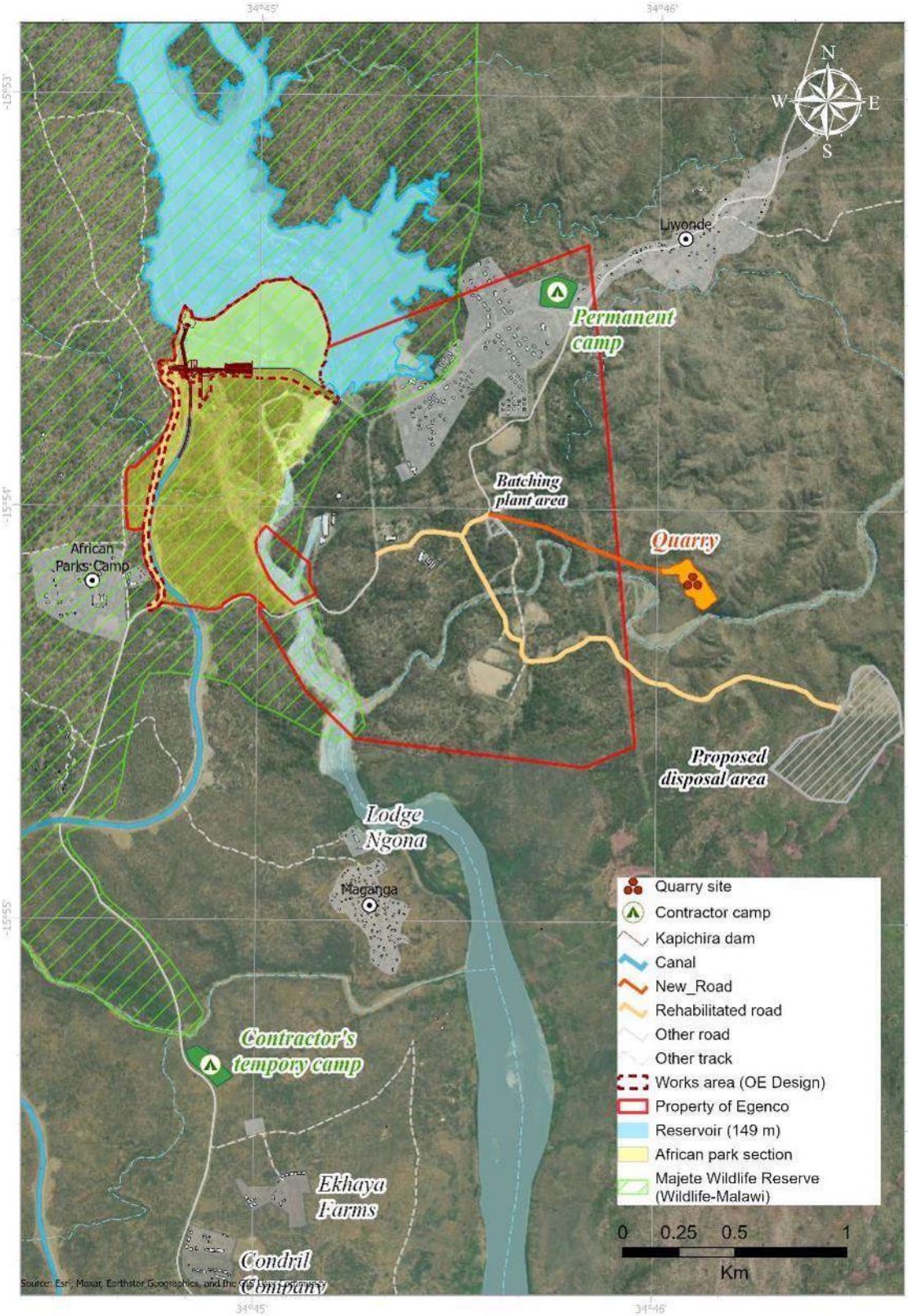


Figure 5-43: Land tenure context

5.4.3. Land use

Land use In the Shire River Basin

The project area is situated on the Shire River Basin.

The Shire River watershed is modified a lot by anthropogenic activities and most of it is degraded as a result of agriculture, deforestation, soil erosion and climate change.

Such as the country, the Shire River catchment is heavily modified by human activities such as agriculture, deforestation, soil erosion and climate change. Agriculture accounted for 35% of land use in 2021 (water bodies excluded), as shown in the following table.

Table 5-20: % of land use in the Shire River Basin in 2021

Type of land use	Malawi (km^2)	% in the Shire River Basin
Cropland	29%	31%
Shrubland	17%	20%
Grassland	15%	19%
Tree cover	17%	16%
Herbaceous wetland	1%	2%
Build-up	1%	1%
Permanent water bodies	*20%*	*11%*

Source: ESA WorldCover, 2021

Land use in the construction area

The following Figure 5-44 shows that the construction area was well covered by shrubland and trees in 2021, corresponding mainly to the area belonging to the Majete Wildlife Reserve. However, the construction activities linked to the SVTP project has cleared the vegetation in the direct footprint area.

Downstream the construction area, the land is mainly dominated by crops.

The contractor's temporary camp is in an area dominated by crops.

The quarry site is close to trees cover along the riverbank. The rest of the land is covered by shrubland and trees.

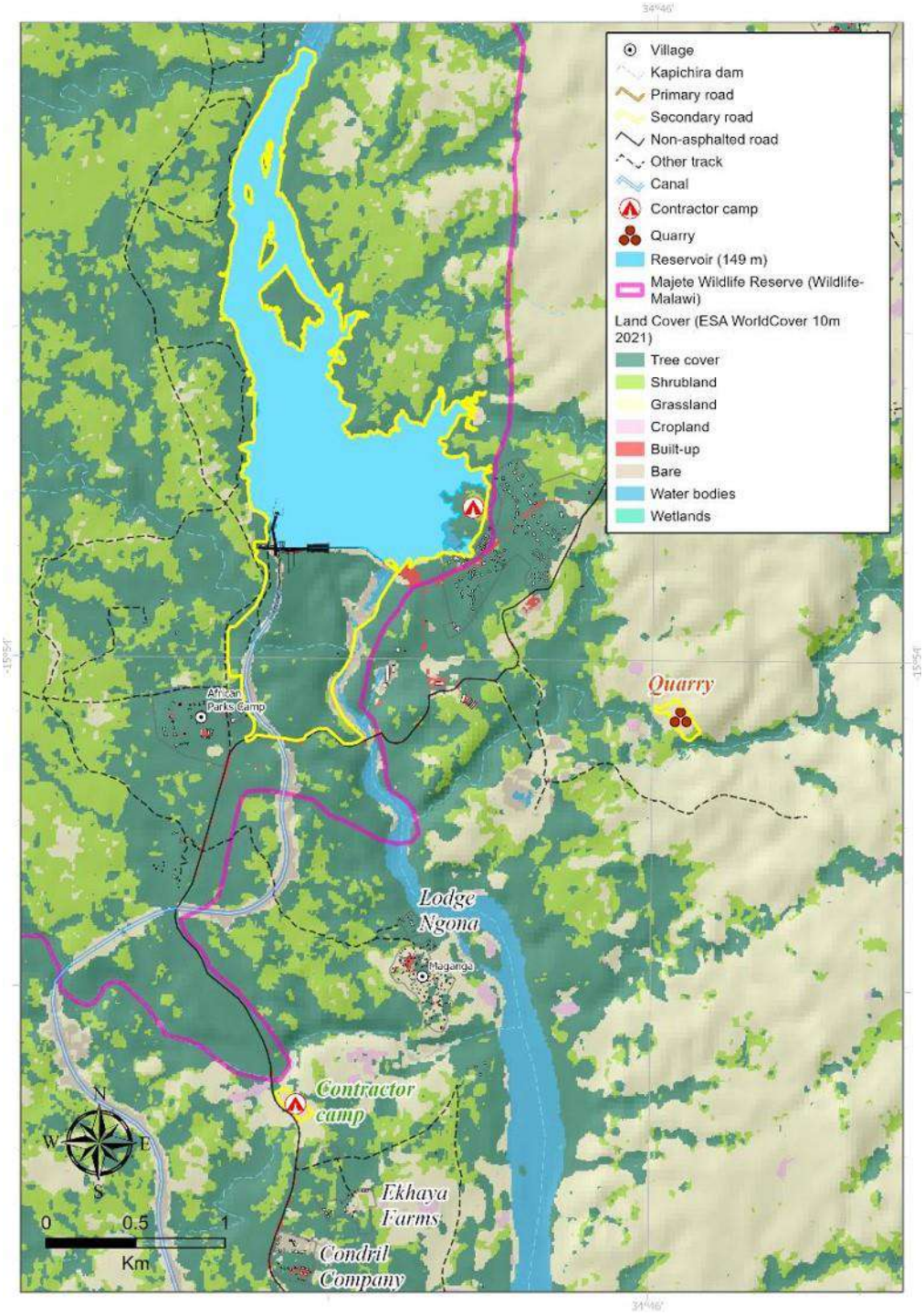


Figure 5-44: Land use in the construction influence area

5.4.4. Social Characteristics

5.4.4.1. INTRODUCTION

This section describes the social characteristics at national, district and project area level. The project area is described based on the results of the socio-economic survey detailed in the Appendix K and secondary data listed in the Appendix B.

The following map shows the location of the villages in the construction influence are with all the main public infrastructures.

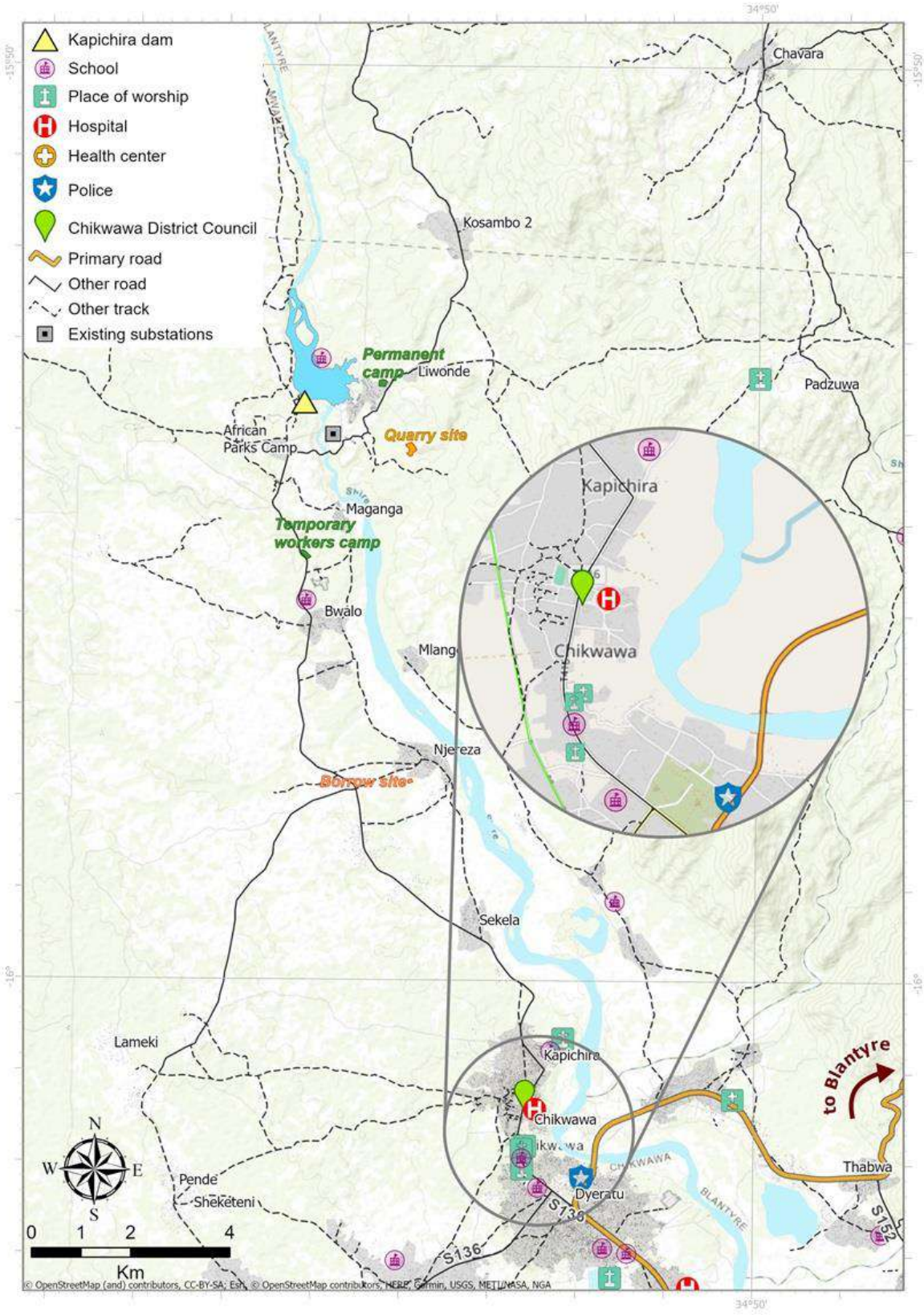


Figure 5-45: Public infrastructures in the construction influence area

5.4.4.2. CONTEXT OF THE CONSTRUCTION INFLUENCE AREA

In the past, some households in the construction influence area are the result of successive displacement. As an example, Liwonde was a fishing camp located on the right bank that was relocated on the left bank when the Majete Wildlife Reserve was created. It was again relocated outside the boundaries of EGENCO campsite when the Kapichira dam was built.

Downstream, some residents were displaced as a result of floods.

5.4.4.3. POPULATION AND DISTRIBUTION

National level

The 2018 Population and Housing Census enumerated 17,563,749 persons with 51.5% females and 48.5% males. 83.9% of the population live in rural areas. The estimated population in 2024 is 20.3 million[15].

The Southern Region, where is located the project, had the highest population with 44% the total population, compared to the Central Region (42.8%) and the Northern region (13%).

The overall population density for Malawi in 2018 was 186 persons per square kilometre. It is now estimated to 214 persons/sq.km. The national population density of Malawi is much higher than that of the neighbouring countries, mainly on account of massive land sizes of the neighbouring countries compared to Malawi.

Malawi is characterized by a young population with half of the population under the age of 19. The older population (65 and older) represents 3.75 percent of the population in 2022.

In 2018, average household size was 4.4 for Malawi and 4.3 for the Southern region.

District level

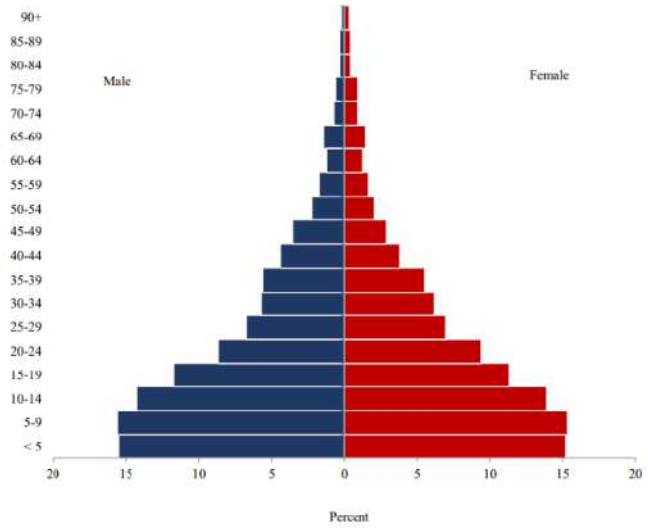
The Chikwawa District had a total population of 564,684 people in 2018[15] (49% males and 51% females) contributing to 3.2 percent of the population of Malawi. In 2024, the total population is estimated to 654,860.

The population density in Chikwawa District is 116, less than the average population in Malawi.

The average household size for Chikwawa district was 4.4 in 2018[11].

The age and sex pyramid in the following Figure 5-46 shows that Chikwawa district has a young population, characteristic of prevalence of high fertility.

[15] 2018 Population and housing census, National Statistical Office



Source: National Statistical Office, 2018 Malawi Population and Housing Census

Figure 5-46: Population pyramid in Chikwawa District

TA Kasisi

The 2018 Census (National Statistical Office, 2018 Malawi Population and Housing Census) recorded 23,266 people with 51% female and 49% male in TA Kasisi, meaning 4% of the district population.

The Projected population for 2024 is 27,238 people which includes residents of both Majete Wildlife Reserve and Kapichira Power Station.

The 2018 Malawi Population and Housing Census states that the household size was 4.1 with 75% of male headed households (compared to the 72% at district level and 67% at national level).

In 2018, TA Kasisi had the lowest density (69 persons per square kilometre) compared to the 11 other TA in the District.

51% of the people had more than 18 years old which is more than at district and national levels (49%).

Study area level

In the study area, the average household size is 4.7, which is more than in TA Kasisi and district level in 2018.

The age and sex pyramid in the study area is quite similar as in Chikwawa District (see above) with a majority of young population (less than 18 years old).

Most (65%) of households in the study area are headed by men, which is similar as the national level (67% in 2018 census).

5.4.4.4. ETHNICITY, RELIGION AND LANGUAGES

National level

Malawi is characterized by a large ethnic diversity. The first ethnic group recorded is the Chewa that concerns 34.5 % of the population followed by Lomwe at 18.9% and then Yao at 13.3%.

Malawi people generally enjoy association of people of diverse tribal affiliation and ethnic origins. Intermarriages across tribes is not a strange phenomenon and this has contributed to tolerance of tribal values and cultures.

Christianity is the predominant religion in Malawi. The Constitution of Malawi prohibits discrimination based on religion and provides for freedom of conscience, religion, belief, and thought.

English is the official language of Malawi event if Chichewa emerged as the predominant language of communication for 57% of the total population. Regional variations were observed: people in the Northern Region speak mostly the Chitumbuka (65%) while the Central Region embrace Chichewa (91%). The Southern Region use a mix with Chichewa at 42%.

District level

The dominant ethnic groups in Chikwawa are Mang'anja and Sena at 48.6% and 30.6% respectively. Chewa and Lomwe each constitute 7% with the rest of minor ethnicities as shown in the following table.

Table 5-21: Ethnic groups

Tribe	Percentage
Sena	48.6%
Mang'anja	30.6%
Chewa	7.4%
Lomwe	7.3%
Ngoni	1.4%
Yao	1.1%
Others	3.6%
Total	**100.0%**

In the Chikwawa district, 92 % of the population are Christian. The rest of the population are whether Muslims or of other religions including traditional cults.

Due to the similarity and cross-fertilisation of cultures in the southern region of Malawi, Chichewa, a dialect influenced by Mang'anja, is the most widely spoken language in the Chikwawa district.

Study area level

The study area is mostly characterized by people of Yao ethnicity (85.9%) following by Chewa (7.3%) and Sena (3.2%). These people migrated from upper shire.

The 2024 study found that 96,6% of households in the study area are Christians, followed by traditional cults (1.9%), Muslim (0.6%), Rasta (0.3%) cults and no religion (0.6%).

The Chichewa language is spoken in the project area as in the district.

No history of tribal clashes was reported in the project area.

5.4.4.5. TANGIBLE CULTURAL HERITAGE

Introduction

The World Bank Environmental and Social Standards n°8 specifies that tangible cultural heritage refers to movable or immovable objects, sites, groups of structures, and cultural or sacred spaces associated with natural features and landscapes with archaeological, ethnological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance.

National level

Malawi's Monuments and Relics Act (see chapter 3.3.15) and the Cultural Policy (see chapter 3.2.18) define cultural heritage in tangible and intangible forms. Although the Act refers to only tangible heritage (i.e. monuments and relics), the Department of Museums and Monuments acknowledges that "tangible cultural heritage comprises the physical, cultural heritage resources, both movable and immovable, including, but not limited to, the following:

- Places, buildings, and structures of cultural significance.
- Places to which oral traditions are attached.
- Historical settlements and townscapes.
- Landscapes and natural features of cultural significance.
- Geological sites of scientific or cultural importance.
- Archaeological and paleontological sites, and
- Graves and burial grounds".

In 2025, Malawi has three Official World Heritage sites listed by the United Nations Educational, Scientific and Cultural Organization (UNESCO), located outside the study area as shown in the following figure:

- The Lake Malawi National Park is recognised as a natural world heritage site since 1984 and is globally important for biodiversity conservation due to its fish diversity (UNESCO World Heritage List, 2025).
- The Chongoni Rock Art Area is recognised as a cultural world heritage region since 2006. The 127 sites of this area, which span 126.4 km², are high on the plateau of central Malawi and are surrounded by a group of forested granite hills, including the region's richest concentration of rock art in Central Africa. The art depicts paintings by BaTwa hunter-gatherers who lived in the region starting in the late Stone Age and the relatively uncommon practice of farmer rock art (ibid). The agrarian Chewa people, who have resided there since the late Iron Age, continued to paint on rocks long into the 20th century. The rock art's notable female figures continue to have cultural significance among the Chewa, and the locations are frequently used for rituals and festivities (UNESCO World Heritage List, 2025).

- The Mount Mulanje Cultural Landscape is recognised as a natural world heritage site since 2025. This property encompasses the mountain range located in southern Malawi, with the imposing Mount Mulanje, one of the world's largest inselbergs, and its surrounding environment. Revered as a sacred place inhabited by gods, spirits, and ancestors, it holds deep cultural and spiritual significance. The mountain's geological and hydrological features are connected with the belief systems and cultural practices of the Yao, Mang'anja, and Lhomwe peoples. These communities have sustained the mountain's sacredness through rituals and traditions, making the site a sacred cultural landscape that reflects the spiritual and ecological harmony between people and nature (UNESCO World Heritage List, 2025). This site, the closest one from Kapichira dam site, is located more than 100km from the construction influence area as shown in the following figure.

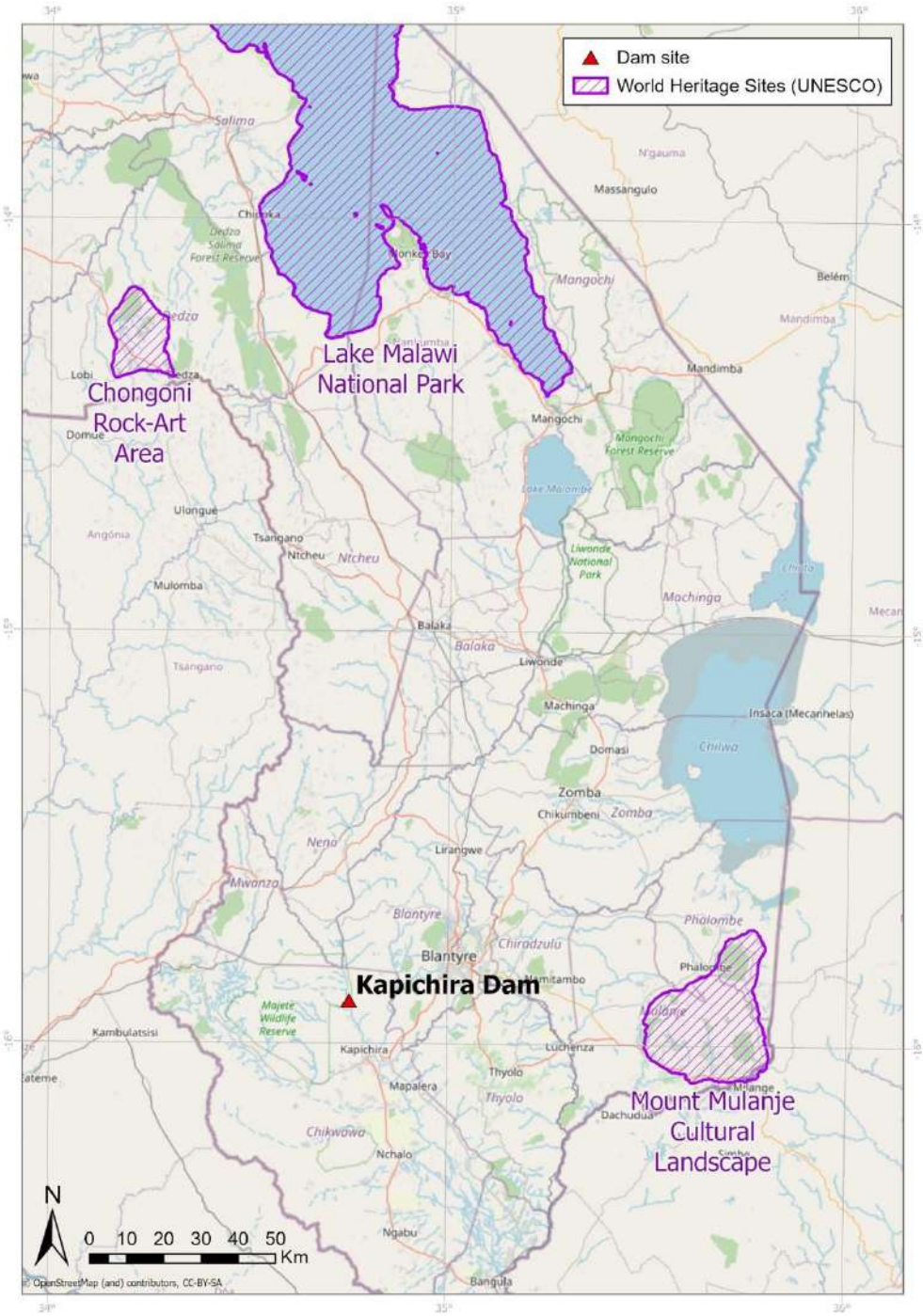


Figure 5-47: Location of UNESCO World Heritage sites in Malawi

Study area level

In separate study, an archaeological and paleontological assessment was carried out by the Department of Museums and Monuments for the Kapichira Dam rehabilitation project in 2022. This section is a summary of the findings.

The conclusions of the palaeontological study revealed that the direct footprint area is endowed with palaeontological fossils from the Jurassic period (fossils in form of fossilized wood, fossilized snails and bones).



Source: Report on paleontological heritage impact assessment for Kapichira dam rehabilitation project, Department of Museums and Monuments, 2022

Figure 5-48: Paleontological fossils collected in the direct footprint area

In addition of this study, the identified sites of cultural significance are as follows:

- The historical site of Richard Thornton grave was identified during the 2024 survey on the right bank of the Shire River at Maganga 1. It is a tourist attraction that holds a historical significance. This site draws visitors who are intrigued by the stories of explorers: By 1863[16], David Livingstone was travelling up the Shire River from the Zambesi on board the steamboat “the Pioneer”. He had taken the geologist Richard Thornton on, because he realised the vital nature of his input into the expedition. However, on 21 April 1863, Richard Thornton became ill and passed away on the Pioneer as it approached the rocky cataracts north of Chikwawa (Kapichira falls). He was 25 years old. Livingstone looked for somewhere to bury him that would be recognisable to members of any future expedition and saw a large Baobab tree on a rise near the River. Knowing something of the longevity of these trees, he decided to bury Richard Thornton just below it on the side facing the River, and, finding a large iron marlinspike on board, got someone to climb the tree and hammer two pieces of wood into the upper part of the tree using the tool as a nail. These formed a makeshift cross for anyone to see from the water, and, being so far from the ground, might escape the termites. A white marble gravestone, always visible (see the Figure 5-49) and well known to Maganga 1 villagers, was shipped from Britain

[16] The Society of Malawi Journal, Historical and scientific, Vol.58, N°1 (2005), pp.23-28 – Theo Campbell-Barker

around 1905, over 40 years after Thornton passed away and described in a book about Dr Livingstone's Journals.



Figure 5-49: Historical site of 1863 Richard Thornton grave on 28 November 2025

Graveyards are also protected areas by culture. None is allowed to cut trees in a graveyard.

- The 2024 socioeconomic survey has identified a traditional church structure has been identified on the potential access road to the quarry site. This church was built in 2016 by EGENCO staff for traditional uses during the construction of the dam.



Figure 5-50: Traditional church structure in the vicinity of the quarry site

5.4.4.6. INTANGIBLE CULTURAL HERITAGE

Introduction

The World Bank Environmental and Social Standards n°8 specifies that intangible cultural heritage practices reflect the local communities' traditions, beliefs, and customs. These practices encompass various elements, including oral traditions, storytelling, music, dance, and rituals.

District level

2024 socioeconomic survey for Kapichira reported ceremonial practices (-*Chinamwali, Dzoma*) such as initiation ceremonies with the puberty, often gender specific, usually conducted in a forest area.

It was reported as well the practice of:

- *Chitsukulumwe,* which is a women dance performed at village functions, or whenever people are happy.
- *Gule Wamkulu*, which is a masquerade performed in forested area to conserve biodiversity.

It was reported that cultural ceremony could be organised for some events, such as the start of a project in the community's area. It was the case when the dam construction started.

5.4.4.7. EDUCATION AND LITERACY

National level

The 2018 Malawi Population and Housing Census (National Statistical Office) reported that the literacy rate in Malawi was 68.6% (71.6 for males, 65.9 for females).

In Malawi, youth are categorized as persons between 10 and 35 years. The national literacy rate for youth was 83.3 % in 2018 (83.3 for male, 82.8 for female). Literacy rate is higher among young people in the urban areas (95.6%) than in rural areas (80.7%). There are no major sex differences in the literacy levels across the regions and places of residence for youth.

District level

Chikwawa district as well as TA Kasisi has a literacy rate of 57.6%, which is lower than both the Southern Region (67%) and Malawi (68.6%) rates. The district literacy data shows that women (51%) have lower literacy rate than men (72%).

The 2018 census reported that 31% of primary school age children are not currently attending school in Chikwawa District. It reported that he majority of the population in the district had primary school as their highest level of education (77.8 %). Those who had tertiary as their highest level of education were 1.4 %, and 1.7 % had never attended school. Considering gender aspects, a higher percentage of females (82.4 %) had attended primary school as their highest level of education compared to males (73.9 %). 22.6 % of males as compared to 14.8 % of females had attended secondary school.

Study area

Based on the 2024 socioeconomic survey, up to 95% of children aged 6-10 years attend school which is better than the district rate.

68% of household heads are literate in the study area, with differences between the villages such as Bwalo (85%) and Liwonde (52%). There is a correlation between illiteracy and the fact that the household head did not attend formal education.

Table 5-22: Education level of the household head

Never attended formal schooling	Attempted primary school	Completed primary school	Attempted secondary school	Completed junior secondary school	Completed senior secondary school	Attempted tertiary education	Completed tertiary education
32.6%	44.4%	5.4%	7.0%	4.2%	4.5%	0.6%	1.3%

The proportion of female headed households who are illiterate is about twice the proportion of male headed households (See the following figure).

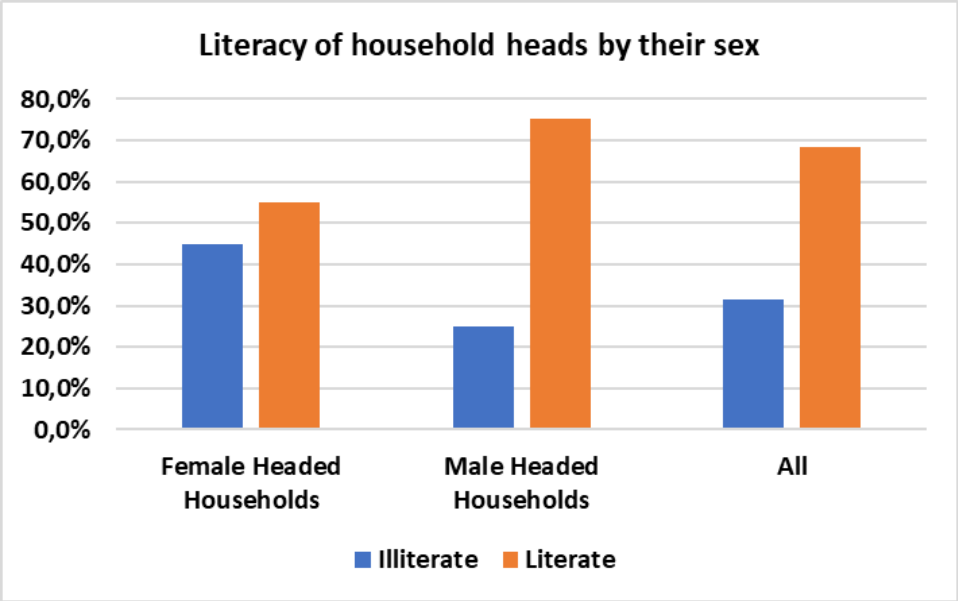


Figure 5-51: Literacy of household heads by their sex

For the other members of the households in the study area, the highest education level reaches is the primary school for 62,1% of people, the senior secondary school for 32,7% and the tertiary level for 4.7%.

Education Infrastructures and services

Chikwawa district has 182 public primary schools, including 23% junior schools. In total, there are 42 secondary schools in the district, of which 10 are registered as private (Malawi Ministry of Education, 2022).

In the study area, there are three primary schools: Kandeu, Kapichira and Dzimbiri (see the location on the Figure 5-45).

The nearest secondary school is Chikwawa District located at about 25km from the furthest group village of Kandeu, A new secondary school will soon be completed at Kandeu village.

5.4.4.8. HEALTH

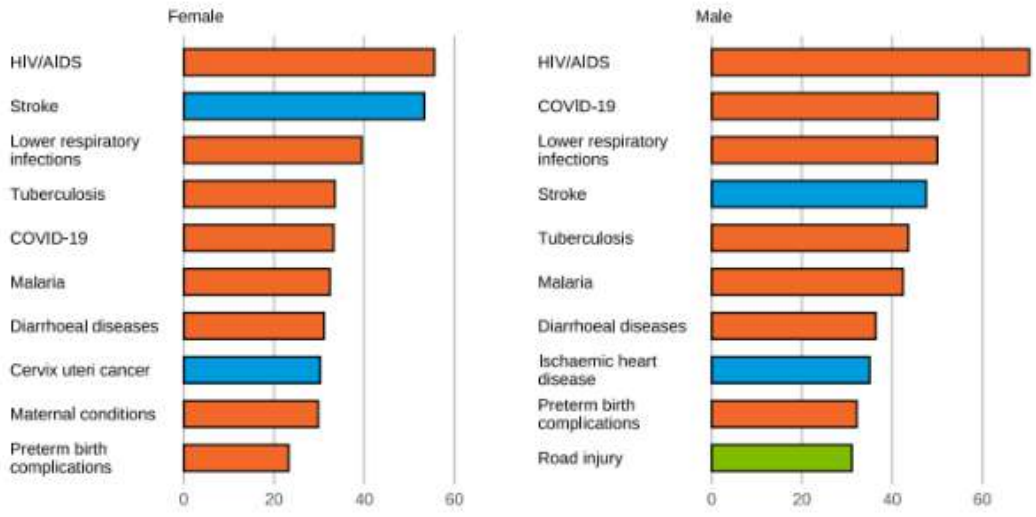
National level

The 2018 census results show that the crude death rate for Malawi is estimated at 6.3 deaths per 1,000 population with that of males slightly higher than for females, 7.3 and 5.4 deaths per 1,000 population, respectively.

The demographic and health survey in 2024 (National Statistical Office, Malawi) stated that the under-5 mortality decreased from 234 deaths per 1,000 live births in 1992 to 48 deaths per 1,000 live births in 2024. Infant mortality and neonatal mortality have similarly declined.

The World Health Organization 2025 data states that the life expectancy at birth in 2021 is 62.5 (65.3 for female and 59.7 for male), which is lower than the average in Africa (63.6).

The leading cause of death is HIV/AIDS (62,9 deaths per 100 000) followed by stroke (50.6) with some gender difference as shown in the following figures[17].



Source: Health at a glance, World Health Organization, 2021

Figure 5-52: Top 10 detailed causes of death by sex in 2021

Malawi experienced a widespread cholera epidemic in 2022-2023, the deadliest in the country's history. Cholera has been endemic in Malawi since 1998, with seasonal outbreaks reported during the rainy season (November to May). However, the latest outbreak continued into the dry season (WHO, 2024 annual report).

Malawi is faced with multifaceted nutrition security challenges. The country has 37% of children under five being chronically undernourished and 52 % of the population experiencing severe food insecurity in 2018. The prevalence of undernourishment was 19 % in 2018 (FAO, country factsheet, 2023).

[17] It should be considered that these WHO data date from 2021, the year of the Covid-19 pandemic.

Study area

The rate of HIV/AIDS is 8% in the Chikwawa District, which is higher than the national level. The head of the Kapichira EGENCO clinic highlighted the increase for 2024 in the number of diagnoses of transmissible diseases, in particular STIs and HIV/AIDS. He attributed this to the presence of workers employed on development projects such as the Ekhaya farm, SVTP, Majete Wildlife Reserve and Kapichira power station.

13.1% of households in the study area states to have chronically ill members in their household. The self-identified diseases reported were mainly HIV/AIDS and high blood pressure followed by epilepsy, cataract and arthritis.

The Chiwawa District health office provided the 2019-2025 data for malaria in the district as follows, showing that April-September is the highest period of malaria incidence.

Table 5-23: Malaria data in Chikwawa District from 2019 to 2025

Period	Incidence rate at Chikwawa District Hospital	Incidence rate at EGENCO Kapichira clinic
April - September 2019	363.1	326.5
October - March 2019/20	282.8	299.9
April - September 2020	232.7	279.2
October - March 2020/21	190.9	244.4
April - September 2021	243.7	221.8
October - March 2021/22	47.7	101.6
April - September 2022	58.4	170.8
October - March 2022/23	126.0	254.6
April - September 2023	142.8	329.7
October - March 2023/24	91.4	296.6
April - September 2024	128.9	410.0
October- March 2024/25	67.3	199.8
April - September 2025	32.6	123.9

Health infrastructures and services

The Chikwawa district has one referral hospital located at the district chief town, 26 Health Centres and four dispensaries. The health services provided in the district include outpatients, in patients, nutrition rehabilitation, antenatal, postnatal, ambulatory, referral, laundry, pharmacy, mortuary, eye care, dental therapy, x-ray, orthopaedics, psychiatry, theatre, nutrition rehabilitation, maternal and child health, antenatal, postnatal, family planning, laboratory,) voluntary counselling and testing of HIV, skin clinics.

The EGENCO clinic provides all out-patient services including antenatal, postnatal, anti-retroviral therapy, HIV/AIDS testing and counselling.If a case requires referral, an ambulance is given freely to carry the patient to the district hospital at Chikwawa.

In the study area, the health facilities used by the households are the Chikwawa District hospital (46.3% of households), EGENCO health clinic (44.9%) and the Majete 5 health clinic at Kandeu (8.9%). The choice of the health facilities depends on the proximity of the infrastructure with the village (see the location of the infrastructures on the map in the Figure 5-45).

5.4.4.9. WATER AND SANITATION

National level

The Malawi 2063 goal under “Clean Water, Sanitation and Hygiene” is to promote the adoption of safe water and sanitation practices at individual and household levels. The water policy aims to achieve sustainable water development that is adaptive to climate change and enhances ecosystem services through enhanced integrated management and development of water resources. This further links to Sustainable Development Goals (SDG 6), which aims to achieve universal access to safe drinking water and ensure its availability and sustainable management.

UNICEF (UNICEF, 2025) states 54% of the population in Malawi used basic drinking water services and 5.3% used unimproved drinking water sources in 2022.

District level

The 2018 Malawi Population and Housing Census (National Statistical Office) reported that the main source of drinking water in Chikwawa district is supplied by borehole (72.4%) which is more than the national rate (61.6%). The main other sources are the river or stream (6.6%), the community standpipe (6.5%) and the source piped into yard/plot (5.3%).

The 2018 Malawi Population and Housing Census (National Statistical Office) reported that 77.1% of the household in Chikwawa district have a pit latrine with/without earth/sand slab in 2018, but 10.7% have no facility. These percentages are quite similar in TA Kasisi.

Study area

The most common source of water for domestic use in the study area is borehole (91.7% of households), followed by the water from the Shire River when it is calm. For the villages close to the river such as Maganga and Bwalo, women generally use the Shire River to wash the dishes and clothes as it is easier than the borehole.

For sanitation, 64% of households use pit latrines without a slab, 21% use pit latrines with slab and 15% of households have no facility.

5.4.4.10. WASTE MANAGEMENT

National level

Malawi faces many challenges concerning waste management and poor management of chemicals[18]. This implies a negative impact on human health and environment. Nearly all cities in Malawi are lacking waste collection, disposal facilities and waste treatment.

District level

Chikwawa district has no waste management plan and has no designated waste disposal sites.

About 20 % of households throw away their waste in pits, the rest (80%) commonly dispose of waste in the countryside like dumping and burning in their home yards.

[18] United Nations Environment Programme. (n.d.). *Malawi finds innovative solutions to tackle chemicals and waste management*

Study area

69% of households in the study area dispose of their refuse in pits in their yards, except for Maganga 2 which 50% of households throw their refuse in public areas. Burning of refuse was the least (2%) method of managing waste.

5.4.4.11. ENERGY

National level

The 2018 Malawi Population and Housing Census (National Statistical Office, households and living conditions report, July 2020) reported that torch/battery was the main source of energy for lighting in 2018. 52.9 % of households in Malawi used torch/battery for lighting seconded by electricity at 11.2 %. There was higher percentage of households in urban areas that used electricity for lighting at 48.4 % than in rural areas at 4.1 %.

In 2018, 77.4% of households in Malawi used firewood for cooking seconded by charcoal at 18.2 % and thirdly electricity at 1.9 %.

District level

The 2018 Malawi Population and Housing Census (National Statistical Office, Chikwawa Central Constituency Report, May 2021) reported that 82.7 % of the population in Chikwawa District use firewood and 13.6% use charcoal for cooking.

In addition, 50.4% use battery as source of energy for lighting, 9.4% use firewood, 6.9% use solar, 6.6 % use electricity and 4.7% candles for lighting.

Study area level

Firewood is widely used in the project area by the households, except at Kapichira Power Station and Majete Wildlife Reserve where the households use hydroelectricity.

The 2024 survey found that firewood was the first source of energy for cooking (88.8%). This firewood was most often recovered (77.7%) from nearby communal lands (55%), from forests (24%) or from nearby farmlands (13%).

Charcoal is used by few households around urban centres in the district because of its cost. However, some households in Maganga 2, Njereza and Mlangeni are involved in charcoal production to generate cash income.

5.4.4.12. HOUSING

National level

The 2018 Malawi Population and Housing Census (National Statistical Office, households and living conditions report, July 2020) reported that 45.3 % of dwelling units in Malawi were permanent structures, 23.2% were semi-permanent structures and 31.5% were traditional structures. There was higher percentage of male headed households at 42.4 % with permanent dwelling units compared to 38.6 % female headed households.

Housing tenure is not limited to strict legal status but rather to the clarity of, and predictability of terms of occupation of the dwelling. Dwelling units can be very broadly classified into two main tenure categories namely, owner occupied and renting. Owner

occupied refers to where the head and/or any other member(s) in the household owns the dwelling unit. This includes dwelling units paid for in full and those with outstanding housing loans or mortgages. Renting is where the head and/or any other member(s) in the household rents the whole or part of the dwelling unit from the owner. The 2018 Malawi Population and Housing Census reported that 85.1% households that owned dwelling units, 11.5 % lived in rented dwelling units and 1.9 % lived in institutional dwelling units.

Durability of a dwelling unit in Malawi is determined by the type of construction material used for the walls and the roofs. For example, a dwelling unit is considered more durable if its walls are constructed with burnt bricks and the roof is made up of iron sheets. On the other hand, a dwelling unit is not durable if its walls are constructed by mud and the roof is grass thatched. A dwelling unit with grass thatched roof and its walls made up of burnt bricks is moderately durable. The 2018 Malawi Population and Housing Census reported that more than half (58.0 %) of dwelling units in Malawi had burned brick walls compared to 32.3 % dwelling units with unburnt brick walls. Slightly over half (53.8 %) of dwelling units in Malawi had grass thatched roofs compared to 45.8 % dwelling units which had iron sheet roofs. About 70 % of dwelling units in Malawi had their floors made of earth/sand compared to 24.8 % dwelling units with cement floor in 2018.

District level

The 2018 Malawi Population and Housing Census reported that the housing units in Chikwawa district include 44.2% traditional houses, 41% of permanent houses and 14.8% of semi-permanent houses.

The 2011 Welfare Monitoring Survey reported that half the houses in the district are built of baked bricks. The others are built of unburnt or mud bricks (37.7%), of compacted earth (4.5%), of straw (2.9%) or other materials (4.3%) such as cardboards, tarpaulins, mud, etc.

89.2% live in their own house, 7.4% in rented house, 1.9% in institutional houses, while 1.5% live in houses that they neither own nor rent

Study area level

Most of the dwelling houses in the study area are made of unburnt earth bricks, with generally iron roofed.



Figure 5-53: Dwelling in the project area

88% of households live in their own houses, with no difference between female or male headed households.

5.4.4.13. TRANSPORT

National level

Malawi has 15,415 km of classified roads, out of which approximately 4,405 km is of bitumen. The rest of the roads are unpaved and tend to be characterized by dusty conditions and uneven surfaces which can be dangerous for the users.

Road transport is the most use mode of transport in Malawi. Indeed, the evolution of road conditions, infrastructure, and traffic regulations has failed to keep up with the growing trend of motorization, potentially increasing road hazards.[19]

District level

The Chikwawa district has a road network of 2,656 km, the majority of which are dirt roads (94.5%), which pose traffic problems during the rainy season. Only three roads are asphalted:

- M01 from Madziabango to Sorgin,
- T416 from Dyeratu to Kapichira (3.5km out of the 21km)
- S136 Chikwawa to Chapananga road

Study area level

The road T416 passes through the villages of Liwonde and Kandeu to reach Chileka and Chilomoni. All the villages in the study area are accessible all year round via the T416, with the exception of Mlangeni, which is isolated during the rainy season due to two rivers that can only be crossed by boat.

The most common modes of transport in the project area are bicycles and motorbikes. 20% of households own bicycles, 5% own ox carts and 6% of households own motorbikes. A boat crosses the Shire River.

5.4.4.14. COMMUNICATION

National level

In Malawi, there is currently six Internet Service Providers. Comparing the other African countries, Malawi telecommunication industry is young. In 2022, 28% of the population had access to internet.

District level

There is no local radio in the study area. The local communities use regional and national radio stations. The project area is served by the two main communication network providers in Malawi: Airtel and TNM. In some communities, network signal maybe weak especially when moving out of the M1 road.

[19] Ministry of Transport and Public Works - Malawi. (n.d.). *Transport sector overview*

SVTP's 2020 survey reported that 55% of male-headed households owned a mobile phone, compared with 23% of female-headed households.

Study area

The 2024 survey reported that 44% of households have a mobile phone, 20% use radio for communication, 10% have a smart phone, 2% a television and 1 % a laptop.

5.4.4.15. SECURITY

National level

The 2024 Mpatamanga ESIA reported that inadequate allocation of resources extends beyond policing to the judicial and fire management sectors. Magistrate courts and prison facilities in various districts face challenges, with disparities in infrastructure and accessibility. Furthermore, the deficiency in firefighting resources in the districts is alarming, especially considering the high incidence of bush fires and deforestation. Insufficient firefighting equipment, non-usable fire bowsers in rural areas, and inadequate training compound the vulnerability of these regions to fire emergencies.

The concept of community policing was adopted by the government as a vehicle to facilitate police and the public engagement in fighting crimes. Community policing involves volunteers from local communities (Community Police Committees) which are given training e.g. in child protection to assist police in carrying out their duties.

For approximately 40% of the respondents to Malawi's first National Crime Victimisation Survey, the nearest police station was more than two hours walk away, and for a further 24% between an hour and two hours away (Pelser et al., 2004). Based on this it is estimated that for most people, the nearest police station would be 5-10 km away.

District Level

Security services in Chikwawa district are mainly provided by the Malawi Police Services. The district has one Police Station at Chikwawa and two Police Posts at Nchalo and Ngabu. New establishments of police units are foreseen at Bereu and Therere. The district has also a mobile unit camp accommodated within the district headquarters at Mitole.

Study Area level

There are community policing structures in all the villages in the study area, which coordinate well with security arms of both Majete and EGENCO in ensuring vigilance. The village leaders also play a facilitator role in any security and safety breaches in their jurisdictions.

During the 2024 survey, no criminal case was reported in the study area. The cases reported generally concern domestic problems, disagreements over land boundaries or the intrusion of animals onto other people's land.

5.4.4.16. GENDER BASED VIOLENCE CONTEXT

National level

Malawi has a number of policies in place to curb violence against women and girls. The Sexual Offences Act (2016) for example, strengthens the legal framework for protecting women and girls from sexual violence, including increased penalties for offenders and

improved support for victims. However, according to a 2020 survey by UNICEF, 42% of women in Malawi have experienced physical violence from a partner at some point in their lives. This is significantly higher than the global average of 27%.

Study Area level

During the 2024 socioeconomic survey, the community members, both male and female, reported that sex for work was a way to get a job: *"If you were a man, you were asked to bring your sister"*. *"If you were a woman, you were asked to offer your body".*

The outcome of the focus groups with women is that the violence based on gender are a real issue in the Chikwawa district with not equally treatment between men and women for job opportunities. Women reported to be often confronted to sexual favours against job opportunities. Women reported that unintended consequences from sexual exploitation were unintended pregnancies, break up of marriages, risk of spread of diseases and child marriages.

During 2024 socioeconomic survey, the District Social Welfare reported an increase on GBV cases from an average of 30 cases in a month to 70, links to the works for SVTP. The main issue was relative to women who become head of household after divorce or separations due to the departure of their husband for work opportunities.

5.4.4.17. CHILD LABOUR RISK CONTEXT

National level

The Malawi National Action Plan on Child Labour 2020-2025 indicates that poverty was the major cause of Child Labour as most of the parents in the rural communities lack basic needs such as food, clothes, and shelter as well support to education to support their children with education. Most of these children rarely attend classes as they choose to look for job to support their parents with food and other basic necessities.

In addition, the 2015 National Child Labour Survey of Malawi found that 38 percent of children aged 5-17 were engaged in child labour (between 2.1 million). An examination of the survey trends since the first child labour survey conducted in 2012 indicated that the child labour prevalence had not significantly changed with the last survey reporting child labour prevalence at 32 percent.

Study Area level

During the 2024 socioeconomic survey, local communities reported that children were recruited to fetch sand or perform household chores during school hours.

5.4.4.18. VULNERABILITY

National level

The Malawi Vulnerability Assessment Committee (MVAC) is a Government-led, multi-agency body that is mandated by the Government to conduct vulnerability assessments and analyses to provide timely early warning information on the food security situation in the country. The Committee was formed in 2002 following the Southern African Food Crisis of 2001-2002 and it has been in operation since then.

Study area level

According to the World Bank's definition, a vulnerable group is a section of the population that is at greater risk of poverty than other people living in the same area targeted by a project.

Vulnerable people include the elderly, people with disabilities (mental or physical), children and young people at risk, displaced persons, refugees, people living with HIV, ethnic minorities and possibly women heads of household. Vulnerable groups are characterised by limited resilience to avoid poverty and very few opportunities to escape chronic poverty.

However, measuring vulnerability remains complex, as it is a concept that includes a wide range of variables: a single indicator cannot assess all the variables that can affect vulnerability. According to the literature available on the Kapichira project, and studies on food vulnerability in particular, a household is more likely to be in a situation of vulnerability in the following cases, among others:

- Women-headed household: Household headed by women who are unmarried, divorced, widowed or have been abandoned by their husband, with or without children. Based on the 2024 socioeconomic survey, 35% of households in the study area are headed by women, which is similar as the national level.
- Household headed by a disabled person: Household headed by an individual who is unable to work or to communicate and understand information due to a chronic illness, mental or physical disability.
- Household headed by an elderly person (over 65).
- Orphan-headed household: Households composed by children under-18 who do not live with any other over-18 physically able and productive household member
- Landless household: Household who do not have access to (own or rent) any agricultural land. Landless individuals constitute a minority: national-level data from 2007 indicates that only approximately 2% of people did not own productive land. The 2024 study reported that 14.7% of the households have no farming land. Among them, 56 % are male headed household and 44% female headed household.

5.4.5. Socioeconomic characteristics

5.4.5.1. GENERAL CONTEXT OF LIVELIHOOD

National level

The 2018 Malawi Population and Housing Census (National Statistical Office) reported the total percentage of economically active persons among the total working age population (persons aged 15 to 64 years) was higher in rural areas (72.7 %) compared to urban areas (68.6 %).

The 2018 Malawi Population and Housing Census reported that the primary sector dominated the Malawi economy: in 2018, 73 % of the employed persons were in the primary sector (including agriculture, natural resources, mining and fisheries industries), 22.9% in the tertiary sector (service industry) and 4.2% in the secondary sector (manufacturing industry) with the repartition by sex in the following figure.

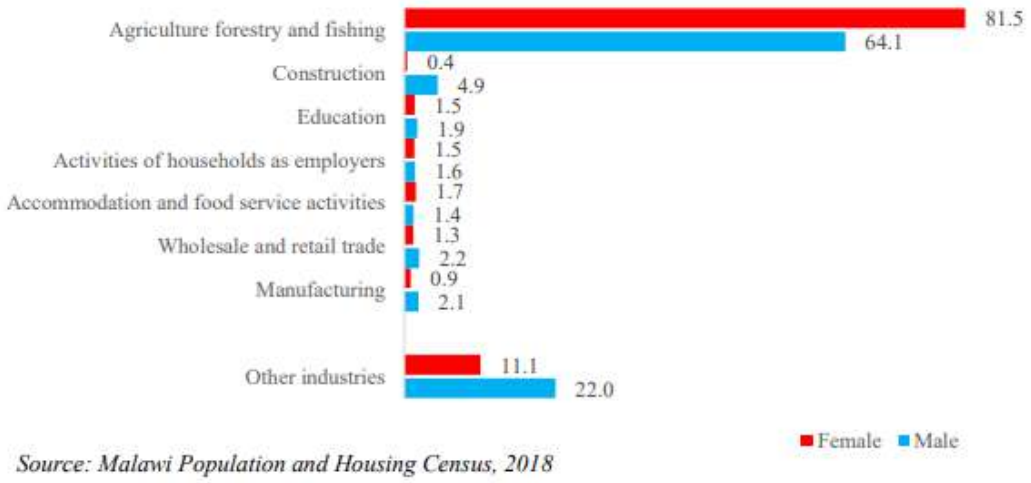


Figure 5-54: Percentage distribution of employed persons by industry and sex in Malawi in 2018

In Malawi, casual off-own-farm labour is very common and is called "*ganyu*". Common *ganyu* tasks include ridging – land preparation done before the growing season – and weeding – which is done during the growing season. The 2018 Malawi Population and Housing Census reported that *ganyu* was the main source of income in Malawi with 37.4 % of households relying on *ganyu* to earn income.

District level

The 2018 Malawi Population and Housing Census reported that *ganyu* was the main source of income in Chikwawa district with 50.6 % of households relying on *ganyu* to earn income followed by food crops sales for 10.8% of households.

Study area

The 2024 survey showed that the source of income come from task-based work for 43.5% of the people, from the combination of task work and farming for 21.4% of the people, from the combination of task work, business and farming for 9.9% of the people.

In total, 83% of household income come from task-based work.

5.4.5.2. AGRICULTURE

National level

Around 85 percent of Malawi's population is estimated to live in rural areas and rely on rainfed agriculture for employment. Nine-tenths of rural households engage in subsistence farming, cultivating small and fragmented land held under uncertain customary tenure.

Malawi's commercial estate farms generate 80 percent of the country's exports—mainly tobacco, tea, and sugar—and are run mostly by multinational firms operating out-grower schemes that contract nearby smallholders. These large firms are generally vertically integrated and dominant in their sector.[20]

[20] World Bank, Country partnership framework for Republic of Malawi, 2021

District level

The farming system in Chikwawa district is composed of rainfed system from December to April and irrigated farming system between April and May.

Up to 89.2% of households in Chikwawa are engaged in farming especially rain-fed (75.8%) agriculture. However, the floods recorded in the years 2015, 2019 and 2022 have devasted the plots on the Shire riverbanks.

The Chikwawa District Socio-economic Profile (2017-2022) reported that 39% of the population in the district are farmers with an average area of less than 0.5 ha per farming family.

Study area

The floodplain agriculture is mostly practised along the riverbanks downstream of the Kapichira Dam. Two farming systems: rainfed from December to April and irrigated from May to April, with three harvests a year considering that the third round of maize is harvested in December. It has been reported that, during the wet season, rice and maize are produced in the nutrient-rich soils brought in by the floods. Farming is nevertheless disrupted by flooding, which leads to the loss of land and crops, soil erosion and the accumulation of sandy sediment on arable land.

The 2024 survey found that 87% of households grew maize in 2024. 60% of households grew sorghum and 14,6% of households grew millet. However, the harvest for all the three crops was very low, requiring having other source to get maize grains. Therefore, 62.3% bought maize grains, 25% bought food, 7% received maize from relations, 5.1% received food rations and 0.6% used their own production.

The flood-prone Shire Valley (Chikwawa and Nsanje Districts) is a beneficiary of the Malawi Drought Relief and Recovery Programme (MDRRP) and the Malawi Flood Emergency Recovery Programme (MFERP). These two programmes have helped rural families by providing them with agricultural inputs and other necessities such as maize flour, pulses, salt, cooking oil, textured vegetable protein and sugar.

The 2024 survey found that 14.7% of households have no farming land, 41.1% of farm households own less than 0.5 hectare of land, 29% own 0.5 to 1 hectare and 14.9% own one hectare or more. The average plot of land is 0.6 hectares in the study area.

5.4.5.3. LIVESTOCK

National Level

Most households in Malawi owned chickens (33.2 percent), seconded by goats at 17.8 percent and then pigs at 7.7 percent. Across regions, Northern region had the highest percentage of households who owned chickens at 49.7 percent compared to Central and Southern regions at 32.0 percent and 30.0 percent respectively

Livestock production, which contributes about one-fifth of the value of total agricultural production, consists mainly of subsistence grazing of sheep, cattle, goats, poultry and pigs [21].

[21] WTO, 2002

District level

The livestock in the district are cattle, goats, poultry, pig, rabbits and sheep. Chikwawa district estimates that about 48% of households own livestock.

Study area

In the study area, 29% of households owned chickens, 16% of households owned goats, 13% of households owned cattle and 4% of households owned pigs.

In the study area, it was reported that the goats provide considerable support to families when agricultural production is low. Some organizations (such as World Vision International, Catholic Development Commission, Food and Agriculture Organisation of the United Nations through the District Agriculture Office) have assisted rural households by providing support with goat's programme.

5.4.5.4. FISHERIES

National level

Total reported fish landings average 143,000 t of catch each year, and approximately 128,700 t of this are from small-scale fisheries

District level

The 2018 Malawi Population and Housing Census reported that fishing is the main source of livelihood for 0.2% of households in the Chikwawa district (less than national rate = 0.9%).

Chikwawa district includes 1,324 fishers and 594 fish farmers and traders.

The fish production[22] is however declining due to the overfishing, habitat degradation of aquatic environment and climate change. The following table shows the average fish capture for the past years.

Table 5-24: Fish capture in Chikwawa district

Year	Catch of fishes (Tons)
2018/2019	313.51
2019/2020	339.50
2020/2021	265.41
2021/2022	233.33

Source: Chikwawa District Council Socio-economic Profile, 2022-2030

Study area

The fishing practised in the study area is both angling and netting. Line fishing is popular in the dry season, but during the rainy season, when the water is murky, fishermen use nets.

[22] Chikwawa District Council Socio-economic Profile, 2022-2030

The main fish species include: Chambo (*Oreochromis karongae*), Agale (*Labeo cylindricus*), Milamba (*Clarias gariepinus*), Mitcheni, Kholomo, Nyanda, Gundawala (*Labeo congoro*).

Fishermen have indicated that the quantity of fish fluctuates throughout the year. However, they have noticed a reduction in catches over the years and especially after the Kapichira dam break. Fishermen have indicated that they have lost breeding grounds due to siltation and consequent loss of depth. Therefore, some fishermen reported that they had diversified their livelihoods by taking up charcoal production in the communal forests, although this is illegal.

5.4.5.5. TOURISM

General context

Blantyre is a key hub for business, while neighbouring Chikwawa District is home to the successful Majete Wildlife Reserve, restored through conservation efforts. Another attraction is the Elephant Marsh, offering diverse landscapes.

Study area

Chikwawa District is the home to the Majete Wildlife Reserve, where is located the dam.

The Majete Wildlife Reserve is a testament to successful conservation efforts in the region. Originally established in 1955, the reserve faced severe depletion of its wildlife populations due to poaching and habitat loss. However, a remarkable transformation occurred in 2003 when African Parks initiated an ambitious restoration project in collaboration with the Malawi Department of National Parks and Wildlife (African Parks, 2023). African Parks assumed responsibility for the management of Majete Wildlife Reserve on 28th March 2003 in a Public Private Partnership agreement on an area of 720 km^2. The management agreement runs for an initial term of 25 years until 2028, with the option of a further extension of 15 years on agreement between parties.

This intervention involved reintroducing key species, implementing anti-poaching measures, and rehabilitating habitats. The results have been noteworthy, with the once-depleted animal populations rebounding, including significant increases in elephant, rhinoceros, and other keystone species. The reserve now boasts a thriving ecosystem, drawing attention for its successful conservation model that intertwines community engagement, sustainable tourism, and biodiversity preservation.

The reserve includes two lodges (Thawale and Mkulumadzi) and bush camping with tents.



Figure 5-55: Majete environmental education center

Downstream Kapichira dam, along the Shire River, at Maganga 1, two lodges thrive on tourism linked to the Majete Wildlife Reserve:

- at 3 km downstream from the dam site, Ng'ona (meaning "crocodile" in local language) lodge, opened in 2010, consisting of 5 chalets, restaurant and swimming-pool;
- at 4 km downstream from the dam site, Zua Safari lodge, opened in 2022, consisting of chalets, dormitory, camping, restaurant and swimming-pool.





Figure 5-56: N'gona lodge (left) and Zua safari lodge (right)

Another tourist attraction, is in the Chikwawa District, is the Elephant Marsh. The Elephant Marsh is located at the Lower Shire Valley's southern end and outside the construction influence area. The Elephant Marsh, situated in the floodplain of the Shire River, occupies the southernmost tip of Malawi. It resembles a semi-permanent marshland at its northern edges, transitioning into a small lake to the south. Salt-formed islands host palm trees, while a floating mass of vegetation (sudd) thrives in the marsh, sometimes becoming so dense that it obstructs boat passage.



Figure 5-57: Elephant Marsh

5.4.5.6. SUPPORT PROGRAMMES

The flood prone region of the Shire Valley (Chikwawa and Nsanje) makes it a beneficiary under the Malawi Drought Relief and Recovery Programme (MDRRP) and the Malawi Flood Emergency Recovery Programme (MFERP). Both programmes have assisted rural families with farm input support and other household essentials like maize flour, grain legumes, salt, cooking oils, textured vegetable protein, sugar among others. Most non-governmental organisations operating in the district follow the same process.

Some organizations (such as World Vision International, Catholic Development Commission, Food and Agriculture Organisation of the United Nations through the District Agriculture Office) have assisted rural households by providing support with goat's programmes.

5.4.5.7. ECOSYSTEM SERVICES

Introduction

The World Bank Environmental and Social Standards specify that the ecosystem services are the benefits that people derive from ecosystems. They are organized into four types:

- Provisioning services are the products people obtain from ecosystems and which may include, but are not limited to, food, freshwater, timbers, fibres, and medicinal plants.
- Regulating services are the benefits people obtain from the regulation of ecosystem processes, and which may include surface water purification, carbon storage and sequestration, climate regulation, protection from natural hazards.
- Cultural services are the non-material benefits people obtain from ecosystems, and which may include natural areas that are sacred sites and areas of importance for recreations and aesthetic enjoyment; and
- Supporting services are the natural processes that maintain the other services, and which may include soil formation, nutrient cycling and primary production.

Ecosystem services valued by humans are often underpinned by biodiversity and impacts on biodiversity can often adversely affect the delivery of ecosystem services. Therefore, the identification of ecosystem services requires both social and environmental expertise and stakeholder consultation. While ecosystem services should be considered across multiple topic areas, with an emphasis on interlinkages between social and environmental aspects, the provisioning and cultural services are more related to social components of the environment.

Study area

In general, all villages collect wood for fire and construction. As indicated in sub-chapter 6.4.4.10, firewood is used for both cooking and heating. Charcoal is produced for home consumption and for sale, mainly used daily for cooking.



Source: Tractebel, August 2024

Figure 5-58: Charcoal sales on the road between Chikwawa and Blantyre

As described in the chapter 6.4.5.4, fishing is part of product coming from the Shire River for the benefit of the population.

As stated in the description of the biological environment (chapter 6.3.2.2), Elephant Marsh in the downstream area helps to store water, regulate hydrological regimes and provide nutrient-rich sediments. These functions are vital to local agriculture, particularly in winter when water availability declines. However, the site is under increasing pressure, including agricultural expansion, overexploitation of natural resources and the effects of climate change. Preserving its ecological integrity remains essential to maintain the exceptional biodiversity it hosts and to support the local population.



Source: Tractebel, August 2024

Figure 5-59: Elephant Marsh important for fisheries, flood control, water purification, nutrient cycling

6. ENVIRONMENTAL AND SOCIAL RISKS AND IMPACTS

6.1. Introduction

Environmental and Social risk for this project has been rated high in the project appraisal document from the World Bank (IDA – 6 June 2022) because the capacity of EGENCO with regard to environmental and social management and its knowledge of the ESF requirements of World Bank financed projects was noted to have been limited on previous World Bank funded project, even though since then improvements have been made on staffing under the current project to ensure adequate attention to safeguards issues. There is also significant risk to biodiversity if mitigation measures are not implemented appropriately, including at Majete Wildlife Reserve, fish biota within the river, and the Ramsar Elephant Marsh wetland downstream of the project site.

By identifying and analysing potential impacts, it is possible to assess their significance to propose the corresponding mitigation measures (to avoid, minimise and compensate the potential impacts), which will be included in the Environmental and Social Management Plan (volume 2 of the ESIA).

For memory, the Kapichira dam is an existing dam. In the construction influence area, the Majete Wildlife Reserve is the most sensitive receptor to be considered during the implementation of the project.

To carry out a relevant environmental and social impact assessment, the Owner's Engineer provided the technical characteristics, anticipated organization of the works and operational modalities.

This chapter includes:

- The methodology for risks and impacts assessment,
- The risks and impacts during the construction phase,
- The risks and impacts during the operation phase,
- The cumulative impacts.

6.2. Methodology for risks and impacts assessment

6.2.1. Impact significance assessment methodology

Based on the findings from the baseline, impacts are identified and assessed according to a methodology that refers to the following aspects:

- The project phases including two phases:
  - The construction phase includes the preparatory work for the rehabilitation works as well as all the construction activities up to the commissioning of the rehabilitated components of the projet (end of constructor activities).

- The operation phase takes place after the end of constructor activities and extends throughout the entire commissioning period of the hydroelectric development.

- The sources of impact, which are the activities and components of the project that generate impacts on the physical, biological, or human environment. This identification requires a thorough understanding of the technical project and is conducted for each project phase (construction and operation).
- The components of the environment, which can be divided into:
  - The physical environment (water, soil, air),
  - The biological environment (natural habitats, fauna and flora), and,
  - The human environment (population, human activities).
- The identification and analysis of impacts, which is carried out for each phase of the project by studying the interactions between the sources of impact of the project and the components of the environment, particularly the most sensitive ones.
- The Impact assessment criteria: Impact assessment considers the intensity, duration and scale of the impact. Adapted to this project, the criteria for assessing impacts, whether direct or indirect, reversible or irreversible, are as follows:
  - Nature: the risk or impact is positive or negative,
  - Duration: the risk or impact may be:
    - Temporary (linked to the activity that generates it), or,
    - Long-lasting (beyond the period of this activity), or,
    - Irreversible (of indefinite duration).
  - Extent (geographical): For this project, the extent is considered as:
    - Local: If the impact affects:
      - the direct footprint area and the associated construction facilities,
      - within the same traditional authority area, and,
      - out of Majete Wildlife Reserve.
    - Regional: If the impact affects:
      - a territory aggregating more than two (2) traditional authority area within the same district (administrative region) and/or
      - an area of ecological importance such as the Majete Wildlife Reserve.
    - National: If the impact affects:
      - a territory aggregating more than two (2) districts.
    - International when it affects an area beyond Malawi.
  - Intensity of impact, which is qualified as follows:
    - Low, when the impact causes minor changes in the affected component,
      - with no economical or physical displacement,
      - with only a limited number of people affected,
      - with no fauna and flora species of conservation value
      - with no sensitive receptor (such as critical habitat or vulnerable communities).

- Medium, when the impact significantly disrupts a component of the environment without jeopardising its use or existence, or,
  - . When the land acquisition affects less than 200 people with no physical displacement, or,
  - . When the project disrupts several species but none that are of conservation value,
  - . With no sensitive receptor (such as critical habitat or vulnerable communities).
- High, when the impact affects a significant component of the environment or
  - . when the land acquisition affects more than 200 people[23] or
  - . when the project affects remarkable species (species of conservation value) or,
  - . when sensitive receptor (such as critical habitat or vulnerable communities or cultural heritage of importance…)

- The impact significance assessment methodology: The significance of an impact is its final assessment. It is determined by weighting the duration, extent and intensity of the impact according to the evaluation grid[24] presented in the following table. The significance of the impact is defined as Minor, Moderate, or, Major as follows .

Table 6-1: Impact significance assessment

Duration	Extent	Intensity	Negative significance	Positive significance
Irreversible	National / International	High	Major	Major
		Medium		
		Low		
	Regional	High	Major	Major
		Medium		
		Low	Moderate	Moderate
	Local	High	Moderate	Moderate
		Medium		
		Low	Minor	Minor
Long-lasting	National / International	High	Major	Major
		Medium		
		Low	Moderate	Moderate
	Regional	High	Major	Major
		Medium	Moderate	Moderate
		Low		
	Local	High	Moderate	Moderate
		Medium		
		Low	Minor	Minor
Temporary	National / International	High	Moderate	Moderate
		Medium		
		Low	Minor	Minor
	Regional	High	Moderate	Moderate
		Medium		
		Low	Minor	Minor
	Local	High	Minor	Minor
		Medium		
		Low		

[23] The World Bank, Involuntary resettlement sourcebook, 2004

[24] It is an adaptation of the Hydro-Quebec grid that is already used in the environmental studies.

When negative, the impact significance is qualified as follows:

- A minor impact is one that:
  - Causes limited change to the affected environment;
  - Is confined to a small area;
  - Is temporary or readily reversible;
  - Does not threaten the viability or function of the affected resource;
  - Can usually be managed through standard mitigation measures.
- A moderate impact is one that:
  - Produces a noticeable change in environmental or social conditions;
  - Extends beyond the immediate project footprint;
  - May persist for several years;
  - Affects sensitive receptors but does not fundamentally compromise their long-term integrity;
  - Requires specific mitigation and follow-up measures.
- A major impact is one that:
  - Causes substantial change in the environment or community ;
  - Affects highly sensitive or valuable resources;
  - Is regional in extent, long-term, or permanent;
  - May be irreversible or difficult to reverse;
  - Can significantly affect ecosystem functions, biodiversity, livelihoods, or cultural values;
  - May jeopardize project approval unless avoided, reduced, or compensated.

The application of the methodology described above makes it possible to characterise each impact of the project in the following way, for each phase of the project.

Table 6-2: Impact characterisation matrix

Source of risk/impact	Risk / Impact	Component of the environment	Criteria		Importance
Description	Description	Physical Biological human	Nature		*Minor* *Moderate* *Major*
			Duration		
			Extent		
			Intensity		

This analysis makes it possible to determine the most significant impacts on the environment and to compare the impacts with each other. The application of the grid provides an indicative result that does not replace the analyses and expert assessments that may be carried out in certain cases.

- The mitigation measures hierarchy: If a particular potential impact of the project is considered to be significant (major or moderate) through the above methodology, the next step is to determine which mitigation measures can be taken to avoid (or eliminate), minimise (or reduce), restore (or repair) the impact, and if necessary, compensate for it.

- The residual impact methodology: It refers to the impact that remains after the application of mitigation measures. The impact assessment process should seek to iteratively consider the likely effectiveness of the measures in reducing the magnitude of the impact, and identify additional or alternative measures, so that the residual impact is not significant. The analysis of residual impacts considers all proposed avoidance and impact reduction measures. If, after implementing the mitigation strategy, an impact remains and is still considered significant, it may trigger the need for offset measures.

  Residual impacts are assessed for each previously identified impact. This step is critical in the overall assessment, as it directly influences whether compensatory actions will be required.

6.2.2. Cumulative impacts

During the process of identifying environmental and social impacts and risk, the Consultant has identified that the project activities may contribute to cumulative impacts on environmental and social components on which other existing or future developments may also have detrimental effects.

A list of historical, current, and planned activities and projects in the project area have been established to assess the cumulative impacts resulting from the interactions between the project and other activities in the affected region.

A desk review was carried out about the main projects in the project's area of influence, in particular the rapid assessment of the cumulative impact of the Mpatamanga hydroelectric project (Southern Waters, March 2022) and the Mpatamanga cumulative impact study (Multiconsult, Southern Waters, Deltares, C12, October 2024).

Based on this analysis, consultations with the affected communities enables the Consultant to determine whether the activities are likely to significantly affect the sustainability of identified environmental and social components.

6.3. Risks and impacts during the construction phase

6.3.1. Description of the main activities in the construction phase

The construction works will be carried out according to the execution plan detailed below:

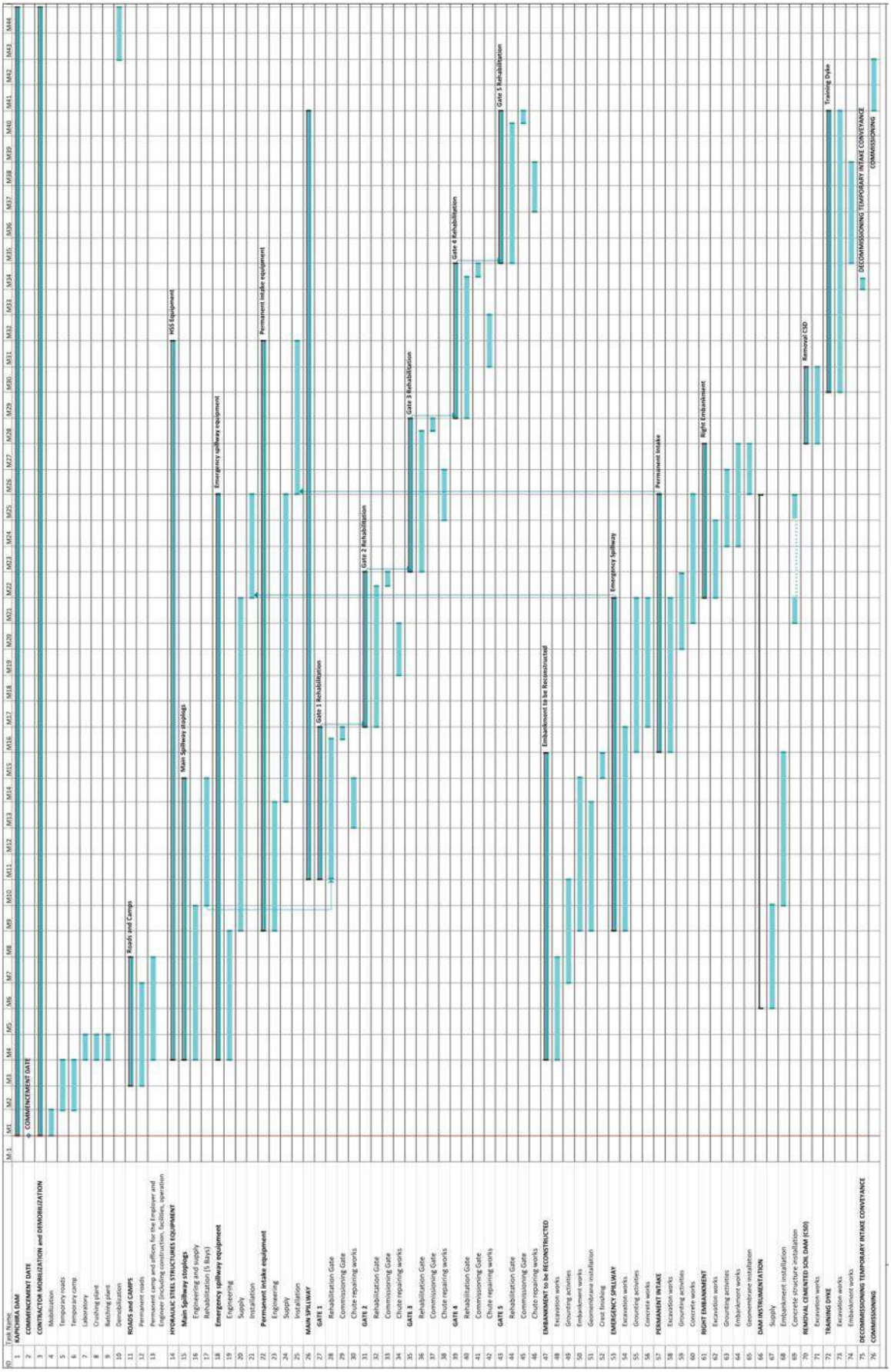
- Recruiting and mobilization of workers for the project
- Installation of construction camps
- Construction and maintenance of access roads
- Acquisition of quarry site and access road
- Power and lighting installations
- Removal of dam material (in the embankment section that will be rehabilitated)
- Excavation works in the quarry site
- Zone filling of breached dam wall
- Construction of new emergency spillway

- Rehabilitation of existing main spillway
- Reconstruction of SVTP irrigation intake
- Decommissioning of temporary cofferdam
- Excavation of sediment in the works area of the reservoir
- Rehabilitation of works areas
- Demobilization of the contractor upon completion of construction activities.

The time needed for all the construction activities is estimated to 42 months plus 2 months of demobilization, meaning 3,5 years. A duration of 2 months was considered for commissioning activity.

The tentative Gantt diagram is provided in the following figure. The duration of the construction time for the Kapichira rehabilitation project has been estimated based on a suitable contractor's standard production for excavations, cement, etc. It should be adapted by the Constructor with the seasonal constraints when the commencement date is known.

It must be noticed that some construction activities must be carried out during low level of Shire River, meaning the dry season, such as the partially removal of the training dyke.



Source: Studio Pietrangeli Consulting Engineers, 200GENRSP001A, Detailed Design Report, May 2025

Figure 6-1: Tentative construction activities

6.3.2. Identification of impact sources in the construction phase

The impact sources are the activities and components of the project that generate impacts on the physical, biological, or human environment for the construction phase.

Identifying the most significant sources of impact makes it possible to analyse and assess the project's impacts more precisely by comparing them with the most sensitive environmental components. The sources of impact that the project may generate during the construction phase are presented in the table below.

Table 6-3: Impact sources during the construction phase

Impact sources	Description
Construction phase	
Labour influx and community interaction	All activities relative to the mobilisation of workers with the community interaction.
Site setup and construction works	All activities related to the dam rehabilitation, including supply-chain resource extraction, excavation works, earth movements, and blasting required for the dam rehabilitation as well as the construction of temporary camp, the access roads and all the construction facilities.
Transport and traffic related to the construction activities	Transport of construction materials, movement of construction vehicles on the construction site and the external roads
Presence of workers	Around 150 workers will be employed for the construction activities: Job opportunities, equipment and facilities dedicated to workers. Residence and circulation of contractor staff, migrants and consultants.
Exploitation of the quarry and borrow areas	Temporary exploitation of quarry and borrow sites, excavation works and blasting
Removal of the coffer dam	Part of the current embankment material, between the existing training dyke and the dam embankment, will be removed, both to restore the function of the training dyke and to allow the water in the reservoir to feed the permanent SVTP irrigation intake. This activity will be carried out when the other components (embankment dam, spillways and intake) are rehabilitated.
Dismantling of all temporary construction facilities	Dismantling of the temporary contractor's camp, of the construction facilities, and restoration of construction temporary sites

6.3.3. Impacts on the physical environment

6.3.3.1. INTRODUCTION

The impacts identified on the physical environment are as follows:

- Deterioration in air quality due to dust and gas emissions
- Increase in noise level
- Soil and water pollution by liquid or solid waste
- Risk of erosion and modification of the physicochemical properties of the soil
- Pressure on water resources
- Modification of flow conditions on the Shire River

- Disaster risk due to the lack of emergency spillway
- Increase of sediments in the reservoir

6.3.3.2. DUST AND GAS EMISSIONS – DETERIORATION IN AIR QUALITY

Impact analysis

This impact is relative to the following sources:

- Site setup and construction works,
- Transport and traffic related to the construction activities,
- Exploitation of the quarry and borrow sites,
- Dismantling of all construction facilities at the end of the construction phase.

These nuisances are dealt with together, since they originate from the same source of impact. The earth movements at the dam site, the quarry and borrow sites exploitation as well as the batching plant works will generate dust emissions due to excavations works. A deterioration in air quality is to be expected, particularly as a result of the dust emitted by vehicles passing along the roads (in particular when working on the clay borrow site located at 10km from the dam site) and on the construction activities (such as batching plant activities, waste disposal sites). CO_2 emissions from the use of machinery will also have an impact on air quality. This deterioration in air quality could lead to occasional health risks (respiratory problems, coughing, etc.).

These effects will be felt beyond the construction influence area. Considering that the wind is coming from the South, it is likely that the change in air quality is felt at the EGENCO residential site due to quarry site and batching plant activities located less than 1 km.

The following WB environmental and social standards apply:

- ESS 1 - Assessment and Management of Environmental and Social Risks and Impacts
- ESS 3 - Resource Efficiency and Pollution Prevention and Management

Impact assessment

- This impact negatively affects the physical environment, and consequently the human environment.
- The duration is temporary as the impact will only occur during the construction activities.
- The extent is regional as the impact could be felt beyond the construction influence area. Borrow site at 10 km from the dam site, quarry blasting, haul roads and concrete batching at 1 km from a wildlife reserve and settlements could exceed 150 µg/m³ PM_{10} 24-h limit without control.
- The intensity of this impact is considered as medium due to the nature of the works (rehabilitation), the duration (3,5 years) and the limited number of vehicles.

The significance of the impact is defined as follows:

Sources of risk/impact	Impact/Risk	Affected components of the environment	Criteria		Importance before mitigation
- Site setup and construction works - Transport and traffic related to the construction activities - Exploitation of the quarry and borrow sites - Dismantling of all temporary construction facilities	Dust and gas emissions - Deterioration in air quality	Physical *Human*	Nature:	Negative	Moderate
			Duration:	Temporary	
			Extent:	Regional	
			Intensity:	Medium	

The following mitigation measures must be implemented to minimize this environmental impact:

- Regarding the movement of the construction vehicles, the speed limit must be restricted to 40 km/h on the unpaved surfaces to prevent dust and 20 km/h within the direct footprint area.
- The Contractor must provide well-maintained machinery in compliance with current standards.
- The vehicles motor must be turned off when parked to prevent useless air pollution.
- When the vehicles transport construction materials, the material must be covered up by a tarp to avoid the materiel dispersion, especially during wind periods.
- If the vehicle passage on non-paved roads causes significant sand dispersion, the Contractor must spray water on these areas to minimize dust dispersion.

The mitigation measures are detailed in the resource efficiency and pollution prevention and management plan (CP4) in the ESMP (volume 2 of the ESIA).

Residual impact

Impact	Significance *before mitigation*	Residual impact significance
Dust and gas emissions - Deterioration in air quality	Moderate	**Minor**

6.3.3.3. INCREASE IN NOISE LEVEL

Impact analysis

This impact is relative to the following sources:

- Site setup and construction works,
- Transport and traffic related to the construction activities,
- Exploitation of the quarry and borrow sites,
- Dismantling of all construction facilities at the end of the construction phase.

The construction activities will increase the noise level, disturbing workers, local communities and the local wildlife, in particular blasting at quarry site or dam site. The increase of traffic related to the construction activities will as well increase during the four years of works.

These effects will be felt within the construction influence area. Considering that the wind is coming from the South, it is likely that the increase of noise is felt at the EGENCO

residential site due to the proximity of the quarry site and the batching plant (less than 1 km) as well by the wildlife due to the proximity of the Majete wildlife Reserve (less than 1 km from the direct footprint area).

The following WB environmental and social standards apply:

- ESS 1 - Assessment and Management of Environmental and Social Risks and Impacts
- ESS 3 - Resource Efficiency and Pollution Prevention and Management

Impact assessment

- This impact negatively affects the physical environment, and consequently the biological (fauna) and human environment.
- The duration is temporary as the impact will only occur during the construction activities.
- The extent is regional as the impact could be felt within the construction influence area with African Parks field camp and EGENCO housing lying within 2 km.
- The intensity of this impact is considered as medium due to the nature of the works (rehabilitation), the duration (3,5 years) and the level of noise (the intensity during blasting could be considered as high (blasting Lmax could exceed daytime 55 dB limit). However, the level of noise and the frequency will be limited for this rehabilitation works activities).

The significance of the impact is defined as follows:

Sources of risk/impact	Impact	Affected components of the environment	Criteria		Importance before mitigation
- Site setup and construction works - Transport and traffic related to the construction activities - Exploitation of the quarry and borrow sites - Dismantling of all temporary construction facilities	Increase in noise level	Physical *Biological (fauna)* *Human*	Nature: Duration: Extent: Intensity:	Negative Temporary Regional Medium	Moderate

The following mitigation measures must be implemented by the Contractor to minimize this environmental impact:

- The blasting (or any other noisy activities) should be scheduled during the day (avoiding night period) and provide advance warning to EGENCO compound and African Park camp well as local communities (Liwonde and Maganga villages located less than 2 km).
- The Contractor must provide well-maintained construction vehicles to avoid excessive noises. The vehicles motor must be turned off when parked to prevent useless noise.
- The Contractor must also provide adequate earmuffs and earplugs for all workers and visitors close to noisy activities. Wearing earplugs must be mandatory for the workers during noisy activities on the construction site.

The mitigation measures are detailed in the resource efficiency and pollution prevention and management plan (CP4) in the ESMP (volume 2 of the ESIA). .

Residual impact

Impact	Significance *before mitigation*	Residual impact significance
Increase in noise level	Moderate	**Minor**

6.3.3.4. SOIL AND WATER POLLUTION BY LIQUID OR SOLID WASTE OR HAZARDOUS MATERIALS

Risk analysis

The risk of pollution is relative to the following sources:

- Site setup and construction works,
- Transport and traffic related to the construction activities,
- Exploitation of the quarry and borrow sites,
- Removal of the coffer dam,
- Presence of workers,
- Dismantling of all construction facilities at the end of the construction phase.

The risk of pollution can be solid or liquid and can impact soil, surface water and groundwater. The contamination of land and surface water can come from spills of hazardous substances.

The risk of solid pollution is due to the presence of workers during the construction activities: poor waste management can cause excessive domestic waste that can lead to soil and water pollution. The construction activities will generate solid waste requiring appropriate management to avoid any pollution.

Liquid pollution could come from accidental spill of chemical substance or leak of hydrocarbons coming from construction vehicles. For instance, repeated passage of site machinery can imply accidental oil spills that lead to soil contamination and point source pollution. The release of sewage from workers camp or uncontrolled and/or polluted surface runoff from site installation areas and workers' camp can also result in the pollution of soils, groundwater or surface water.

Accidental spills and leaks of hazardous substances at worksites, quarry, borrow site, camp sites should be as well considered. The Project will require storage and handling of hazardous substances, such as chemical additives used in preparing concrete, small quantities of solvents and paints and larger quantities of hydrocarbons comprising diesel fuel, hydraulic fluids, lubricating oils. The inventory of hazardous substances and the types of storage and handling activities will be defined by the Contractor. However, it can be expected that there will be several diesel storage tanks (typically in the order of 20-30 m^3 volume), vehicle refuelling areas, and areas dedicated to the storage of chemicals and hazards wastes (such as used oils) stored in iso-containers and drums.

The project area is surrounded by several sensitive receptors such as the Shire River, with the Elephant Marsh wetland situated downstream. The tributaries of the Shire River (downstream the dam site) along the campsite and the quarry site are in particular sensitive areas due to risk of water pollution.

The following WB environmental and social standards apply:

- ESS 1 - Assessment and Management of Environmental and Social Risks and Impacts
- ESS 3 - Resource Efficiency and Pollution Prevention and Management

Impact assessment

- This impact negatively affects the physical environment, and consequently the biological and human environment.
- The duration is temporary as the impact will only occur during the construction activities.
- The extent is regional as the risk of pollution could be felt beyond the construction influence area, in particular downstream.
- The intensity of this impact is considered as low due to the nature of the works (rehabilitation with limited number of vehicles and workers) and the level of pollution (the project might have a limited quantity of chemical products).

The significance of the impact is defined as follows:

Source of risk/impact	Risk	Affected components of the environment	Criteria		Importance before mitigation
- Site setup and construction works - Transport and traffic related to the construction activities - Exploitation of the quarry and borrow sites - Removal of the coffer dam - Dismantling of all temporary construction facilities - Presence of workers	Soil and water pollution by liquid and solid waste	Physical	Nature:	Negative	Minor
			Duration:	Temporary	
			Extent:	Regional	
			Intensity:	Low	

The following mitigation measures must be implemented by the Contractor to minimize this environmental impact:

- Use of machinery and equipment in compliance with current standards and regularly maintained.
- Establishment of an area for unloading chemicals and for parking and maintenance of machinery. No fuel or chemical storage shall be located within 50 m of watercourses or within 100 m of floodplain margins of the Shire River.
- Storage and handling of chemicals and explosives in accordance with safety rules (storage compatibility rules, retention basin, suitable location, ventilated without sources of heat, light, or humidity, etc.).
- Consider the Basal Convention on the control of transboundary movements of hazardous wastes and their disposal (BC-14/12).
- Management of aqueous discharges: installation of a tank for the recovery of industrial effluents (evacuated to an approved channel), installation of sanitary facilities for wastewater.
- Management and sorting of waste according to its type.
- Implementation of an emergency pollution management procedure (anti-pollution kits, use of absorbent booms, etc.) and staff awareness.

- During the rainy season, consider the possibility of flooding from nearby river tributaries and implement measures to prevent the spread of pollution (diversion, trench, or creation of a structure)

The mitigation measures are detailed in the waste management plan (CP2), hazardous substances management plan (CP3) and the resource efficiency and pollution prevention and management plan (CP4) in the ESMP (volume 2 of the ESIA).

6.3.3.5. LIGHT POLLUTION

Risk analysis

The risk of pollution is relative to the following sources:

- Site setup and construction work including nightworks activities,
- Transport and traffic related to the construction activities,
- Presence of workers.

The risk of light pollution is likely to significantly affect the quality of the living environment for visitors and local communities.

The nighttime construction lighting can intensify the sky glow phenomenon, reduce star visibility and degrade the nocturnal landscape value, which is central to the immersive experience in the MWR. Indeed, the presence of artificial lights can diminish the sense of wilderness isolation and sensory immersion, directly affecting the MWR's tourist appeal. Moreover, the impacts of the construction activities add to those already generated by the dam existing infrastructure, further degrading the nocturnal living environment and reducing the recreational and heritage value of the reserve.

The following WB environmental and social standards apply:

- ESS 1 - Assessment and Management of Environmental and Social Risks and Impacts
- ESS 3 - Resource Efficiency and Pollution Prevention and Management
- ESS 6 – Biodiversity Conservation and Sustainable Management of Living Natural Resources

Impact assessment

- This impact negatively affects the physical environment, and consequently the biological and human environment.
- The duration is temporary as the impact will only occur during the construction activities.
- The extent is regional as the risk of pollution could be felt beyond the construction influence area, within the MWR.
- The intensity of this impact is assessed as low, since it represents a cumulative effect that will further disturb an already degraded lighting environment within the Majete Wildlife Reserve.

The significance of the impact is defined as follows:

Source of risk/impact	Risk	Affected components of the environment	Criteria		Importance before mitigation
- Site setup and construction works - Transport and traffic related to the construction activities - Presence of workers	Light pollution	Physical *Biological* *Human*	Nature:	Negative	**Minor**
			Duration:	Temporary	
			Extent:	Regional	
			Intensity:	Low	

The following mitigation measures must be implemented by the Contractor to minimize this environmental impact:

- Avoid using lighting continuously for 24 hours where not necessary and use warm-colored LED lights.
- Limit the lighting in the construction area with limited and non-permanent lighting to reduce light 'spillage' if feasible and acceptable from a security standpoint.
- Install lighting systems that provide targeted illumination and use non-permanent fixtures to reduce light pollution.
- Ensure that high pole top lighting at these locations is shielded from the south, i.e. aimed towards the north and specifically away from the sensitive viewpoint sites especially for Majete. .

The mitigation measures are detailed in the lighting minimization measures included in the Construction biodiversity management plan (CP6) in the ESMP (volume 2 of the ESIA).

6.3.3.6. RISK OF EROSION AND MODIFICATION OF THE PHYSICOCHEMICAL PROPERTIES OF THE SOIL

Impact analysis

This impact is relative to the following sources:

- Site setup and construction works,
- Transport and traffic related to the construction activities,
- Exploitation of the quarry and borrow sites,
- Removal of the coffer dam,
- Dismantling of all construction facilities at the end of the construction phase.

All these actions can harm soil stability by disrupting its natural structure, leading to increased soil erosion. The removal of the existing vegetation makes the soil prone to erosion caused by wind and surface runoff. The soil structure, particularly the topsoil (i.e. the upper soil layer rich in organic material), can be damaged by earth movements, stockpiling, and compaction from heavy vehicles passing over.

This impact is particularly significant where vegetated and cultivated soils are affected such as the quarry, borrow site and camp site.

The exploitation of the quarry can lead to increased erosion in the water course situated south of the quarry. The construction activities can also cause an increased erosion and sedimentation of riverbanks downstream and in the reservoir.

Construction activities can also cause the formation of an impermeable layer on the soil surface, which will lead to more difficult water infiltration and favorize water runoff.

The following WB environmental and social standards apply:

- ESS 1 - Assessment and Management of Environmental and Social Risks and Impacts
- ESS 3 - Resource Efficiency and Pollution Prevention and Management

Impact assessment

- This impact negatively affects the physical environment, and consequently the biological and human environment.
- The duration is temporary as the impact will only occur during the construction activities.
- The extent is regional as the risk of pollution could be felt beyond the construction influence area, in particular downstream.
- The intensity of this impact is considered as medium due to the proximity with the tributaries of the Shire River for the quarry site and the temporary camp site as well as the proximity with the reservoir for the construction site area, taking into account the rainy season that could lead to heavy rains and the low vegetation cover of the project area.

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Affected components of the environment	Criteria		Importance before mitigation
- site setup and construction works - Transport and traffic related to the construction activities - Exploitation of the quarry and borrow sites - Removal of the coffer dam - Dismantling of all temporary construction facilities	Risk of erosion and modification of the physicochemical properties of the soil	Physical	Nature:	Negative	Moderate
			Duration:	Temporary	
			Extent:	Regional	
			Intensity:	Medium	

The following mitigation measures must be implemented by the Contractor to minimize this environmental impact:

- Limit earthworks to the strict site footprint.
- Limit soil sealing.
- Limit deforestation and revegetation (the root system helps maintain the soil and limits erosion caused by run-off and wind).
- Instal silt fences closed to the tributaries of the river near the quarry site and the temporary camp site.
- During the rainy season, consider the possibility of flooding via the tributaries of the river near the quarry site and the temporary camp site and put in place means of avoiding it (diversion, trench or creation of a facility).

The mitigation measures are detailed in the Sedimentation Control Plan (CP5) in the ESMP (volume 2 of the ESIA).

Residual impact

By implementing these measures, the intensity of this impact will be reduced as low, consequently the significance of the impact will be minor.

Impact/Risk	Significance *before mitigation*	Residual impact/risk significance
Risk of erosion and modification of the physicochemical properties of the soil	Moderate	**Minor**

6.3.3.7. PRESSURE ON WATER RESOURCES

Impact analysis

This impact is relative to the following sources:

- Site setup and construction works,
- Presence of workers.

The amount of water for drinking and sanitary needs depends on factors like the duration of construction activities, the number of workers and the nature of the construction works.

The water needed for the construction work (rehabilitation) should not represent a major water requirement based on the information provided by the owner's engineer and the phase 1 works. If water is abundant on site, a tanker can be used to spread water during construction to reduce dust.

For worker water consumption, an average of 50 L/day/person should be considered. Considering the maximum number of workers, estimated at 150 people, the total water consumption during the largest phase of work would be approximately 7,500 L of water per day.

Local communities did not mention difficulties in accessing water for their daily needs during phase 1 of the project and SVTP works.

The following WB environmental and social standards apply:

- ESS 1 - Assessment and Management of Environmental and Social Risks and Impacts
- ESS 3 - Resource Efficiency and Pollution Prevention and Management

Impact assessment

- This impact negatively affects the physical environment, and consequently the biological and human environment.
- The duration is temporary as the impact will only occur during the construction activities.
- The extent is local as the pressure on water resources is limited at the construction area.
- The intensity of this impact is considered as low as the construction activities should not represent a major water requirement.

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Affected components of the environment	Criteria		Importance before mitigation
- Site setup and construction work - Presence of workers	Pressure on water resources	Physical *Biological* *Human*	Nature:	Negative	Minor
			Duration:	Temporary	
			Extent:	Local	
			Intensity:	Low	

The following mitigation measures must be implemented by the Contractor to minimize this environmental impact:

- Study the most appropriate water supply solutions complying with current legislation.
- Consider the dry season and avoid competition with village boreholes.
- Use low-water consumption construction methods.
- Limit water consumption (taps fitted with aerators, dry toilets, etc.).

The mitigation measures are detailed in the resource efficiency and pollution prevention and management plan (CP4) in the ESMP (volume 2 of the ESIA).

6.3.3.8. RISK OF MODIFICATION OF FLOW CONDITIONS ON THE SHIRE RIVER

Impact analysis

This impact is relative to the following sources:

- Site setup and construction works.

The construction activities, especially the rehabilitation of the main spillway, can modify the flow conditions downstream of the Kapichira dam. The rehabilitation of the main spillway implies a change in the hoisting system.

During the works on the radial gates, the outflow can be modified because the concerned gates cannot operate correctly and pass water during the construction works. During the rehabilitation of the main spillway, all gates will not be operational simultaneously. This can alter the flow conditions on the Shire River downstream of Kapichira dam.

Part of the current embankment, between the existing training dyke and the dam embankment, will have to be dismantled, both to restore the function of the training dyke and in addition to allow the water in the reservoir to feed the permanent irrigation intake. This work will be carried out with reservoir water level of approximately 144.0 m, meaning at Minimum Water Level, avoiding the modification of flow conditions on the Shire River.

The following WB environmental and social standards apply:

- ESS 1 - Assessment and Management of Environmental and Social Risks and Impacts

Impact assessment

- This impact negatively affects the physical environment, and consequently the biological and human environment.

- The duration is temporary as the impact will only occur during the construction activities.
- The extent is regional as the modification of flow conditions can be felt beyond the construction area, downstream.
- The intensity of this impact is considered as low as the rehabilitation activities should not represent a major change in the flow conditions.

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Affected components of the environment	Criteria		Importance before mitigation
- Site setup and construction work - Removal of the coffer dam	Modification of flow conditions on the Shire River	Physical *Biological* *Human*	Nature:	Negative	Minor
			Duration:	Temporary	
			Extent:	Regional	
			Intensity:	Low	

The following mitigation measures must be implemented by the Contractor to minimize this environmental impact:

- Avoid the rainy season to work on the main spillway.
- Plan the activities on the main spillway after the availability of the emergency spillway.

The mitigation measures are detailed in the Construction Emergency Preparedness Plan (CP11) in the ESMP(volume 2 of the ESIA).

6.3.3.9. DISASTER RISK DUE TO FLOODING

Impact analysis

This impact is relative to the following sources:

- Site setup and construction works
- Removal of the coffer dam.

The disaster risk during construction phase could be linked due to the events of the spillway gate malfunction or a dam break in case of breach / failure on temporary cofferdam / training dyke. In these cases, the impact will lead to uncontrolled complete or partial emptying of the reservoir. This risk will be greater during the rainy season (period January – March) when the monthly flow is the highest.

High significance will occur downstream with catastrophic impact of flooding if it occurs (such as January 2022 floods caused by the tropical storm Ana). It could lead to the plant shutdown with power generation shutdown affecting all the country. However, the risk applies only until the new emergency spillway is functional, meaning during two years after the commencement of construction works.

The Consultant has defined a hydro-geomorphological floodplain using a 30 m AW3D digital terrain model, applied at the scale of the study. The method applied is based on identifying the minor bed and its immediate surroundings, then simulating a uniform rise in water level of approximately +5 m above the average thalweg elevation. This value was defined based on local topographical and hydrological observations. The approach thus adopted makes it possible to reconstruct a theoretical area likely to be submerged

in the event of a major flood, taking into account the relief forms and identifiable hydro-geomorphological constraints.

The results of this analysis were compared with the flooded areas produced by the hydraulic simulations presented in the Kapichira Dam Emergency Preparedness Plan. These simulations include several breach scenarios, notably the probable maximum flood (PMF) extreme scenario and a hundred-year flood (Q100) scenario, modelled downstream of the structure using two-dimensional propagation (HEC-RAS 2D).

The comparative analysis shows that, for all the scenarios considered, the modelled areas remain broadly included within, or locally coincide with, the hydro-geomorphological area. The spatial concordance between the two approaches, one based on morphological and topographical criteria, the other on transient hydraulic calculations, confirms the robustness of the delimitation obtained.

Consequently, the construction area (quarries, contractor camp, access roads) are located outside the identified flood hazard zones (see the Figure 6-2) and are therefore not directly exposed to inundation risk under the considered assumptions.

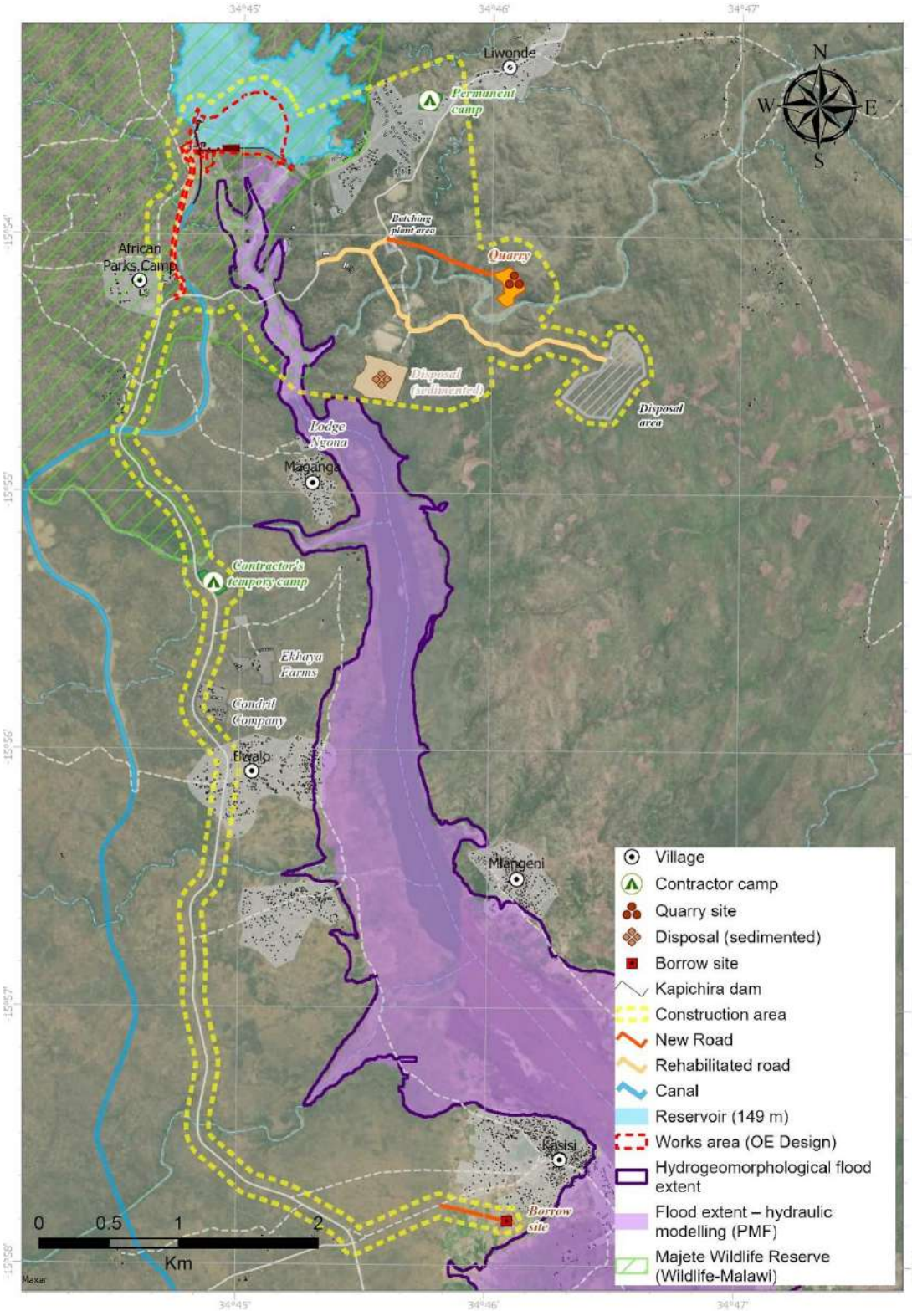


Figure 6-2: Hydrogeomorphological floodplain

The following WB environmental and social standards apply:

- ESS 1 - Assessment and Management of Environmental and Social Risks and Impacts

Impact assessment

- This impact negatively affects the physical environment as well as the biological and human environment.
- The duration is temporary as the risk will only occur during the construction activities.
- The extent is national as the risk could be felt in the downstream area with potential national impact in case of plant shutdown.
- The intensity of this risk is considered as high as it could lead at significant impacts downstream (including physical displacement).

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Site setup and construction works - Removal of the coffer dam	Disaster risk due to flooding	Physical *Biological* *Human*	Nature:	Negative	Moderate
			Duration:	Temporary	
			Extent:	National	
			Intensity:	High	

The Emergency preparedness plan should be put in place before starting the construction phase considering the followings:

- Monitoring of the flow during the rainy season.
- Provide flood contingency plan with trigger water levels, cofferdam overtopping criteria, standby pumps and 24-h weather watch.

The mitigation measures are detailed in the Construction Emergency Preparedness Plan (CP11) in the ESMP (volume 2 of the ESIA).

Residual impact

By implementing these measures, the intensity of this impact will be reduced as low, consequently the significance of the residual impact will be minor.

Risk/Impact	Significance *before mitigation*	Residual impact/risk significance
Disaster risk due to flooding	Moderate	**Minor**

6.3.3.10. INCREASE OF SEDIMENTS IN THE RESERVOIR

Impact analysis

This impact is relative to the following sources:

- Site setup and construction works
- Removal of coffer dam.

The construction activities and especially the works to be undertaken on the dam area can increase the accumulation of sediments in the reservoir of Kapichira dam.

The movement of machinery and soils in the dam construction area can lead to increased erosion of riverbanks, excess and dispersion of construction waste in the reservoir.

The following WB environmental and social standards apply:

- ESS 1 - Assessment and Management of Environmental and Social Risks and Impacts

Impact assessment

- This impact negatively affects the physical environment.
- The duration is temporary as the risk will only occur during the construction activities.
- The extent is local as the risk is limited to the reservoir area.
- The intensity of this impact is considered as low as the rehabilitation activities should not lead to a major change in the sediment's accumulation in the reservoir.

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Site setup and construction works	Increase of sediments in the reservoir	Physical	Nature:	Negative	Minor
			Duration:	Temporary	
			Extent:	Local	
			Intensity:	Low	

The following mitigation measures must be implemented by the Contractor to minimize this environmental impact:

- Avoid the movement of vehicles in the vicinity of the reservoir.
- Protect the vicinity of the reservoir from any soil spillage.

The mitigation measures will be detailed in the Sedimentation Control Plan (CP5) in the ESMP (volume 2 of the ESIA).

6.3.4. Impacts on the biological environment

6.3.4.1. INTRODUCTION

The impacts identified on the biological environment are as follows:

- Loss, fragmentation and degradation of natural habitats and flora
- Disturbance of wildlife
- Spread of flora invasive species
- Risk of human-wildlife conflict
- Risk of increased poaching
- Risk of aquatic mortality and loss of aquatic habitats

6.3.4.2. LOSS, FRAGMENTATION AND DEGRADATION OF NATURAL HABITATS AND FLORA

Impact analysis

This impact is relative to the following sources:

- Site setup and construction works,
- Transport and traffic related to the construction activities,
- Exploitation of the quarry and borrow sites

The setup of the construction camp site, batching plant area, borrow site and quarry site require land clearing, excavation works in the quarry site, removal and storage of dam material, construction and maintenance of access road during the construction phase. All these activities will lead to risk of habitat loss and degradation on about 25 hectares.

These impacts will be felt at the dam construction site itself, which is located in an area of Majete Wildlife Reserve leased by African Parks for SVTP project and dam rehabilitation activities, but also along the new access roads, quarry and camp site. However, it should be considered that the construction activities for SVTP project as well as the phase 1 rehabilitation have already cleared the trees in the direct footprint area (See Figure 5.18 in the chapter 5.2.13).

It must be highly considered in relation to the access road to the quarry site, the quarry site itself, and the disposal area, all of which are in well-conserved natural habitats outside the Majete Wildlife Reserve. These habitats consist of dry deciduous forest with mixed species, a type that is generally heavily degraded by human activities but is here found in good conservation status. Any disturbance to these habitats is therefore of high importance regarding the biodiversity associated.

For example, riparian vegetation clearance may reduce suitable habitats for water-dependent species including the African Openbill (*Anastomus lamelligerus*), Cattle Egret (*Bubulcus ibis*), and Grey Heron (*Ardea cinerea*) present along the tributary of the Shire River close to the planed access road to the quarry. Similarly, reptiles such as *Trachylepis varia*, *Bitis arietans*, and *Agama armata* rely on microhabitats of these areas like leaf litter and fallen logs that are vulnerable to site clearance. Moisture-dependent species inventories in these areas such as *Varanus niloticus* and *Ptychadena anchieta* may also be impacted by changes in hydrology and microclimatic conditions.

The following WB environmental and social standards apply:

- ESS 1 – Assessment and Management of Environmental and Social Risks and Impacts
- ESS 6 – Biodiversity Conservation and Sustainable Management of Living Natural Resources

Impact assessment

- This impact negatively affects the biological environment.
- The duration is irreversible because of the permanent loss of some habitat caused by the quarry and camp site excavation and new access road which are composed of well-conserved deciduous forest.
- The extent is local as the impact will be felt within the construction influence area.

- The intensity of this impact is considered as medium due to the nature of land of the works (land clearing, excavation) in several sites.

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Site setup and construction works - Exploitation of the quarry	Fragmentation or loss of habitat	Biological	Nature:	Negative	Moderate
			Duration:	Irreversible	
			Extent:	Local	
			Intensity:	Medium	

The following mitigation measures must be implemented to minimize this environmental impact:

Avoidance

- No additional land clearing or habitat loss will be allowed in the immediate footprint area, as this is the same land that has already been cleared for the SVTP project.

Minimization

- At the quarry site, the impact of land clearing will be reduced to avoid unnecessary cutting down of trees especially along the river where mature trees are present.
- Environmental education and awareness programmes will be implemented to promote responsible interaction with the natural environment and reduce anthropogenic pressures on the remaining vegetation patches.

Restoration

- A restoration plan for areas temporarily cleared for project infrastructure, including the quarry site, the disposal area, the temporary camp site and the borrow site, and the dam area, is planned to re-establish the vegetation cover and ecological functionality of the affected areas, thereby minimizing long-term biodiversity loss.
- With the restoration plan, 22 hectares will be restored in the temporarily cleared area.

The mitigation measures are detailed in the Biodiversity Management Plan (CP6) of the ESMP (volume 2 of the ESIA).

Residual impact

The residual impact is considered moderate due to the **loss of habitat** at the worker's campsite, and along the new access road to the quarry site.

Risk/Impact	Significance *before mitigation*	Residual impact/risk significance
Fragmentation or loss of habitat	Moderate	**Moderate**

Offset

As the impact of deforestation on the camp and quarry sites and access road remains significantly residual, an offset strategy is needed for the loss of habitat. The compensation plan for the loss of habitat is described in the ESMP: the measure will be to support seeds collection and conservation effort , and at least 3 hectares of net loss

must be offset (it was estimated that all the construction activities could lead to risk of habitat loss and degradation on about 25 hectares. Considering that 22 hectares will be restored with the restoration plan, it was estimated that the remaining area, meaning at least 3 hectares, must be offset).

Once the offset strategy has been implemented successfully, there will be no residual impact.

6.3.4.3. DISTURBANCE OF WILDLIFE

Impact analysis

This impact is relative to the following sources:

- Site setup and construction works,
- Transport and traffic related to the construction activities,
- Exploitation of the quarry and borrow sites,
- Removal of the coffer dam,
- Presence of workers,
- Dismantling of all construction facilities at the end of the construction phase.

Construction activities are expected to disturb local wildlife, particularly in the Majete Wildlife Reserve and along the access roads, due to the proximity of these areas to the direct footprint area.

These activities will generate significant disturbances such as noise, dust, vibrations, and lighting at night. The movement of machinery both on-site and along the access roads will further disturb wildlife, especially sensitive species. The presence of workers is an additional source of disturbance, which could lead to heightened stress and disruption, particularly among wildlife sensitive to human presence. Furthermore, these disturbances will extend to aquatic species, as work on the banks can disturb riparian habitats, affecting both plant and animal species living in these areas.

The noise, vibrations, and activity associated with construction could interfere with the breeding and feeding patterns of species, potentially reducing their reproductive success and access to food.

Furthermore, artificial lighting alters the behavior of bats, nocturnal birds, and insects, leading to displacement, reduced activity or increased mortality. Nocturnal insects are attracted and disoriented by artificial light sources, reducing pollination efficiency and weakening plant reproduction. Combined with the impacts of the dam and road networks, construction activities increase pressure on nocturnal biodiversity and exacerbate the degradation of essential ecological processes.

Construction activities such as vegetation clearance, excavation, and soil movement are also expected to disturb habitats that are actively used by several birds and herpetofauna species. Ground-nesting birds like the Common Buttonquail *(Turnix sylvaticus*) and Bronze Manikin (*Spermestes cucullata*) may be affected by the removal of grasses and shrubs, while dominant species such as the Blue Cordon-bleu (*Uraeginthus angolensis*) and Yellow-fronted Canary (*Serinus mosambicus*) could experience disruptions in feeding and breeding due to noise and human presence.

These effects will be felt within the construction influence area.

The following WB environmental and social standards apply:

- ESS 1 – Assessment and Management of Environmental and Social Risks and Impacts
- ESS 6 – Biodiversity Conservation and Sustainable Management of Living Natural Resources

Impact assessment

- This impact negatively affects the biological environment.
- The duration is temporary as the impact will only occur during the construction activities.
- The extent is regional as the impact will be extended beyond the construction influence area to the Majete Wildlife Reserve area.
- The intensity of the impact is considered high, primarily due to the presence of sensitive Majete Wildlife Reserve area and the presence of conservation concern species

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Site setup and construction activities - Transport and traffic related to the construction activities - Exploitation of the quarry and borrow areas - Presence of workers - Dismantling all temporary construction facilities	Disturbance of wildlife	Biological	Nature:	Negative	Moderate
			Duration:	Temporary	
			Extent:	Regional	
			Intensity:	High	

The following mitigation measures must be implemented to minimize this environmental impact:

- Installation of warning signs around the Majete Wildlife Reserve in addition to the existing boundaries.
- Comprehensive biodiversity surveys must be conducted to identify ecologically sensitive features before starting the construction activities, including species present on site, active nesting sites of key bird species, mammal denning sites and bat roosts in the direct footprint area. According to the surveys, species-specific buffers will be established.
- A traffic and Road Safety Management Plan as part of the Contractor Environmental and Social management program must be set up with speeds limits, adjustment of work schedule to avoid peak wildlife activity and wildlife impact reporting system.
- Light minimization mitigation measures to reduce lights directed toward Majete and minimize sky glow effects during both the construction and operation phases.
- Awareness sessions about conservation species for all workers must be implemented.

The mitigation measures are detailed in the Biodiversity Management Plan (CP6) of the ESMP (volume 2 of the ESIA).

Residual impact

By implementing these measures, the intensity of this impact will be reduced as low, consequently the significance of the impact will be minor.

Risk/Impact	Significance *before mitigation*	Residual impact/risk significance
Disturbance of wildlife	Moderate	Minor

6.3.4.4. SPREAD OF FLORA INVASIVE SPECIES

Impact analysis

This impact is relative to the following sources:

- Site setup and construction works,
- Transport and traffic related to the construction activities,
- Exploitation of the quarry and borrow sites,
- Removal of the coffer dam,
- Dismantling of all construction facilities at the end of the construction phase.

Terrestrial Invasive Species

The construction activities, particularly the movement of machinery and transport of materials, pose a significant risk of spreading terrestrial invasive exotic species within the project footprint and surrounding areas. These species can be introduced through contaminated soil, plant material, or construction equipment, leading to the degradation of native vegetation and habitat structures.

Key terrestrial invasive species recorded in the project area include *Lantana camara* and *Ageratum conyzoides*, both of which are highly aggressive and were found in multiple sites, including the downstream areas and the construction site of the dam.

Lantana camara was found in the direct footprint area.

Aquatic Invasive Species

The spread of aquatic invasive species poses an additional environmental risk, particularly through the contamination of water bodies with floating or submerged invasive plants. The construction activities, especially in or near waterways, may facilitate the introduction of these species, either through direct transport or through alterations in hydrology that create favorable conditions for their establishment.

Among the key aquatic invasive species recorded in the project area are *Potederia crassipes* (water hyacinth), *Pistia stratiotes*, and *Azolla filiculoides*. These species were found downstream of the dam in the Chikwawa floodplain and upstream of the Elephant Marsh, where they can form dense floating mats that reduce oxygen levels, alter water quality, and hinder the movement of aquatic fauna. *Eichhornia crassipes*, in particular, is known for its rapid spread, leading to water flow obstruction and increased sediment accumulation, which can contribute to localized flooding and habitat degradation.

None of these species were recorded in the dam area and in the construction site of the dam.

These effects will be felt within the construction influence area.

The following WB environmental and social standards apply:

- ESS 1 – Assessment and Management of Environmental and Social Risks and Impacts
- ESS 6 – Biodiversity Conservation and Sustainable Management of Living Natural Resources

Impact assessment

- This impact negatively affects the biological environment.
- The duration is estimated as long-lasting, as many of these species are difficult to eradicate and can continue to spread post-construction.
- The extent for invasive species is regional as the impact will be felt beyond the construction area. For aquatic species, it can be felt in the reservoir and in downstream water bodies.
- The intensity of this impact is considered as low for both terrestrial and aquatic species due to the limited scope of hydrological disturbances caused by the project and the limited number of vehicles.

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Transport and traffic related to the construction activities - Exploitation of the quarry and borrow areas - Removal of the coffer dam - Site setup and construction activities - Dismantling of all temporary construction facilities	Spread of invasive species	Biological	Nature:	Negative	Moderate
			Duration:	Long-lasting	
			Extent:	Regional	
			Intensity:	Low	

The following mitigation measures must be implemented to minimize this environmental impact:

Reduction

- A strict control of exotic species spread must be implemented by the Contractor as part of the Contractor Environmental and Social management program including biosecurity protocols, monitoring program and removal program.

The mitigation measures are detailed in the Biodiversity Management Plan (CP6) of the ESMP (volume 2 of the ESIA).

Residual impact

By implementing these measures, the duration of this impact could be reduced as temporary linked to the duration of the construction activities, consequently the significance of the impact will be minor.

Risk/Impact	Significance *before mitigation*	Residual impact/risk significance
Spread of invasive species	Moderate	**Minor**

6.3.4.5. RISK OF HUMAN-WILDLIFE CONFLICT

Impact analysis

This impact is relative to the following sources:

- Employment of workers,
- Transport and traffic related to the construction activities,
- Exploitation of the quarry and borrow sites,
- Dismantling of all construction facilities at the end of the construction phase.

During the construction phase, the presence of workers in the direct footprint area, on the access road, and at the quarry and camp sites may result in potential conflicts between humans and local wildlife, particularly for the MWR fauna.

Animals from the Majete Wildlife Reserve (such as lions, elephants, hippos, crocodiles) may come close to the construction site (especially from the reservoir) and be perceived as a threat by the workers. In fact, some species (a lion and crocodiles) have been found on the construction site during the SVTP works. This can cause accidents and pose a threat to both animals and the workers.

The following WB environmental and social standards apply:

- ESS 1 – Assessment and Management of Environmental and Social Risks and Impacts
- ESS 6 – Biodiversity Conservation and Sustainable Management of Living Natural Resources

Impact assessment

- This impact negatively affects the biological environment.
- The duration is temporary as the impact will only occur during the construction activities.
- The extent is regional as the impact is related to the Majete Wildlife Reserve.
- The intensity of this impact is considered as high primarily due to the presence of the presence of conservation concern species in the Majete Wildlife area

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Presence of workers - Transport and traffic related to the construction activities - Exploitation of the quarry and borrow sites, - Dismantling of all construction facilities at the end of the construction phase.	Risk of human-wildlife conflict	Biological	Nature:	Negative	Moderate
			Duration:	Temporary	
			Extent:	Regional	
			Intensity:	High	

The following mitigation measures must be implemented to minimize this environmental impact:

Reduction

- Awareness trainings must be implemented for construction workers on wildlife protection laws.
- An emergency safety plan must be implemented in the event of the introduction of species on site.

The mitigation measures are detailed in the Biodiversity Management Plan (CP6) of the ESMP (volume 2 of the ESIA).

Residual impact

By implementing these measures, the intensity of this impact could be reduced as low with minimum risk of conflict. Consequently, the significance of the impact will be minor.

Source of Risk/Impact	Significance *before mitigation*	Residual impact/risk significance
Risk of human-wildlife conflict	Moderate	**Minor**

6.3.4.6. RISK OF INCREASED POACHING

Impact analysis

This impact is relative to the following sources:

- Presence of workers,
- Transport and traffic related to the construction activities,
- Exploitation of the quarry and borrow sites,
- Dismantling of all construction facilities at the end of the construction phase.

The presence of workers increases the risk of poaching around the construction influence area. This doesn't only concern the Majete Wildlife Reserve, but every location was bushmeat can be found. The wildlife reserve is situated in proximity to local communities and villages. Increase in human density following construction work can have negative effects on this natural resource. This can deplete animal populations and disrupt the ecosystem balance.

Poaching and illegal harvesting of fish, reptiles, mammals and birds also takes place inside the Elephant Marsh. If local population pressure increases, such challenges may continue to exert negative effects on this natural resource.

The following WB environmental and social standards apply:

- ESS 1 – Assessment and Management of Environmental and Social Risks and Impacts
- ESS 6 – Biodiversity Conservation and Sustainable Management of Living Natural Resources

Impact assessment

- This impact negatively affects the biological environment.
- The duration is temporary as the impact will only occur during the construction activities.

- This impact is regional as it could affect the Majete Wildlife Reserve and indirectly the biodiversity in the downstream area.
- The intensity of this impact is considered as high as the risk of poaching in MWR involve very sensitive species of conservation concern.

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Employment of workers - Transport and traffic related to the construction activities - Exploitation of the quarry and borrow sites, - Dismantling of all construction facilities at the end of the construction phase.	Risk of increased poaching	Biological	Nature:	Negative	Moderate
			Duration:	Temporary	
			Extent:	Regional	
			Intensity:	High	

The following mitigation measures must be implemented to minimize this environmental impact:

Reduction

- The contractor must implement a prevention of poaching and wildlife crime as part of the Contractor Environmental and Social management program with a zero-tolerance policy for poaching among workers and increase surveillance and set up anti-poaching patrols.
- Awareness training must be conducted for construction workers on wildlife protection laws.

The mitigation measures are detailed in the Biodiversity Management Plan (CP6) of the ESMP (volume 2 of the ESIA).

Residual impact

By implementing these measures, the intensity of this impact could be reduced as low with minimum risk of conflict. Consequently, the significance of the impact will be minor.

Risk/Impact	Significance *before mitigation*	Residual impact/risk significance
Risk of increased poaching	Moderate	**Minor**

6.3.4.7. RISK OF AQUATIC MORTALITY AND LOSS OF AQUATIC HABITATS

Impact analysis

This impact is relative to the following sources:

- Site setup and construction works,
- Transport and traffic related to the construction activities,
- Exploitation of the quarry and borrow sites,
- Removal of the coffer dam,
- Dismantling of all construction facilities at the end of the construction phase.

Construction activities near water bodies are likely to result in the release of sediment into the Shire River and its tributaries, particularly the Mimvunza and Mwembezi Rivers resulting in reduced water clarity, smothering of benthic habitats, and degradation of spawning grounds for native fish species. These impacts are primarily associated with the excavation works at the dam site, quarry, camp, and new access roads.

Additionally, contamination from hydrocarbons, cement, and other construction materials (see Section 5.3.3.3) may enter the aquatic system through surface runoff or accidental spills, posing risks to the health of fish and aquatic invertebrates.

Threatened species such as *Oreochromis karongae* and *Oreochromis mossambicus* inhabit both the upstream and downstream sections of the river, and these habitats may be further reduced or degraded as a result of these disturbances.

This impact will be felt on the Shire River and the tributaries close to the quarry (Mimvunza River) and the camp site (Mwambezi River).

The following WB environmental and social standards apply:

- ESS 1 – Assessment and Management of Environmental and Social Risks and Impacts
- ESS 3 - Resource Efficiency and Pollution Prevention and Management
- ESS 6 – Biodiversity Conservation and Sustainable Management of Living Natural

Impact assessment

- This impact negatively affects the biological environment.
- The duration is long-lasting because the consequence on aquatic habitat will be felt after the construction activities.
- The impact is regional as it concerns the catchment area of the Shire River (upstream and downstream of the dam).
- The intensity of this impact is considered as low due to the nature of the works (rehabilitation) with limited sources of chemical products that could impact a large number of aquatic species.

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Transport and traffic related to the construction activities - Site setup and construction activities - Exploitation of the quarry and borrow areas - Removal of the coffer dam - Dismantling all temporary construction facilities	Risk of aquatic mortality and loss of aquatic habitats	Biological	Nature:	Negative	Moderate
			Duration:	Long-lasting	
			Extent:	Regional	
			Intensity:	Low	

The following mitigation measures must be implemented to minimize this environmental impact:

Reduction

- Protection of aquatic ecosystems must be implemented by the contractor during the construction phase in the Contractor's Environmental and Social Management Program, including a waste management plan as part of a wastewater and spill prevention plan and a resource efficiency and pollution prevention management plan.

The mitigation measures are detailed in the Biodiversity Management Plan (CP6) of the ESMP (volume 2 of the ESIA).

Residual impact

By implementing these measures, the intensity of this impact could be reduced as low with minimum risk of aquatic issues. Consequently, the significance of the impact will be minor.

Risk/Impact	Significance *before mitigation*	Residual impact/risk significance
Risk of aquatic mortality and loss of aquatic habitats	Moderate	**Minor**

6.3.4.8. IMPACTS ON CRITICAL HABITAT

This section describes the impacts specific to the critical habitat qualifying species as follows: the Black Rhino and African Wild dog confined in the Majete Wildlife Reserve (MWR); the Vultures between the Liwonde, the Lengwe and the Majete; and the Black Heron, the African Openbill, the African Skimmer, the Whiskered Tern, the Collared Pratincole and the Basra Reed-warbler primarily associated in the Elephant Marsh.

As the work site is located alongside the MWR in an area borrowed from African Parks for the duration of SVTP and Kapichira work, the species triggering the critical habitat which are confined in the MWR are subject to the same impacts mentioned in the previous section regarding the wildlife disturbance, the risk of mortality, the risk of human-wildlife conflict and increasing the risk of poaching.

The following sections describe the species-specific nature of each impact. The aim is to understand each characteristic of the species and then adapt the impact accordingly.

Species confined to the Majete Wildlife Reserve

- **Black Rhino**

Black Rhinos in Majete WR inhabit well-protected thicket and woodland habitats. The population has steadily grown since reintroduction[25] and now exceeds 35 individuals (Mpatamanga, ESIA 2024).

Risk of disturbance and mortality

Rhinos are highly sensitive to noise and disturbance. No direct disturbance is expected to affect black rhinoceros within Majete Wildlife Reserve, as the construction works related to the Kapichira rehabilitation project are located several kilometers south-east of the core areas where these animals are more likely found. The central part of the reserve, where rhinos are likely to concentrate, is far from the direct footprint area.

[25] African Parks – Biodiversity Conservation.

However, as animals may occasionally move towards the eastern sectors of the reserve, a low risk of temporary disturbance cannot be entirely excluded. This risk remains limited in space and time.

Therefore, the potential impact is classified as temporary, regional, and of medium intensity—not because major disruption is expected, but because any disturbance affecting such a slow-reproducing and threatened species must be taken seriously, even if the likelihood is low.

The mitigation measures related to the risk of disturbance presented in section 6.3.4.3 considered this species. The residual significance of the impact is considered to be minor.

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation	Importance after mitigation
- Site setup and construction activities - Transport and traffic related to the construction activities - Removal of the coffer dam	Disturbance of the Black Rhino	Biological	Nature: Duration: Extent: Intensity:	Negative Temporary Regional Medium	Moderate	**Minor**

Direct mortality due to machineries and vehicles from the construction activities is highly unlikely given the physical barrier of the park's electric fencing, and the absence of construction in the reserve. The potential impact on mortality is considered to be non-significant.

Risk of increased poaching

The major concern relates to increased human presence near the reserve's boundary.

This impact has a negative effect on the species. It is considered temporary, as it primarily results from the presence of workers in the project's direct footprint. The impact is regional in extent, given its potential to affect the nearby Majete Wildlife Reserve. Its intensity is rated as medium: while the loss of individuals from this reintroduced population would be significant, the presence of a perimeter fence and active patrols within Majete significantly limits the likelihood of such events occurring, thus preventing the impact from being classified as high.

The mitigation measures related to the risk of poaching presented in the section 6.3.4.6. considered also this species. The residual significance of the impact is considered to be minor.

Source of risk/impact	Risk	Impacted environment	Criteria		Importance before mitigation	Importance after mitigation
- Presence of workers - Transport and traffic related to the construction activities	Risk of increased poaching	Biological	Nature: Duration: Extent: Intensity:	Negative Long-lasting Regional Medium	Moderate	**Minor**

Risk of human – wildlife conflict

The impact here is the same as described in 6.3.4.5. for all terrestrial and semiaquatic species present in the Majete Wildlife Reserve.

The mitigation measures related to the risk of human-wildlife conflict are presented in the section 6.3.4.5.

Application of mitigation hierarchy

Regarding the Black Rhino, no residual impacts are anticipated as the project activities remain outside its core sensitive areas. Furthermore, data from African Parks indicates a stable and increasing population trend within the Majete Wildlife Reserve. Consequently, the Net Gain strategy does not include direct interventions for this species but focuses instead on broader habitat integrity and targeted measures for other high-priority receptors.

- **African Wild Dog**

African Wild Dogs are wide-ranging carnivores requiring extensive undisturbed landscapes. In Majete WR, they have been reintroduced. The protected population in the MWR represents one of the few remaining viable groups in the region[26].

Risk of disturbance and mortality

The African Wild Dog is highly sensitive to human presence and disturbance, particularly during denning and pup-rearing periods[27]. There is a potential for temporary disturbance from construction-related noise or movement, especially if animals are active near the park's boundaries. However, the core areas of the reserve, where denning is more likely, are distant from the project footprint.

The impact is thus considered temporary, regional, and of medium intensity—given the species' sensitivity and endangered status.

The mitigation measures related to the risk of disturbance are presented in section 6.3.4.3. The residual significance of the impact is considered to be minor.

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation	Importance after mitigation
- Site setup and construction activities - Transport and traffic related to the construction activities - Exploitation of the quarry and borrow areas - Dismantling the temporary camps and all temporary construction facilities	Disturbance of the African Wild Dog	Biological	Nature:	Negative	Moderate	**Minor**
			Duration:	Temporary		
			Extent:	Regional		
			Intensity:	Medium		

Direct mortality due to machinery and vehicles from the construction activities is highly unlikely given the physical barrier of the park's electric fencing, and the absence of in-park construction. The potential impact on mortality is considered to be non-significant.

Risk of increased poaching

Increased human presence due to construction may lead to higher poaching risks, even if unintentional (e.g., snares set for bushmeat that catch non-target species). While

26 African Parks - The Wild Dogs of Malawi – A Historic Reintroduction

27 Sievert, O., Hammer, M., Comley, E., Hintz, B., Mgoola, W. O., & Davis, R. S. (2023). A novel record of African wild dogs (Lycaon pictus) in Vwaza Marsh Wildlife Reserve, Malawi. Ecology and Evolution, 13, e10671. https://doi.org/10.1002/ece3.10671

African wild dogs are not typically targeted, they are highly vulnerable to accidental snaring.

The poaching risk is temporary but could occur. The spatial extent is regional, and the intensity is medium, as the fenced and patrolled reserve limits — but does not eliminate — the risk.

The mitigation measures related to the risk of poaching are presented in section 6.3.4.6. The residual significance of the impact is considered to be minor.

Source of risk/impact	Risk	Impacted environment	Criteria		Importance before mitigation	Importance after mitigation
- Presence of workers - Transport and traffic related to the construction activities	Risk of increased poaching on the African Wild Dog	Biological	Nature:	Negative	Moderate	**Minor**
			Duration:	Long-lasting		
			Extent:	Regional		
			Intensity:	Medium		

Risk of human wildlife conflict

The impact here is the same as described in 6.3.4.5. for all terrestrial and semiaquatic species present in the Majete Wildlife Reserve. The mitigation measures related to the risk of human-wildlife conflict are presented in the section 6.3.4.5.

Application of mitigation hierarchy

To achieve a measurable net gain for the African Wild Dog, specific Species Conservation Actions (SCAs) will be implemented in a net gain program. This program provides capacity building and financial support for population tracking. These SCAs, coupled with community awareness programs to prevent human-wildlife conflict, ensure that the project actively contributes to the recovery of these apex species within the MWR.

Such measures are described in the ESMP (volume 2 of the ESIA).

Vultures between Liwonde, Majete and Lengwe

White-backed and white-headed vultures, both critically endangered, regularly occur and likely breed in Majete Wildlife Reserve[28].

Disturbance and risk of mortality

These species may be indirectly disturbed by construction activity if noise or presence disturbs the breeding, resting or feeding activities. However, no construction is planned within the reserve, and disturbance sources are relatively limited in space and time.

Given that vultures' forage over vast areas and are less sensitive to localized human presence compared to ground-dwelling species, the disturbance impact is considered temporary, regional, and low to medium intensity, depending on the proximity of key nesting or feeding sites to the construction areas.

Although vultures do not remain strictly within the Majete Wildlife Reserve and are known to travel long distances daily in search of food, the likelihood of direct mortality due to construction activities at the Kapichira site is considered low. The direct footprint

[28] Sievert, O.et al. (2021, November) Recent records of vulture nests in Malawi's Southern Region. Vultures news 81.

area does not provide feeding opportunities or attractive perching areas for vultures, and these birds typically soar at high altitudes, reducing the risk of collisions with machinery or vehicles.

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation	Importance after mitigation
- Site setup and construction activities - Transport and traffic related to the construction activities - Exploitation of the quarry and borrow areas - Dismantling the temporary camps and all temporary construction facilities	Disturbance of the Vultures	Biological	Nature:	Negative	Minor to Moderate	Minor
			Duration:	Temporary		
			Extent:	Regional		
			Intensity:	Low to medium		
	Risk of mortality on Vultures		Nature:	Negative	Minor	Minor
			Duration:	Temporary		
			Extent:	Regional		
			Intensity:	Low		

Risk of increased poaching

Vultures are often victims of intentional poisoning — when poachers poison carcasses to avoid aerial detection. If human activity around the reserve increases, so could this practice. Although the park is fenced, its periphery is still vulnerable, especially near access points. While this is not a direct project activity, the increased local activity could indirectly contribute to this risk.

The impact is temporary, regional, and of medium to high intensity depending on the frequency of poaching activities.

The mitigation measures related to the risk of poaching are presented in section 6.3.4.6. The residual significance of the impact is considered to be minor.

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation	Importance after mitigation
- Presence of workers - Transport and traffic related to the construction activities	Risk of increased poaching on the Vultures	Biological	Nature:	Negative	Moderate	Minor
			Duration:	Temporary		
			Extent:	Regional		
			Intensity:	Medium to high		

Risk of human-wildlife conflict

As vultures are a flying species and they can easily escape from the construction influence area, the risk of conflict with humans during construction, other than poaching, is not considered to be significant.

Application of mitigation hierarchy

To achieve a measurable net gain for the White-headed and White-backed Vultures, specific Species Conservation Actions (SCAs) will be implemented. This involves a GPS tagging and regional monitoring program to identify and protect flight corridors. These SCAs, coupled with community awareness programs to prevent accidental poisoning, ensure that the project actively contributes to the recovery of these apex species within the MWR. Such measures are described in the ESMP (volume 2 of the ESIA).

Species primarily associated with the Elephant Marsh

This section considers the following triggering critical habitat species:

- **The Black Heron, the African Openbill, the African Skimmer, the Whiskered Tern, the Collared Pratincole and the Basra Reed-warbler.**

None of these species were recorded in the Majete Wildlife Reserve regarding the African Parks inventories of 2023 unless the African skimmer was observed during the ESIA survey. 6 birds were recorded. However, the Majete does not provide suitable habitat for numbers of these birds. The river habitat is rocky and fast flowing, for example, it is not well suited to foraging for skimmers who roost and breed in sandbanks.

The species are most likely to be associated with the southern portions of the Elephant Marsh.

No viable populations or suitable habitats for these species were identified within the direct project footprint. As such, impacts during the construction phase are not expected to be significant.

- **The Zambezi Flapshell turtle**

This species is primarily associated with the Elephant Marsh but no recent presence of this species has been observed for a long time (before 2016)[29]. Regarding the Majete list of fauna species in 2023, the species is present in the reserve.

Disturbance of wildlife and risk of mortality

Construction activities (noise, vibrations, presence of machinery and workers) may disturb basking, nesting, or foraging behavior of the species, particularly near water bodies or on sandbanks where turtles are likely to be active.

There is a direct risk of mortality from heavy equipment or vehicles operating near riverbanks or wetland habitats. Eggs, juveniles, or adults may be crushed or buried if nesting areas are disturbed.

Therefore, the potential impact is classified as temporary, regional, and of medium intensity—given its endangered status.

The mitigation measures related to the disturbance of wildlife and the risk of mortality are presented in section 6.3.4.3. The residual significance of the impact is considered to be minor.

[29] Turpie, J.K. et al. (2016, August) Climate resilient livelihoods and sustainable natural resource management in the elephant marsh, Malawi.

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation	Importance after mitigation
- Site setup and construction activities - Transport and traffic related to the construction activities - Exploitation of the quarry and borrow areas - Removal of the coffer dam - Dismantling the temporary camps and all temporary construction facilities	Disturbance and risk of mortality of the Zambezi Flapshell turtle	Biological	Nature:	Negative	Moderate	**Minor**
			Duration:	Temporary		
			Extent:	Regional		
			Intensity:	Medium		

Risk of increased poaching

Increased human presence and limited surveillance during construction may lead to opportunistic poaching. Although turtles are not typically targeted like large mammals, they may be collected for consumption or sale. Indeed, there is a main threat of collection for international trade, especially around the area of Lake Malawi, destined primarily for the East Asian consumption and medicinal trade (this remains unquantified but potentially severe).

The impact is thus considered temporary, regional, and of low intensity.

The mitigation measures related to the risk of poaching are presented in section 6.3.4.6. The residual significance of the impact is considered to be minor.

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation	Importance after mitigation
- Presence of workers - Transport and traffic related to the construction activities	Disturbance of the Zambezi Flapshell turtle	Biological	Nature:	Negative	Moderate	**Minor**
			Duration:	Temporary		
			Extent:	Regional		
			Intensity:	Low		

Risk of human-wildlife conflict

Cycloderma frenatum is a cryptic and non-aggressive species, and thus unlikely to cause direct conflict with workers. The impact is considered non-significant.

Application of mitigation hierarchy

For species primarily associated with the Elephant Marsh (such as the Zambezi Flapshell Turtle and key migratory birds), the Net Gain program focuses on reinforcing the ongoing establishment of the Community Conservation Area (CCA). By integrating targeted monitoring protocols and supporting baseline data collection for these specific wetland-dependent species, the project ensures their long-term protection. This integrated approach, spanning from the restoration of the Shire Riverbanks in Majete to institutional support in the Elephant Marsh, forms a cohesive Net Gain Program that delivers sustainable biodiversity benefits for all Critical Habitat-triggering species.

The mitigation measures are detailed in the Biodiversity Management Plan (CP6) of the ESMP (volume 2 of the ESIA).

Summary of the general mitigation strategy for critical habitat

To ensure the protection of Critical Habitat, the project adopts a strict mitigation hierarchy: first by avoiding any activity outside the designated footprints to preserve intact habitats, and second by implementing a comprehensive Construction Biodiversity Management Plan. This plan includes general mitigation measures such as minimizing land clearing and restricting in-water construction activities, alongside specific operational controls: adjusting work schedules to avoid peak wildlife activity periods, minimizing lighting to prevent disorientation, and enforcing a zero-tolerance policy for poaching. Furthermore, the project establishes a collaboration with African Parks. to increase patrols and integrates emergency protocols for wildlife interactions to mitigate any direct risk during the construction phase.

6.3.5. Impacts on the human environment

6.3.5.1. INTRODUCTION

The impacts identified on the human environment are as follows:

- Employment opportunities
- Spontaneous migration
- Health and safety risks for communities
- Health and safety risks for workers
- Risk of violence based on gender
- Risk of damage to the cultural heritage
- Loss of land due to the construction facilities

6.3.5.2. EMPLOYMENT OPPORTUNITIES

Impact analysis

This impact is relative to the following sources:

- Site setup and construction works,
- Presence of workers.

The rehabilitation of the Kapichira dam can offer employment opportunities for the local population. Job opportunities for skilled and unskilled workers are expected with an estimation of at least 150 workers during the construction activities.

The influx of workers will create economic opportunities for the local population, linked to activities such as small-scale catering, accommodation, the supply of agricultural produce, petty trading, etc. in the vicinity of the camp sites and roads, or in a more diffuse manner.

The other source of employment could be boosting commercial activity due to the materials needed for the construction activities.

The following WB environmental and social standards apply:

- ESS 1 – Assessment and Management of Environmental and Social Risks and Impacts

- ESS 2 - Labour and Working Conditions
- ESS 4 - Community Health and Safety

Impact assessment

- This impact is positive and relative to the human environment.
- The duration is temporary as relative to the construction activities.
- The impact is national as employment opportunities could be felt out the district.
- The intensity of this impact is considered as low due to the nature of the works (rehabilitation) with limited number of workers (estimated around 150).

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Site setup and construction works, - Presence of workers.	Employment opportunities	Human	Nature:	Positive	Minor
			Duration:	Temporary	
			Extent:	National	
			Intensity:	Low	

The following enhancement measures must be implemented:

- Prioritize the employment of local workers from the TA Kasisi, in particular the villages close to the construction site, such as Bwalo, Njerez, Maganga 1 & 2, Sekela, Mlangeni, Liwonde and Kandeu, especially for the non-skilled employment.
- Support for the organisation of the demand for jobs on the site at district level (District Labor Office with the support of the village chiefs).
- Ensuring parity in the recruitment of local staff (gender dimension) with the strategy of recruitment considering at least the employment of 20% of women amount the workers.
- Guide migrants to a designated competent recruitment office.
- Systematic consultation of local suppliers for the purchase of materials and basic foodstuffs.

The measures are detailed in the labor Management Plan (CP1) of the ESMP (volume 2 of the ESIA).

Residual impact

By implementing these measures, the duration of this impact will be increased as long-lasting at local level with a moderate intensity. Consequently, the significance of the benefit could become moderate.

Risk/Impact	Importance *before enhancement*	Residual impact Importance
Employment opportunities	Minor	**Moderate**

6.3.5.3. SPONTANEUS MIGRATION

Impact analysis

This impact is relative to the following sources:

- Site setup and construction works.

The presence of the construction site will lead to an influx of migrants attracted by the economic prospects linked to the rehabilitation of the Kapichira project, whether in terms of jobs on the site or opportunities on the fringe of the site. The main consequence of this immigration will be a temporary increase in the local population, which could lead to conflicts with the resident population, with the potential for delinquency and criminal practices. The number, origin and length of stay of these people are difficult to predict. Some of these migrants are expected to leave the area at the end of the project.

However, the importance of the construction activities (rehabilitation) is less important than the construction of large infrastructure in the region such as SVTP (phase 2) and the construction of Mpatamanga dam, with construction schedules running parallel to that of Kapichira dam rehabilitation project. The OE Engineer has estimated the need of about 150 workers during the construction activities.

The following WB environmental and social standards apply:

- ESS 1 – Assessment and Management of Environmental and Social Risks and Impacts
- ESS 2 - Labour and Working Conditions
- ESS 4 - Community Health and Safety

Impact assessment

- This impact is negative and relative to the human environment.
- The duration is temporary as relative to the construction activities.
- The impact is regional as the effect could be felt within the district.
- The intensity of this impact is considered as low due to the nature of the works (rehabilitation) with limited opportunities for the construction activities.

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Site setup and construction works - Employment of workers	Spontaneous migration	Human	Nature:	Negative	Minor
			Duration:	Temporary	
			Extent:	Regional	
			Intensity:	Low	

The following mitigation measures must be implemented to minimize this environmental impact:

- Guide migrants to a designated competent recruitment office where they would be informed about the recruitment procedure etc at District level.

- Regular information meetings with focal points designated by the concerned communities (village chiefs / customary authority / administrative authority) about work schedule, job opportunities, various events.

The measures are detailed in the Community Health and Safety Plan (CP8) in the Environmental and Social Management Plan (volume 2 of the ESIA).

6.3.5.4. HEALTH AND SAFETY RISKS FOR THE COMMUNITY

Impact analysis

This sub-chapter focus on the health and safety risks relative to the works activities, considering that the disaster risk assessment is carried in the chapter 6.3.3.9.

This impact is relative to the following sources:

- Site setup and construction works,
- Exploitation of the quarry and borrow sites
- Transport and traffic related to the construction activities
- Presence of workers.

The nuisances mentioned above (noise, dust, traffic etc.), the pressure on natural resources and the loss of land for the construction facilities are disrupting people's way of life.

The traffic related to the constructions activities could lead to an increase of road accidents: The population most at risk would be the children, especially those of school age. Increased vehicle speeds coupled with increased heavy vehicle numbers and presence of vulnerable road user movements worsens the risks. In order to reduce this risk, the location of schools was considered during the selection of the temporary sites for the construction (chapter 7.2.2 about alternatives for construction facilities).

The presence of migrants could lead to a general risk of social tensions linked to:

- An increase in demographic pressure, with a risk of conflict between residents and migrants, due, for example, to the high proportion of men among the migrants or their taking of natural resources or competition for jobs on the site. This high concentration of people generally leads to gender-based violence (GBV), which encompasses acts perpetrated without consent and includes physical, psychological and sexual violence, sexual harassment, exploitation and sexual abuse.
- An increased pressure on existing community infrastructure and social services (the health centre in particular).
- The weakening of the power of traditional chiefs in the face of outsiders who do not recognise them.
- The risk of economic tensions linked to supply problems in the area due to the overall increase in population, which could lead to inflation in the price of goods and services, as well as a risk of reduced food availability (although this would be mitigated by the proximity of major trade routes).
- Competition with local people for jobs on construction sites as reported by the communities.

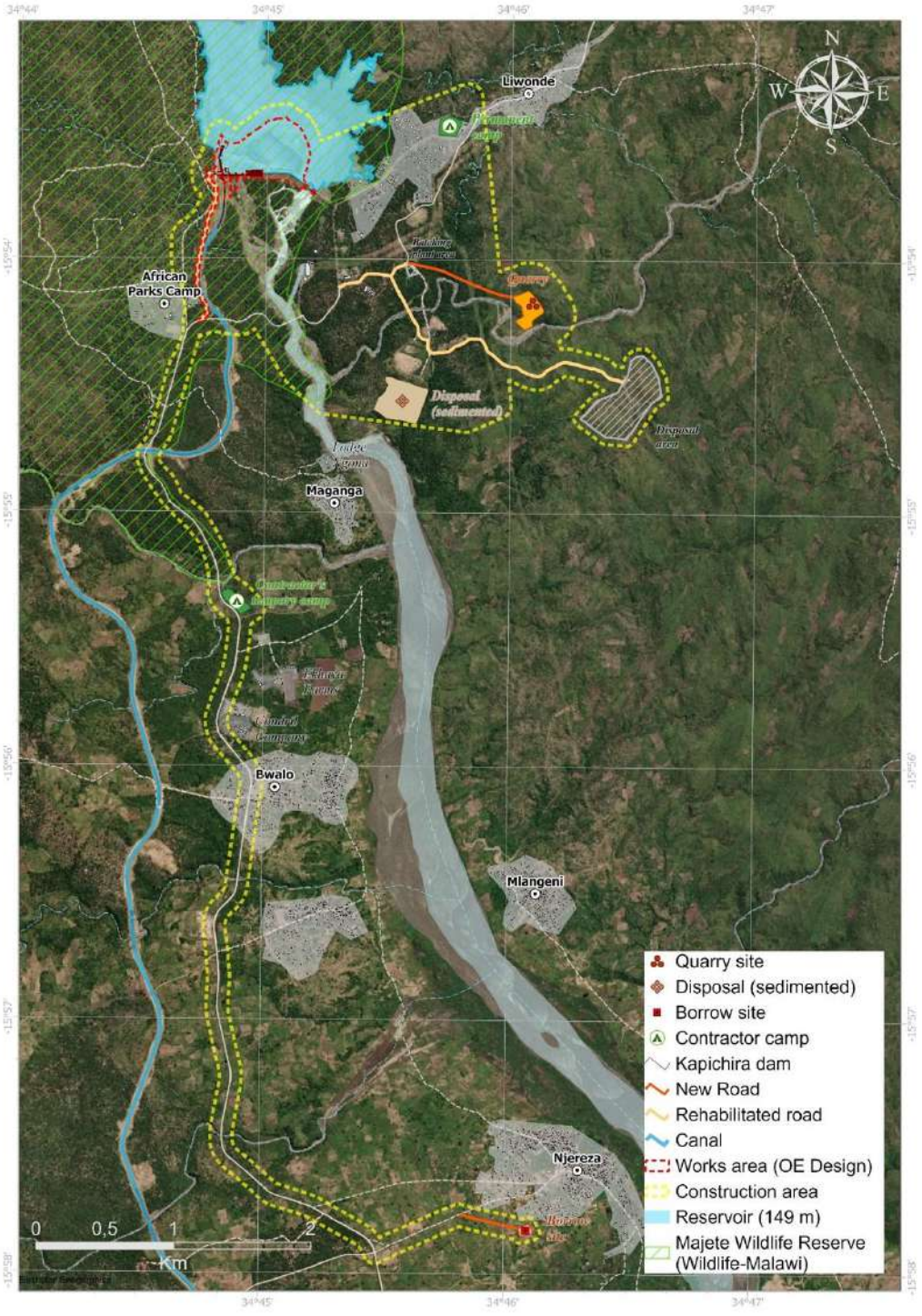


Figure 6-3: Location of construction facilities

The impacts are estimated as follows (see the map):

- Considering that the wind is coming from the South, it is likely that the change in air quality and noise level is felt at the EGENCO residential compound due to quarry site and batching plant activities located less than 1 km. Furthermore, the EGENCO residential compound will be affected by the construction of the permanent camp.
- The village Liwonde located less than 1 km from the permanent camp and 1,5 km from the quarry site could be affected by the noise and traffic related the construction activities.

- The villages located less than 1 km from the contractor's temporary camp, meaning Maganga 1 and Bwalo, could be disturbed mainly by the presence of workers as well by the traffic related to the construction activities although the access road does not cross these villages. Some noise activities such as blasting should be as well hear by these villages.
- The villages between Chikwawa and the direct footprint area, meaning Kasisi, Sekela, Kapichira, Njerez and Chikwawa, could have the effect on a smaller scale by the traffic on the T146 road related to the borrow site activity and in general due to the construction activities or the presence of workers.

The following WB environmental and social standards apply:

- ESS 1 – Assessment and Management of Environmental and Social Risks and Impacts
- ESS 4 - Community Health and Safety
- ESS 5 - Land Acquisition, Restrictions on Land Use and Involuntary Resettlement
- ESS 10 - Stakeholder Engagement and Information Disclosure

Impact assessment

- This impact is negative and relative to the human environment.
- The duration is temporary as relative to the construction activities.
- The impact is regional as the effect could be felt at different scales in the whole district.
- The intensity of this impact is considered as low as no village are in 1 km from the direct footprint area and the nature of the works (rehabilitation) with limited number of workers (estimated around 150 people, which represents about 10% of the population of Bwalo the closest village from the Contractor's camp).

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Site setup and construction works, - Exploitation of the quarry and borrow sites -Transport and traffic related to the construction activities - Presence of workers	Disturbance of local communities	Human	Nature:	Negative	Minor
			Duration:	Temporary	
			Extent:	Regional	
			Intensity:	Low	

Avoidance

Five locations for the Contractor's camp site were selected. The location of the Contractor's temporary camp was chosen considering the proximity with the construction area (3 km) and the absence of villages and community facilities (such as school) on the road between the contractor's camp and the construction area.

The Owner Engineer's proposed new rock quarry was initially located some 4.7 km north-east of the Kapichira dam. The site was located near a village (GVH Kandeu / Kosambo 2), the nearest house was less than 150 away. The proposed access road ran for more than 1 km through the village, including its center (where it is quite narrow in some locations), passes through an under-construction secondary school, goes

through village Liwonde and possibly passes near the residential area within EGENCO property. To avoid the significant E&S risks and impacts due to the proximity of villages, it was decided to find another location to avoid impacts on the communities. The chosen location for the quarry site is around 1.5 km from the dam site. The first village is about 1 km from the site and the access road does not pass through a village.

Reduction

The following main mitigation measures must be implemented as follows:

- Informing the population about the timetable and nature of the works.
- Demarcate the working areas.
- Setting up the social infrastructure and services needed to make the site population independent of the services intended for the local population.
- Strengthening the EGENCO health centre.
- Setting up security services in the workers' camp site.
- Support for the local administration and customary authorities to promote communication between the local population and the migrant workers.
- Implement the Stakeholder Engagement Plan including grievance redress mechanism (see appendix A of the ESMP included in the volume 2 of the ESIA).
- Implement the SEA/SH action plan (see appendix B of the ESMP included in the volume 2 of the ESIA).

The measures are detailed in the traffic and safety management plan (CP7) and in the Community Health and Safety Plan (CP8) in the Environmental and Social Management Plan (volume 2 of the ESIA).

6.3.5.5. HEALTH AND SAFETY RISKS FOR WORKERS

Impact analysis

This impact is relative to the following sources:

- Site setup and construction works,
- Exploitation of the quarry and borrow sites
- Transport and traffic related to the construction activities.

Impacts on worker's health and safety could manifest because of inadequate implementation of existing labour standards by the Contractor or from work related injury or health effects.

In the context of this project, work accidents could occur during several of the planned construction activities, such as:

- site preparation (area not well known, …)
- work on an existing dam (working next to fast flowing water, working at height
- excavations,
- vegetation clearance on quarry site and camp site,
- waste and hazardous materials management,
- transportation and circulation,

- worksite restoration.

The main common causes of accidents in construction are:

- Car accidents.
- Working at height.
- Working in an unsecured excavation.
- Working on slippery surfaces.
- Blasting operation in the quarry site.
- Accidentally falling objects.
- Moving heavy loads.
- Bad working positions.
- Working near live electrical wires and equipment (electrocution).

All workers could be exposed to accidents at the worksite or during travels. However, implementation of suitable health and safety procedures should help preventing or reducing the probability of accidents from occurring.

The health issues must be considered as well considering the health context in the district, in particular:

- AIDS/HIV prevalence,
- Malaria, with a peak in April-September.

The following WB environmental and social standards apply:

- ESS 1 – Assessment and Management of Environmental and Social Risks and Impacts
- ESS 2 - Labour and Working Conditions
- ESS 10 - Stakeholder Engagement and Information Disclosure

Impact assessment

- This impact is negative and relative to the human environment.
- The duration is temporary as relative to the construction activities.
- The impact is local as the effect is relative to the construction area.
- The intensity of this impact is considered as low due to the nature of the works (rehabilitation) with limited number of workers (estimated around 150 people).

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Site setup and construction work - Transport and traffic related to the construction activities - Exploitation of the quarry and borrow sites - Removal of the coffer dam	Health and safety risks for workers	Human	Nature:	Negative	Minor
			Duration:	Temporary	
			Extent:	Local	
			Intensity:	Low	

The main following mitigation measures must be implemented through the Contractor labour management plan and workplace occupational Health, Safety and Security management plan to minimize this impact:

For safety:

- Adapted equipment for individual protection (for working at heights for example),
- Assure equal safety conditions for both men and women
- Prepare an emergency plan in case of accidents.
- Assure the presence of an ambulance on site and first aid kits.
- Develop a blasting schedule to inform the workers and the public of when and where blasts are going to occur throughout the day, including an alert system that typically goes off prior to blasting.
- Implement a code of conduct for all individuals involved in this project (workers, contractors, security services, etc.) that they must sign.

For hygiene and health:

- The Contractor shall submit a construction camp management plan that shows how it intends to operate its camp in accordance with the ESHS requirements.
- Ensure hygienic living conditions for workers, including clean and well-maintained accommodations, dining and kitchen facilities, and ablution and sanitation facilities.
- Take measures to prevent diseases such as Malaria and AIDS among the workforce, including sensibilisations (promotion of mosquito-net use for the workforce; increased awareness of malaria before the highest period of incidence after the rainy season;…).
- Provide Health facilities adapted to the importance of the construction activities.
- Provide a mechanism of grievances available for all workers

The mitigation measures will be detailed in the Workplace Occupational Health, Safety and Security Management Plan (CP10) in the ESMP (Volume 2 of the ESIA).

6.3.5.6. RISK OF VIOLENCE BASED ON GENDER

Impact analysis

This impact is relative to the following sources:

- Site setup and construction works,
- Presence of workers.

The rehabilitation of Kapichira dam can lead to discrimination, gender-based violence (GBV).

Gender-based violence includes various actions such as physical, psychological, and sexual violence. These acts of violence can also manifest themselves in the form of exclusion of women from compensation measures, discrimination against women who are heads of households as well as inequalities and disparities for women regarding job offers. Finally, the spread of sexually transmissive diseases including HIV/AIDS are mostly affecting women and is considered as a form of GBV.

Cases of gender-based violence are common on construction sites and preventing them must be a priority for the Contractor. However, considering that the number of workers for the construction site is estimated to be around 150, the risk is minimized.

The following WB environmental and social standards apply:

- ESS 1 – Assessment and Management of Environmental and Social Risks and Impacts
- ESS 2 - Labour and Working Conditions
- ESS 4 - Community Health and Safety
- ESS 10 - Stakeholder Engagement and Information Disclosure

Impact assessment

- This impact is negative and relative to the human environment.
- The duration is temporary as the risk could occur only during the construction phase.
- The impact is regional as the effect could occur in the whole District.
- The intensity of this impact is considered as medium due to the significance of such issues in previous projects in the area.

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Site setup and construction work - Presence of workers - Exploitation of borrow site.	Risk of violence based on gender	Human	Nature:	Negative	Moderate
			Duration:	Temporary	
			Extent:	Regional	
			Intensity:	Medium	

The main following mitigation measures must be applied during the construction phase:

By the Contractor:

- Provide and implement a GBV/SEA/SH action plan to fight against GBV aligned with EGENCO social and gender inclusion and anti–sexual harassment policy Include a GBV specialist in the Contractor team.
- Provide gender-separate accommodation on camp and gender-separate lockable latrines and wash facilities that are well-lit, conveniently located and easily accessible.
- Launch awareness enhancement campaign on GBV among the workers before the start of the works
- Provide a survivor-centred and confidential reporting system with safe, anonymous and specialized SEA/SH pathways.
- Ensure all employees sign code of conduct at work..

By EGENCO:

- Raise awareness among competent authorities, neighbouring communities, and customary authorities about GBV, SEA/SH, different forms of sexual exploitation and sex trafficking.

The mitigation measures will be detailed in the Labour management plan (CP1) in the ESMP (Volume 2 of the ESIA).

Residual impact

Risk/Impact	Importance *before mitigation*	Importance *after mitigation*
Risk of violence based on gender	Moderate	**Minor**

6.3.5.7. RISK OF DAMAGE TO THE CULTURAL HERITAGE

Impact analysis

This impact is relative to the following sources:

- Site setup and construction works,
- Exploitation of the quarry and borrow sites.

The construction phase can cause a risk of damage to the cultural heritage:

- by uncovering archaeological artefacts such as graves, cultural objects, fossils and other paleontological artefacts. This risk is mainly due to the excavation works in the quarry site for example.
- By damage cultural site such as the community church at the vicinity of the quarry site.

The following WB environmental and social standards apply:

- ESS 1 – Assessment and Management of Environmental and Social Risks and Impacts
- ESS 8 - Cultural Heritage

Impact assessment

- This impact is negative and relative to the human environment.
- The duration is irreversible in case of loss of cultural heritage.
- The impact is local as the effect could be felt in the direct footprint area.
- The intensity of this impact is considered as medium as the potentiality to find archaeological and paleontological site of importance has been estimated as low by the Department of Museums and Monuments. However, a church structure for the communities has been identified at the vicinity of the potential access road to the quarry site.

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Site setup and construction works - Exploitation of the quarry and borrow sites	Risk of damage to cultural heritage	Human	Nature:	Negative	Moderate
			Duration:	Irreversible	
			Extent:	Local	
			Intensity:	Medium	

Avoidance

- Avoid any loss of cultural heritage during the design of the construction facilities such as the communities church close to the potential access road for the quarry site.

Minimization

The following mitigation measures must be applied by the Contractor:

- Draw and apply a cultural heritage management plan as well as a chance finds procedure, including the awareness of the cultural heritage and the procedures to follows in case of any suspicious findings.
- Protect any cultural site in the vicinity of the construction area that could be affected by the work activities.
- Organise a community cultural ceremony before starting the construction activities as requested by the community.

The mitigation measures will be detailed in the Cultural Heritage Management Plan (CP9) in the ESMP (Volume 2 of the ESIA).

Residual impact

By implementing these measures, the intensity of this impact will be reduced as low, consequently the significance of the impact will be minor.

Risk/Impact	Importance *before mitigation*	Importance *after mitigation*
Risk of damage to cultural heritage	Moderate	**Minor**

6.3.5.8. LOSS OF LAND DUE TO THE CONSTRUCTION FACILITIES/SITES

Impact analysis

This impact is relative to the following sources:

- Site setup and construction works,
- Exploitation of the quarry and borrow sites,
- Presence of workers.

The construction phase implies the acquisition of land for, at least, the quarry site, the clay borrow site and the temporary construction campsite:

- For the temporary worker's campsite, the land is a customary land of the Maganga 1 village. The lost surface is estimated to 2,18 hectares.
- For the quarry site, the land is a customary land of the Maganga 2 village. The estimated loss of land for the quarry site covers an estimated area of 3,39 hectares.
- For the proposed clay borrow site, the land is a customary land of the Njezera village. The lost surface is estimated to 2,57 hectares considering the access road.

It should be considered that no physical displacement will occur due to the loss of these land areas. A total of 22 households have been identified as economically affected, including 6 female-headed households and 16 male-headed households. It should be noticed that 5 households are headed by a disabled person.

The asset inventory showed that no crops and no fruit trees were found on the affected land. The inspection did not reveal any evidence of active cultivation, recent harvesting, or fallow preparation. The indigenous trees used as livelihood resources were counted in the 3 sites.

The following WB environmental and social standards apply:

- ESS 1 - Assessment and Management of Environmental and Social Risks and Impacts
- ESS 5 - Land Acquisition, Restrictions on Land Use and Involuntary Resettlement

Impact assessment

- This impact is negative and relative to the human environment.
- The duration is long-lasting or irreversible as the impact will occur during the construction phase for the clay borrow site, and permanently for the quarry site and the temporary camp site..
- The impact is local as the effect affect an area limited to the construction area in the TA Kasisi.
- The intensity of this impact is considered as medium due to the avoidance of physical displacement.

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Site setup and construction work - Exploitation of the quarry and borrow sites - The presence of workers	Loss of land for the construction facilities/sites	Human	Nature:	Negative	Moderate
			Duration:	Long-lasting / irreversible	
			Extent:	Local	
			Intensity:	Medium	

The following mitigation measures were implemented to minimize this environmental impact:

Avoidance

Avoid as much as possible the land acquisition by finding sites within EGENCO property such as for the batching plant. However, due to technical reasons (quantity and quality of materials for the quarry or for the clay borrow site for example), not all the facilities could be found in the EGENCO properties. It should be noted that the Majete Wildlife Reserve was considered to be avoided for this project due to the biodiversity sensitivity.

The chapter 7.2.2 relative to the alternatives for construction facilities details the avoidance process used for the choice of the location for each site.

In other to avoid resettlement impact, the land acquisition was identified considering the absence of building, infrastructures or equipment. However, one seasonal hut was identified at the borrow site.

Minimization

- The size of the area was defined according to the needs.
- The access roads were defined using as much as possible the existing road.

- The use of land was as well considered in order to minimize the loss of livelihood by avoiding crops loss as much as possible.

Residual impact

The residual impact is considered moderate due to the required acquisition of land for the needs of the rehabilitation of Kapichira dam: for the temporary contractor campsite, the quarry site, the borrow site and the new access roads to the quarry and borrow site.

Risk/Impact	Importance *before mitigation*	Importance *after mitigation*
Loss of land for the construction facilities/sites	Moderate	**Moderate**

Compensation

The land acquisition will require compensation for the corresponding loss of land. Therefore, a Resettlement Action Plan (in a separate report) was carried out which detail the compensation measures, outlined in the Land acquisition, restrictions on land use and Involuntary resettlement plan (EP5) in the ESMP (Volume 2 of the ESIA). The vulnerability of persons affected by the project (such as disabled person, female-headed households) was considered to drawn the measures..

6.3.5.9. CHANGE IN LAND USE DUE TO THE CONSTRUCTION FACILITIES

Impact analysis

This impact is relative to the following sources:

- Site setup and construction works,
- Exploitation of the quarry and borrow sites,
- Presence of workers.

The construction phase implies the change of land use for the temporary facilities required for the construction, such as the quarry site, the disposal area, the borrow site and the temporary workers' campsite. The land is mainly dry deciduous forest with mixed species, a type that is generally heavily degraded by human activities with no building and equipment.

The following WB environmental and social standards apply:

- ESS 1 - Assessment and Management of Environmental and Social Risks and Impacts
- ESS 5 - Land Acquisition, Restrictions on Land Use and Involuntary Resettlement

Impact assessment

- This impact is negative and relative to the human environment.
- The duration is long-lasting as the impact will occur during the construction phase, but with an effect of the change of use that may last beyond the period of construction.
- The impact is local as the effect affect an area limited to the construction area in the TA Kasisi.

- The intensity of this impact is considered as medium due to the avoidance of physical displacement. However, economic losses are foreseen for such impact.

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Site setup and construction work - Exploitation of the quarry and borrow sites - The presence of workers	Change in land use for the construction facilities	Human	Nature:	Negative	Moderate
			Duration:	Long-lasting	
			Extent:	Local	
			Intensity:	Medium	

The following mitigation measures must be implemented to minimize this environmental impact:

Avoidance

- Avoid as much as possible the land already uses by the communities.
- Prevent crop destruction by taking into account the crop calendar.

Minimization

- Engage with the community leader to identify sites according to the needs and to inform them in advance to avoid new plantations that could not be harvested before the land use for construction activities.

Residual impact

The residual impact is considered moderate due to the required use of communities' land for the needs of the rehabilitation of Kapichira dam

Risk/Impact	Importance *before mitigation*	Importance *after mitigation*
Change in land use for the construction facilities	Moderate	**Moderate**

Compensation

The loss or change of land use will require compensation for the corresponding loss of livelihood. Therefore, a Resettlement Action Plan (in a separate report) was carried out which detail the compensation measures, outlined in the Land acquisition, restrictions on land use and Involuntary resettlement plan (EP5) in the ESMP (Volume 2 of the ESIA).

6.4. Risks and impacts during the operation phase

6.4.1. Description of the main activities during the operation phase

This phase will start after the demobilization of the Contractor.

During the operation phase, maintenance and servicing operations of the infrastructure will need to take place. The main activities to be undertaken are:

- Presence of new equipment at the Kapichira dam
- Maintenance of equipment at the Kapichira dam
- Monitoring of floods and water level
- Sediment management
- Operations' personnel activities and training

The details of the operation phase are not yet available. However, information about operation for each component is included in the description of the project in chapter 4.3.

6.4.2. Identification of impact sources during the operation phase

The impact sources are the activities and components of the project that generate impacts on the physical, biological, or human environment for the operation phase.

Identifying the most significant sources of impact makes it possible to analyse and assess the project's impacts more precisely by comparing them with the most sensitive environmental components. The sources of impact that the project may generate during the operation phase are presented in the table below.

Figure 6-4: Impact sources during operation phase

Impact sources	Description
	Operation phase
Operation of the rehabilitated dam	The HPP will operate as run-of-river plant in baseload and no peaking operations are foreseen. The operation will include monitoring operations (water level, sediment load etc).
Sediment management	The operating rules will be revised, particularly regarding sediment management (flushing and dredging).
Maintenance of equipment	The maintenance and servicing operations imply the maintenance of all equipment.

6.4.3. Impacts on the physical environment

6.4.3.1. INTRODUCTION

The impacts identified on the physical environment during the operation are as follows:

- Reduced disaster risk due to the presence of emergency spillway
- Disturbance of the sediment balance and erosion of the Shire River
- Siltation of the Shire River downstream of the dam

6.4.3.2. REDUCED DISASTER RISK DUE TO THE PRESENCE OF EMERGENCY SPILLWAY

Impact analysis

This impact is relative to the following sources:

- Operation of the rehabilitated dam.

The presence of the new emergency spillway will reduce the disaster risk of dam failure leading to uncontrolled complete or partial emptying of the reservoir. The emergency spillway permits to discharge the floods during extreme weather conditions.

This reduced risk of dam failure impact positively the physical environment and consequently the biological and human environment.

The TOPS gate operating principle is presented in the following figure. They respond automatically in response to the rising water level in Kapichira to let pass flood and will then automatically close to retain the full supply level in the dam.



Source: Amanziflow - Studio Pietrangeli Consulting Engineers, 100GENRSP002B, Preliminary Design Report, November 2024

Figure 6-5: TOPS gate operation principle

The following WB environmental and social standards apply:

- ESS 1 - Assessment and Management of Environmental and Social Risks and Impacts

Impact assessment

- This impact affects positively the physical environment as well as the biological and human environment.
- The duration is long-lasting as the impact will only occur during the operation activities of the dam.
- The extent is national as the benefit could be felt in the downstream area with potential national impact in case of plant shutdown.
- The intensity of this impact is considered as high due to the nature of the benefit by avoiding major disaster.

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Operation of the rehabilitated HPP	Reduced disaster risk due to the presence of emergency spillway	Physical *Biological* *Human*	Nature:	Positive	Major
			Duration:	Long-lasting	
			Extent:	National	
			Intensity:	High	

To enhance the benefit of this emergency spillway, an emergency preparedness plan should be put in place and implemented as summarized in the chapter 6.4.5.3.

This measure is detailed in the Dam Emergency Preparedness Plan (EP6) in the ESMP (volume 2 of the ESIA).

6.4.3.3. DISTURBANCE OF THE SEDIMENT BALANCE AND EROSION OF THE SHIRE RIVER

Impact analysis

This impact is relative to the following sources:

- Operation of the rehabilitated dam
- Sediment management.

The operation of Kapichira HPP has significantly disturbed the natural sediment balance by retaining sediments upstream of the reservoir then releasing them during flushing since 2003. These practices have impacts upstream and downstream of the dam.

The impact upstream of the dam will be mostly the risk of accumulation of sediment in the reservoir as it is in the current situation. The sediments are transported by courants in the Shire River and its affluents. Because of the Kapichira dam, the sediments cannot be transported downstream, and the sediments are deposit upstream which cause an accumulation of sediments upstream and a reduced reservoir storage capacity over time. The significant flow upstream increases the erosion of riverbanks upstream of the dam. The riverbanks are therefore degraded.

Downstream of the dam, the water responds differently to the disturbance of the sediment balance. Because of the retained sediments, the water comes clear with a lack of sediments and suspended particles, compared to the natural load. The water can be “hungry” of sediments and more aggressive which can cause an erosion of riverbanks downstream of the dam.

According to the hydraulic and sedimentation study report from the Owner Engineer (SP, July 2024), ESCOM periodically carry out the sediment flushing since 2003 through the spillway on selected Sundays by stopping energy generation and lowering the reservoir to about El 143.3 m for a period of about 3 to 4 hours with the aim to restore the preferred flow path and gain back most of the live storage.

The training dyke in the reservoir will allow to reduce the deposition into the reservoir in a range of 12-20% (see the chapter 8.2.1.3 about the alternatives) reducing the disturbance of sediment balance. Moreover, the deposition will occur mainly in a confined area of the reservoir upstream the training dyke, which facilitate the dredging operation.

The following WB environmental and social standards apply:

- ESS 1 - Assessment and Management of Environmental and Social Risks and Impacts

Impact assessment

- This impact affects negatively the physical environment as well as the biological environment.
- The duration is long-lasting as the impact will occur during the operation activities of the dam.
- The extent is regional as the impact could be felt in the downstream area.

- The intensity of this impact is considered as medium because of the presence of the training dyke reducing the disturbance of the sediment balance.

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Operation of the rehabilitated HPP - Sediment management	Disturbance of the sediment balance and erosion of the Shire River	Physical	Nature:	Negative	Moderate
			Duration:	Long-lasting	
			Extent:	Regional	
			Intensity:	Medium	

The following mitigation measures must be applied:

- Sediment sluicing once a month during high flows: The sluicing consists of releasing the sediments directly through the reservoir during flood periods. The objective is to keep the sediments in motion and prevent them from settling in the reservoir.
- Commit to silt curtains near spillway, staged dredging and reservoir bathymetry checks.
- Revegetalization of stored sediments to prevent erosion and particle dispersion
- Remobilization of dredged sediments downstream: This measure will need further investigations, especially on the quality of the sediments.
- Design robust monitoring program (in coordination with the measures included in Mpatamanga project) considering the dredging operations, considering as well topographical survey.

The mitigation measures are described in the Sediment Management Plan (EP2) in the ESMP (Volume 2 of the ESIA).

Residual impact

By implementing these measures, the intensity of this impact will be reduced as low. Consequently, the significance of the impact will be minor.

Risk/Impact	Significance *before mitigation*	Residual impact/risk significance
Disturbance of the sediment balance and siltation of the Shire River	Moderate	**Minor**

6.4.3.4. SILTATION OF THE SHIRE RIVER DOWNSTREAM OF THE DAM

Impact analysis

This impact is relative to the following sources:

- Operation of the rehabilitated dam
- Sediment management.

The operation phase of Kapichira HPP has induced the siltation of the Shire River downstream of the dam. This siltation is due to the Ana floods as well as the flushing periods and the erosion of the riverbanks downstream of the dam (this phenomenon is described in the impact disturbance of the sediment balance).

The siltation means that downstream of the dam, the Shire River will be more loaded in sediments, especially in clay and sand. This increase of load induces a deposit of sediments where the water flow is less strong (on the banks and the bottom of the river). This siltation induces a loss of depths in the Shire River which will become shallower because of the increased deposits of sediments. This has an impact on floods and water can overflow its initial banks.

The following WB environmental and social standards apply:

- ESS 1 - Assessment and Management of Environmental and Social Risks and Impacts

Impact assessment

- This impact affects negatively the physical environment as well as the biological and human environment.
- The duration is long-lasting as the impact will occur during the operation activities of the dam.
- The extent is regional as the impact could be felt in the downstream area.
- The intensity of this impact is considered as medium due to the significantly disturbance of the natural water course although to the reduction measures with the dredging operation.

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Operation of the rehabilitated HPP - Sediment management	Siltation of the Shire River downstream the dam	Physical Biological Human	Nature:	Negative	Moderate
			Duration:	Long-lasting	
			Extent:	Regional	
			Intensity:	Medium	

The following mitigation measures must be applied:

- Implement sediment sluicing once a month during high flows: The sluicing consists of releasing the sediments directly through the reservoir during flood periods. The objective is to keep the sediments in motion.
- Design robust monitoring program (in coordination with the measures included in Mpatamanga project).

The mitigation measures are described in the Sediment Management Plan (EP2) in the ESMP (Volume 2 of the ESIA).

Residual impact

By implementing these measures, the intensity of this impact will be reduced as low. Consequently, the significance of the impact will be minor.

Risk/Impact	Significance *before mitigation*	Residual impact/risk significance
Siltation of the Shire River downstream the dam	Moderate	**Minor**

6.4.4. Impacts on the biological environment

6.4.4.1. INTRODUCTION

The impacts identified on the biological environment during the operation are as follows:

- Risk of trapped fauna in the island between the main spillway and emergency spillway.
- Risk of disturbance of aquatic wildlife due to sediment management
- Risk of human-wildlife conflict
- Risk of site invasion by invasive exotic species
- Reduction of downstream nutriment load

6.4.4.2. RISKS OF TRAPPED FAUNA IN THE ISLAND BETWEEN THE MAIN SPILLWAY AND EMERGENCY SPILLWAY

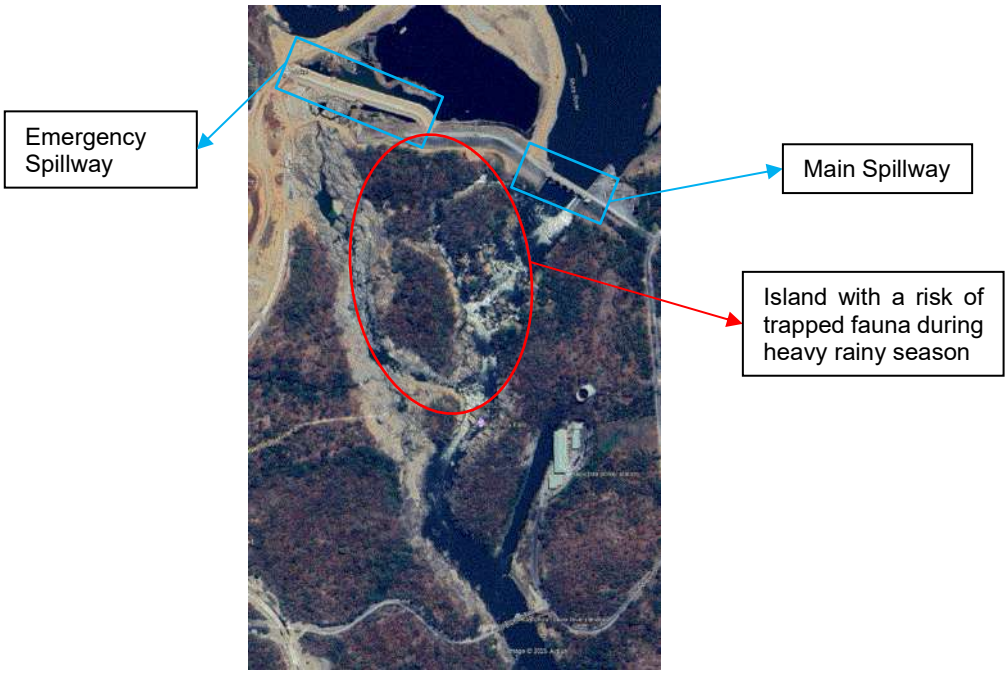


Figure 6-6: Location of the island between the main and emergency spillways

Impact analysis

This impact is relative to the following sources:

- Operation of the rehabilitated dam,
- Maintenance of equipment.

The configuration of the main and emergency spillways presents a potential hazard for wildlife, particularly larger fauna that may become trapped or injured due to sudden water releases or changes in flow (e.g. in the rainy season). Special attention should be given to wildlife corridors and safe passage routes around these spillway areas.

The following WB environmental and social standards apply:

- ESS 1 – Assessment and Management of Environmental and Social Risks and Impacts
- ESS 6 – Biodiversity Conservation and Sustainable Management of Living Natural

Impact assessment

- This impact negatively affects the biological environment.
- The duration is long-lasting as the the risk of mortality during each flooding period of the whole operation phase whose duration is indefinite.
- The extent is local as the impact will only concerns the direct footprint area.
- The intensity of this impact is medium because of the highly sensitive concern species present in the MWR which can be present when the direct footprint area return to African Parks.

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Operation of the rehabilitated HPP - Maintenance of equipment.	Risk of trapped fauna between the main spillway and emergency spillway	Biological	Nature:	Negative	Moderate
			Duration:	Long-lasting	
			Extent:	Local	
			Intensity:	High	

The following mitigation measures must be implemented to minimize this environmental impact:

- Preparation of a prevention plan of fauna trapping between spillways with the establishment of regular monitoring and rescue protocols, which will integrate:
  - Escape Ramps: Gentle-sloped ramps or platforms will be installed at strategic points to allow trapped terrestrial or semi-aquatic animals to exit the spillway channels or confined areas safely.
  - Motion-Sensor Alert System: A network of motion sensors will be installed to detect unusual movement in spillway zones, triggering alerts to relevant personnel for immediate inspection or intervention.
  - Weekly Boat Patrols: A dedicated team will conduct regular patrols by boat at least once per week in heavy rainy season to monitor the area for signs of trapped fauna, verify the functionality of mitigation devices (e.g. ramps, sensors), and implement rescue operations when needed.

The mitigation measures are described in the Biodiversity Management Plan (EP4) of the ESMP (Volume 2 of the ESIA).

Residual impact

By implementing these measures, the intensity of this impact will be expected to be reduced as low. Consequently, the significance of the impact will be minor

Source of Risk/Impact	Significance *before mitigation*	Residual impact/risk significance
Risk of trapped fauna between the main spillway and emergency spillway	Moderate	**Minor**

6.4.4.3. RISK OF DISTURBANCE OR MORTALITY OF AQUATIC WILDLIFE

Impact analysis

This impact is relative to the following sources:

- Operation of the rehabilitated dam,
- Sediment management.

During the operational phase, the risk of disrupting the life cycle of aquatic species is considered negligible, as the aquatic ecosystem is already fragmented due to the presence of the existing dam. The rehabilitation works will not introduce new barriers or significantly alter existing flow patterns and thus are not expected to worsen the current conditions for migratory or resident species.

However, sediment management practices during the reservoir's operational phase could lead to an increase in water turbidity, potentially diminishing water quality. This could impair the photosynthetic activity of aquatic plants, disrupt food chains, and impact species that depend on clear water for feeding and breeding.

The following WB environmental and social standards apply:

- ESS 1 – Assessment and Management of Environmental and Social Risks and Impacts
- ESS 6 – Biodiversity Conservation and Sustainable Management of Living Natural

Impact assessment

- This impact negatively affects the biological environment.
- The duration is long-lasting as the impact can occur at each sediment operation.
- The extent is local as it concerns the dam area.
- The intensity of this impact is considered as medium because of the already existing dam sediment operation.

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Operation of the rehabilitated HPP, - Sediment management.	Risk of disturbance of aquatic wildlife due to sediment management	Biological	Nature:	Negative	Moderate
			Duration:	Long-lasting	
			Extent:	Local	
			Intensity:	Medium	

The following mitigation measures must be implemented to minimize this environmental impact:

- Implement environmental flow (E-flow) as follows: The E-Flow was estimated by applying a percentage (20%) to the mean natural flow. The E-flow ranges between 46 and 67 m^3/s. The value is coherent with the Environmental Flow of 30-50m^3/s that should be currently released from the dam spillway. EGENCO, in collaboration with the National Water Resources Authority, must regularly monitor the E-Flow Regime to ensure that the defined E-flow is respected.

- Strategy of revegetalization of stored sediments to prevent erosion and particle dispersion and remobilization of dredged sediments downstream.

The mitigation measures are described in the Environmental Flow Management Plan (EP3) and Sediment Management Plan (EP2) of the ESMP (Volume 2 of the ESIA).

Residual impact

By implementing these measures, the intensity of this impact will be expected to be reduced as low. Consequently, the significance of the impact will be minor.

Risk/Impact	Significance *before mitigation*	Residual impact/risk significance
Risk of disturbance of aquatic wildlife due to sediment management	Moderate	Minor

6.4.4.4. RISK OF HUMAN – WILDLIFE CONFLICT

Impact analysis

This impact is relative to the following sources:

- Maintenance of equipment
- Operation of the rehabilitated dam

During the operational phase of the dam, the fence that was installed to secure the construction site will be removed, and the land will be returned to the Majete Wildlife Reserve. As a result, wildlife species are expected to gradually return to the site, reoccupying the areas close to the dam infrastructure. It will increase the proximity between wildlife and human activities around the dam. This close interaction may lead to human-wildlife conflicts, particularly with large or territorial species, as animals may venture into operational areas or infrastructure zones, posing safety risks both for the animals and for dam personnel.

The following WB environmental and social standards apply:

- ESS 1 – Assessment and Management of Environmental and Social Risks and Impacts
- ESS 4 - Community Health and Safety
- ESS 6 – Biodiversity Conservation and Sustainable Management of Living Natural

Impact assessment

- This impact negatively affects the biological environment as well as the human environment.
- The duration is long-lasting as the impact will only occur during the life of the dam.
- The extent is regional as it concerns the Majete Wildlife reserve and dam infrastructure.
- The intensity of this impact is considered as medium due to the already existing fence between the Majete Wildlife Reserve and the dam infrastructure

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Maintenance of equipment - Operation of the rehabilitated HPP	Risk of human – wildlife conflict	Biological	Nature:	Negative	Moderate
			Duration:	Long-lasting	
			Extent:	Regional	
			Intensity:	Medium	

The following mitigation measures must be implemented to minimize this environmental impact:

- Regarding the return of the direct footprint area to the MWR, a non-intrusive barrier will be reinstalled.
- Awareness trainings must be implemented for permanent and temporary workers onsite during the operation phase.
- Wildlife monitoring of regular patrols should be carried out in the vicinity of the dam infrastructure to record any incidents.

The mitigation measures are described more precisely in the Biodiversity Management Plan (EP4) of the ESMP (Volume 2 of the ESIA).

Residual impact

By implementing these measures, the intensity of this risk will be expected to be reduced as low. Consequently, the significance of the impact will be minor.

Risk/Impact	Significance *before mitigation*	Residual impact/risk significance
Risk of human – wildlife conflict	Moderate	Minor

6.4.4.5. RISK OF INVASION OF THE SITE BY INVASIVE EXOTIC SPECIES

Impact analysis

This impact is relative to the following sources:

- Maintenance of equipment.

There is a risk that the maintenance of equipment may facilitate the invasion of non-native species. These invasive species could outcompete local flora and fauna, leading to a reduction in biodiversity and ecosystem resilience. Active management strategies, including early detection and eradication programs, will be required to prevent such invasions.

The following WB environmental and social standards apply:

- ESS 1 – Assessment and Management of Environmental and Social Risks and Impacts
- ESS 6 – Biodiversity Conservation and Sustainable Management of Living Natural

Impact assessment

- This impact negatively affects the biological environment.

- The duration is long-lasting as invasives species are particularly difficult to control once established.
- The extent is regional affecting the construction influence area, the reservoir, and downstream water bodies.
- The intensity of this impact is considered as low due to the limited scope of hydrological disturbances caused by the project.

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Maintenance of equipment	Risk of invasion of the site by invasive exotic species	Biological	Nature:	Negative	Moderate
			Duration:	Long-lasting	
			Extent:	Regional	
			Intensity:	Low	

The following mitigation measures must be implemented to minimize this environmental impact:

- An invasive species management into operational plans must be implemented with a regular monitoring for species to survey and control of invasive plant species,

The mitigation measures are described more precisely in the Biodiversity Management Plan (EP4) of the ESMP (Volume 2 of the ESIA).

Residual impact

By implementing these measures, the intensity of this risk could be limited to the direct footprint area meaning as local extent. Consequently, the significance of the impact will be minor.

Risk/Impact	Significance *before mitigation*	Residual impact/risk significance
Risk of invasion of the site by invasive exotic species	Moderate	Minor

6.4.4.6. REDUCTION OF DOWNSTREAM NUTRIENT LOAD

Impact analysis

This impact is relative to the following sources:

- Operation of the rehabilitated dam,
- Sediment management.

This impact relies on the physical impact of risk of disturbance of the sediment balance and erosion.

The operation of the Kapichira hydropower plant significantly alters the natural sediment and nutrient dynamics of the Shire River. By trapping sediments upstream, the dam also retains nutrients bound to those sediments. As a result, the water released downstream is clearer but poorer in essential nutrients and organic matter compared to natural river conditions.

This reduction in nutrient load can negatively affect downstream ecosystems, particularly the Elephant Marsh, a key biodiversity hotspot. Nutrients carried by river sediments are crucial for maintaining the productivity and ecological balance of wetland habitats. A decrease in nutrient inputs may lead to lower primary productivity, changes in plant communities, and reduced food availability for aquatic and terrestrial species that depend on the marsh ecosystem.

The following WB environmental and social standards apply:

- ESS 1 – Assessment and Management of Environmental and Social Risks and Impacts
- ESS 6 – Biodiversity Conservation and Sustainable Management of Living Natural

Impact assessment

- This impact negatively affects the biological environment.
- The duration is long-lasting as the impact will occur during the life of the dam
- The extent is regional as the impact will be felt within the catchment area downstream of the Shire River.
- The intensity of the impact is considered as low due to already existing dam operation.

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Operation of the rehabilitated HPP, -Sediment management	Reduction of downstream nutrient load.	Biological	Nature:	Negative	Moderate
			Duration:	Long-lasting	
			Extent:	Regional	
			Intensity:	Low	

The following mitigation measures must be implemented to minimize this environmental impact:

- Regarding the potential lack of sediment load downstream, it should be implemented a remobilization of dredged sediments downstream.

  As the baseline is not recorded in terms of the sediment balance downstream, especially in the Elephant Marsh, this measure will require further investigation, especially on the quality of the sediments.

The mitigation measures are detailed in the Sediment Management Plan (EP2) of the ESMP (Volume 2 of the ESIA).

6.4.4.7. IMPACTS ON CRITICAL HABITAT

Species confined to the Majete Wildlife Reserve

For the species confined to the MWR, the impacts considered are due to the return of the borrowed area to the reserve after the construction activities:

- the risk of trapped fauna in the island between the main spillway and emergency spillway, and,

- the risk of human-wildlife conflict.

These impacts are the same mentioned in the previous section 6.4.4.2 and 6.4.4.4

Risk of trapped fauna in the island between the main spillway and emergency spillway

The Black Rhino, in particular, is highly vulnerable to these physical barriers, as their less mobile nature makes them more susceptible to getting trapped. The African Wild Dog, being more mobile, faces potential disruption to their territory and hunting routes but is less likely to be directly trapped.

The impact remains the same as the one describes in 6.4.4.2.: long-lasting and local, their intensity are moderate due to the critical conservation status of these species.

The mitigation measures related to the risk of trapped fauna between the main spillway and the emergency spillway presented in the section 6.4.4.2. considered also this species. The residual significance of the impact is considered to be minor.

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation	Impact after mitigation
- Operation of the rehabilitated HPP, - Maintenance of equipment	Risk of trapped fauna between the main spillway and emergency spillway	Biological	Nature:	Negative	Moderate	**Minor**
			Duration:	Long-lasting		
			Extent:	Local		
			Intensity:	Medium		

Risk of human-wildlife conflict

Both species could also face increased human-wildlife conflict as human presence in the area increases following the dam's operation, especially in the proximity of the infrastructure.

The impact here is the same as described in 6.4.4.4. for all terrestrial and semiaquatic species present in the Majete Wildlife Reserve. The mitigation measures related to the risk of human-wildlife conflict are presented in the section 6.4.4.4.

Application of mitigation hierarchy

For species confined in the MWR, the mitigation strategy focuses on preventing conflict through community awareness and reducing entrapment via a prevention of fauna trapping between spillway, while the Net Gain Program delivers targeted Species Conservation Actions (SCAs) such as financial support for population monitoring. Regarding the Black Rhino, impact prevention is ensured through strict access control and anti-poaching collaboration, with the species benefiting indirectly from the project's support for the reserve's overall.

Vultures between Liwonde, Majete and Legnwe

Regarding the vultures, no significant impacts are estimated in the operation phase. There is no risk of vultures being trapped, as they can escape far from the dam infrastructure during flood periods. Moreover, vultures are highly mobile, wide-ranging scavengers that are unlikely to be directly affected by dam infrastructure or altered hydrological conditions.

Unlike species that depend on specific aquatic or wetland habitats, vultures do not rely on the reservoir or downstream marshes for feeding or breeding.

Application of mitigation hierarchy

For vultures, the mitigation strategy focuses on preventing poisoning through community awareness, while the Net Gain Program delivers targeted Species Conservation Actions (SCAs) such as GPS tagging for corridor mapping

Species primarily associated with the Elephant Marsh

This section considers the following triggering critical habitat species:

- **The Black Heron, the African Openbill, the African Skimmer, the Whiskered Tern, the Collared Pratincole and the Basra Reed-warbler.**

The operation of the Kapichira hydropower plant can lead to changes in sediment and nutrient dynamics in the Shire River, impacting the downstream ecosystems, particularly the Elephant Marsh. Additional trapping of sediments upstream, the dam can reduce nutrient loads in the water released downstream. The resulting nutrient-poor water can negatively affect the productivity of wetland ecosystems crucial for species.

Reduction of downstream nutrient load

The species are dependent on nutrient-rich wetland habitats, and the reduction in sediment and nutrient load downstream could decrease primary productivity, affecting their food sources and breeding success. Species like the Whiskered Tern (*Chlidonias hybrida*) and Collared Pratincole (*Glareola pratincola*), which rely on specific breeding and foraging habitats in wetlands, could be forced to move or face reduced reproductive success due to the changes in their environment. Moreover, the African Skimmer requires specific habitat types (e.g., sandbars and shallow waters), making the species more sensitive to habitat alterations caused by the reduction of downstream nutrient load.

This impact is long-lasting, regional, and of medium intensity due to the species' high dependence on specific wetland conditions for survival.

As described in the 6.4.4.6., the residual significance of the impact remains moderate. Indeed, the remobilization of dredge sediment downstream proposed measure needs further investigation (quality of sediment, existing sediment load downstream).

Application of mitigation hierarchy

For migratory birds, the project minimizes impacts through erosion control and trapping prevention, complemented by a Net Gain initiative focused on long-term riparian restoration and invasive species removal.

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation	Importance after mitigation
- Operation of the rehabilitated HPP, - Maintenance of equipment	Reduction of downstream nutrient load.	Biological	Nature:	Negative	Moderate	Moderate
			Duration:	Long-lasting		
			Extent:	Regional		
			Intensity:	Medium		

- **Zambezi Flapshell turtle**

Risk of trapped fauna between the main spillway and the emergency spillway

As the construction area is returned to natural use and barriers are removed, *Cycloderma frenatum* may regain access to areas around dam infrastructure. However, water control structures such as the main and emergency spillways, canals, or water intake points may present physical hazards. During high flows or flood releases, individuals could become trapped or displaced, especially in shallow or slow-moving waters near these structures.

The impact remains the same as the impact described in 6.4.4.2.: long-lasting, local, their intensity is moderate due to the critical conservation status of these species.

The mitigation measures related to the risk of trapped fauna between the main spillway and the emergency spillway presented in section 6.4.4.2. The residual significance of the impact is considered to be minor.

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation	Impact after mitigation
- Operation of the rehabilitated HPP, - Maintenance of equipment	Risk of trapped fauna between the main spillway and emergency spillway	Biological	Nature:	Negative	Moderate	**Minor**
			Duration:	Long-lasting		
			Extent:	Local		
			Intensity:	Medium		

Reduction of downstream nutrient load

Cycloderma frenatum is less directly dependent on primary productivity than birds or fish. While a reduction in nutrient load may eventually affect lower trophic levels, the effect is indirect and likely to be non-significant.

Application of mitigation hierarchy

For Zambezi Flapshell Turtles and migratory birds, mitigation relies on E-Flow maintenance and in-water activity restrictions, while Net Gain is achieved by integrating species-specific monitoring and capacity building into the Elephant Marsh Community Conservation Area (CCA).

During the operational phase, the project focuses on long-term risk prevention through a dedicated management framework. This includes a Human-Wildlife Conflict Mitigation Program designed to manage interactions between local communities and the reserve's fauna, ensuring safety and coexistence. To prevent direct mortality, technical measures are implemented for the prevention of fauna trapping between spillways, alongside strict access controls to sensitive infrastructure. These mitigation efforts are complemented by the continuous monitoring of wildlife movements to identify and address any emerging conflict zones or operational risks.

The mitigation measures are described more precisely in the Biodiversity Management Plan (EP4) of the ESMP (Volume 2 of the ESIA).

6.4.5. Impacts on the human environment

6.4.5.1. HEALTH AND SAFETY RISKS FOR THE EMPLOYEES

Impact analysis

This impact is relative to the following sources:

- Maintenance of equipment
- Operation of the rehabilitated HPP

During the operation phase, there are risks to health and safety for the employees due to the maintenance and servicing operations. It can be for example transport on site, the risk of falling, either at ground level or from a height, during maintenance or infrastructure upkeep activities with new process to consider due to the change of the design (new type of spillway for example).

EGENCO has produced the following documents about health, safety and environmental aspects such as:

- “Social and gender inclusion” dated from May 2018, provided social and gender inclusion policy as well as anti-sexual harassment policy and procedure.
- “Handbook about Occupational Health, Safety and Welfare” dated from October 2019, in line with the Occupational Health, Safety and Welfare Policy, Safety Rules Guidelines and the Occupational Health, Safety and Welfare Act 1997 of the Government of Malawi.
- “Environmental management policy”, issued in September 2022
- “Electrical and mechanical safety handbook”, issued in 2022, with specific forms requested for each activity at risk (excavation works , working at height, hot works, isolation, electrical work, mechanical work…).
- “Traffic safety management plan for project, operations and maintenance works at power stations” issued in January 2024.

It should be noticed that no fatality, no major accident, no occupational disease and no major fire occurred during the period September 2022 to September 2023 with at least 824,000 man hours.

The following WB environmental and social standards apply:

- ESS 1 – Assessment and Management of Environmental and Social Risks and Impacts
- ESS 2 - Labour and Working Conditions

Impact assessment

- This impact negatively affects the human environment.
- The duration is long-lasting linked to the operation.
- The extent is local affecting the direct footprint area.
- The intensity of this impact is considered low due to the limited employees at site (around 30) and due to their knowledge of the dam.

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Maintenance of equipment - Operation of the rehabilitated HPP	Health and safety risks for the employees	Human	Nature:	Negative	Minor
			Duration:	Long-lasting	
			Extent:	Local	
			Intensity:	Low	

The following measures must be applied.

- Update if necessary the health and safety management plan considering the operation of the new Kapichira dam (spillways in particular), including preventive actions, information, and training.
- Maintain lost-time injury frequency rate below 1 per million hours.

The mitigation measures are described in the Occupational Health, Safety and Security (EP7) of the ESMP (Volume 2 of the ESIA).

6.4.5.2. HEALTH AND SAFETY RISKS FOR DIVERS

Impact analysis

This impact is relative to the following sources:

- Presence of new equipment at the Kapichira dam
- Maintenance of equipment at the Kapichira dam

The period for rehabilitation of the spillway will need to be coordinated with the Employer according to the Kapichira reservoir operating constraints. If reservoir water level cannot be lowered to the stoplog sill level, inspection and repairs shall be done with divers. Consequently, there is a risk of commercial divers being trapped or drowning during such operation if they face entanglement, sudden flow or low visibility.

The following WB environmental and social standards apply:

- ESS 1 – Assessment and Management of Environmental and Social Risks and Impacts
- ESS 2 - Labour and Working Conditions

Impact assessment

- This impact is negative and relative to the human environment.
- The duration is temporary as relative to the inspection activities.
- The impact is local as the effect is relative to the construction area.
- The intensity of this impact is considered as low due to the nature of the works (rehabilitation) with limited number of divers which must be professional divers.

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Presence of new equipment at the Kapichira dam - Maintenance of equipment at the Kapichira dam	Health and safety risks for divers	Human	Nature:	Negative	Minor
			Duration:	Temporary	
			Extent:	Local	
			Intensity:	Low	

The main following mitigation measures must be implemented for divers' operation:

- Engage professional divers with adequate experience on such activity.
- Prepare underwater-work safety plan with pre-dive isolation of valves and turbines, lock-out/tag-out procedure, standby diver and surface-supplied air, communication system, emergency extraction drill and annual certification of dive contractors.

The mitigation measures are described in the Occupational Health, Safety and Security (EP7) of the ESMP (Volume 2 of the ESIA).

6.4.5.3. HEALTH AND SAFETY RISKS FOR THE COMMUNITEES

Impact analysis

This impact is relative to the following sources:

- Operation of the rehabilitated HPP

As stated in chapter 6.4.3.2, the Kapichira dam rehabilitation will reduce disaster risk due to the presence of emergency spillway. Compared with the current situation, the presence of the new infrastructure (in particular the emergency spillway) will reduce downstream emergency risk due to the flood.

However, there is still flash-release risk as soon as the emergency spillway discharges, with the risk of downstream drowning. The area is prone to regular climate events, and the region experiences flooding on an annual basis.

The following WB environmental and social standards apply:

- ESS 1 – Assessment and Management of Environmental and Social Risks and Impacts
- ESS 4 - Community Health and Safety

Impact assessment

- This impact negatively affects the human environment.
- The duration is long-lasting linked to the operation.
- The extent is regional affecting the downstream area.
- The intensity of this impact is considered low as the risk is reduced compared to the current situation.

The significance of the impact is defined as follows:

Source of risk/impact	Impact/Risk	Impacted environment	Criteria		Importance before mitigation
- Operation of the rehabilitated HPP	Health and safety risks for the communities	Human	Nature:	Negative	Moderate
			Duration:	Long-lasting	
			Extent:	Regional	
			Intensity:	Low	

The following measures must be applied.

- Engage with the communities to explain the new operation rules of the dam.
- Implement a community emergency-warning protocol linked to the dam-safety plan.

The mitigation measures are described in the Community Health, Safety and Security plan (EP1) and in the Dam Emergency Preparedness Plan (EP6) of the ESMP (Volume 2 of the ESIA).

It should be noticed that the Emergency Preparedness Plan for the Kapichira Dam is a key component of the dam safety program due to the high risk of repeat flooding during the project implementation and scale of impacts as a result of the flooding or further failure of the dam. It aims to protect human life, reduce property damage, and ensure coordinated action during emergency or unusual events. The plan must comply with national regulations, EGENCO policies, and World Bank safety standards.

The plan must address major potential hazards, including dam overtopping or failure, abnormal structural behavior, earthquakes, landslides, and severe storms, internal erosion (piping) or mechanical system failures.

Emergency management must be structured at two levels:

- Dam level (EGENCO): responsible for operation, monitoring, and immediate response;
- National level: led by Malawi's Disaster Management Affairs Department, coordinating broader emergency actions.

The emergency response process should follow a five-step process:

- Detection and evaluation of unusual events;
- Classification of emergency levels (from internal alert to full evacuation);
- Notification and communication with stakeholders and authorities;
- Implementation of emergency actions and reporting;
- Termination and follow-up, including post-event review and improvements.

Preventive actions include:

- Continuous monitoring and surveillance (24/7);
- Staff organization for all conditions (weekends, adverse weather);
- Backup power systems;
- Warning systems (sirens) for downstream communities;
- Training and awareness programs, including evacuation plans.

The EPP will be complemented by a detailed Emergency Action Plan and reviewed every five years as detailed in the Dam Emergency Preparedness Plan (EP6) in the ESMP (volume 2 of the ESIA).

6.5. Cumulative impacts

6.5.1. Introduction

The cumulative impacts results from the combination with impacts from other relevant past, present and reasonably foreseeable developments. The objective is to assess the cumulative environmental and social impacts of the Kapichira dam rehabilitation project with other developments, in particular across the Shire Basin.

The main projects leading to interact with Kapichira dam rehabilitation are as follows:

- the planned construction of Mpatamanga hydropower project on the Shire River, 11 km upstream before entering the existing Kapichira reservoir, with change in the hydro-sedimentary regime when operating as well as an increase of the pressure on the biological and human environment. Construction activities for both projects are currently scheduled with a launch in 2026.
- The operation of SVTP irrigation project, with the irrigation intake included in Kapichira dam, requiring clear responsibility to the management of Kapichira reservoir for the two uses (energy and irrigation) as well as an increase of the pressure on the biological and human environment downstream the dam.

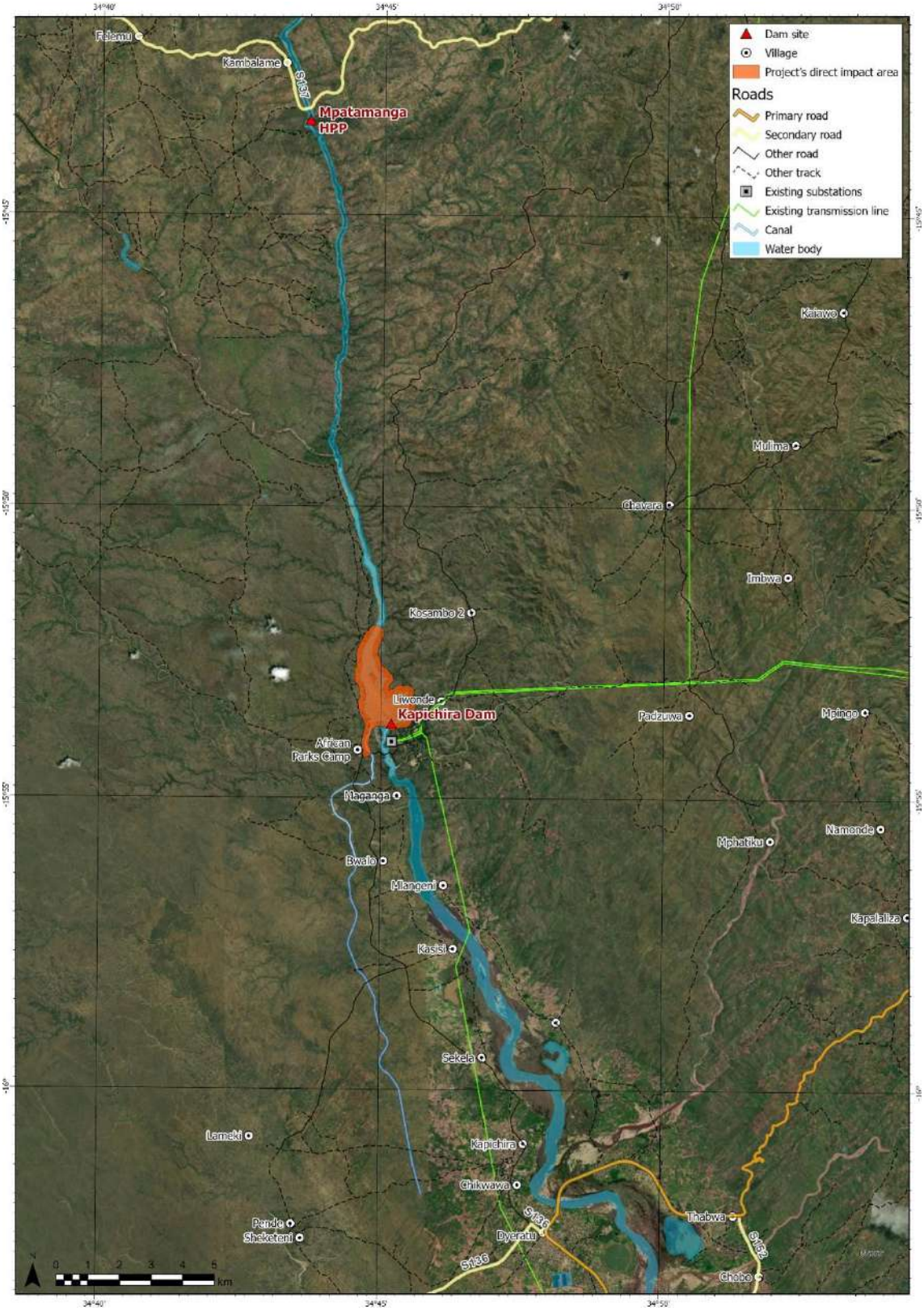


Figure 6-7: Location of development projects

6.5.2. Cumulative impacts with Mpatamanga HPP

6.5.2.1. INTRODUCTION

Approximately 12km upstream of Kapichira dam and to the north of Majete Game Reserve is the proposed location for the Mpatamanga Hydropower Scheme, which is expected to be composed of two dams, a HPP dam and a flow regulation dam. The scheme is likely to be developed with private sector involvement, including in terms of detailed design development. It is currently in the planning phase. The project has completed a full Cumulative Impact Assessment. This section is based on the Rapid Cumulative Impact Assessment Report (Southern Waters – Streamflow solutions – L Koehnken Pty Ltd, 2022) as well as the Cumulative Impact Assessment Report (Multiconsult - Southern Waters - Deltares - C12, 2024).

6.5.2.2. CONSTRUCTION PHASE OF MPATAMANGA

During Kapichira construction, the construction areas for Kapichira rehabilitation project will not overlap the one for Mpatamanga. However, as the areas are close (around 10 km between both), it is expected to have some impacts as follows:

- Local employment

Piecework (ganyu) for wealthier households or commercial farms represents the main source of employment in the Lower Shire (e.g., Dirnowa et al. 2010), although some households have small shops or breed pigs full time, and women also wash clothes or draw water for money. Fishing is also a full-time occupation and main source of income for many (Arthur and Hara 2016). Demand for labour (and labour opportunities) are highest during summer land preparation and harvesting, with changes in the price for ganyu having significant impacts on poor households. Employment opportunities and opportunities for earning money by selling services and/or crafts tend to be higher around the areas that are more frequented by tourists. For instance, through the development of Majete Wildlife Reserve and its inclusive management style, the surrounding communities have benefited from a growing tourism industry as well as from training opportunities, income-generating activities, and improved community infrastructure (ADBG 2018).

During the construction of Mpatamanga, about 2,500 workers on peak will be mobilized on the Mpatamanga construction site. This can induce a great influx of people between Mpatamanga and Kapichira dam but also impact the process in the recruitment of local staff for Kapichira rehabilitation project as the two projects construction is planned to start during the same year (2026). For memory, Kapichira required limited number of workers (estimated around 150).

6.5.2.3. OPERATION PHASE OF MPATAMANGA

Mpatamanga hydropower project will have a regulating effect on the hydrological regime, similar to the effect of the other hydropower projects along the upper reaches of the Shire River, and this may affect sediment transportation patterns downstream.

The commissioning of Mpatamanga is scheduled for mid-2030, with impacts on the Kapichira project as follows.

- Impact of Mpatamanga on sediment management of Kapichira HPP

The hydropower operating patterns and sediment mitigation measures at Kapichira HPP have, at times, had negative impacts on the downstream riverine environment due to periodic hydropeaking and episodic flushing of large volumes of sediment downstream. The driver of these undesirable operations is the lack of peak power in Malawi, and the excessive sediment transport in the catchment attributable to deforestation and other land use practices. Furthermore, the Kapichira Falls are often dry in the dry season because the agreed E-Flows releases were stopped during the 2016 drought, and as of 2022 had not been reinstated.

The development of Mpatamanga will substantially increase the overall electricity supply in Malawi, provide a reliable source of peak power, and reduce sediment input to Kapichira due to trapping in the Mpatamanga impoundment. These changes, combined with the relatively uniform flows that will be discharged from the regulated dam, will enable Kapichira HPP to operate in more of a run-of-river mode, resulting in more uniform flows between Kapichira HPP and the Elephant Marsh, although the assumption is that but there will still be occasional flushes and peaks if the station remains 'free' to operate in any pattern. The trapping of sediment in Mpatamanga impoundments, and the lack of sediment flushing from the main Mpatamanga dam, will substantially reduce the sediment inflow to Kapichira, which should reduce the required frequency of sediment flushing.

The reduction in sediment flushing will also benefit the downstream river in the short-term, through a reduction in the infilling of usable fish spawning habitat, and coating of aquatic and riparian habitats by sediments. Over the long-term, the more uniform flow and sediment regime will move the river back towards a more natural condition, recognising that some re-adjustment of the river channel may have short-term negative impacts.

A comprehensive assessment of the sediment impact producing factors has been undertaken and reported in the 'Sediment Impact Assessment and Sediment Management Plan' (HR Wallingford, 2024) and associated synthesis and complementary analysis report (EDF, 2024d). Additional analysis has been undertaken as part of the Mpatamanga ESIA report to further describe the Project's main impacts associated to sediment transport. The paragraphs below summarize its key findings about Kapichira dam:

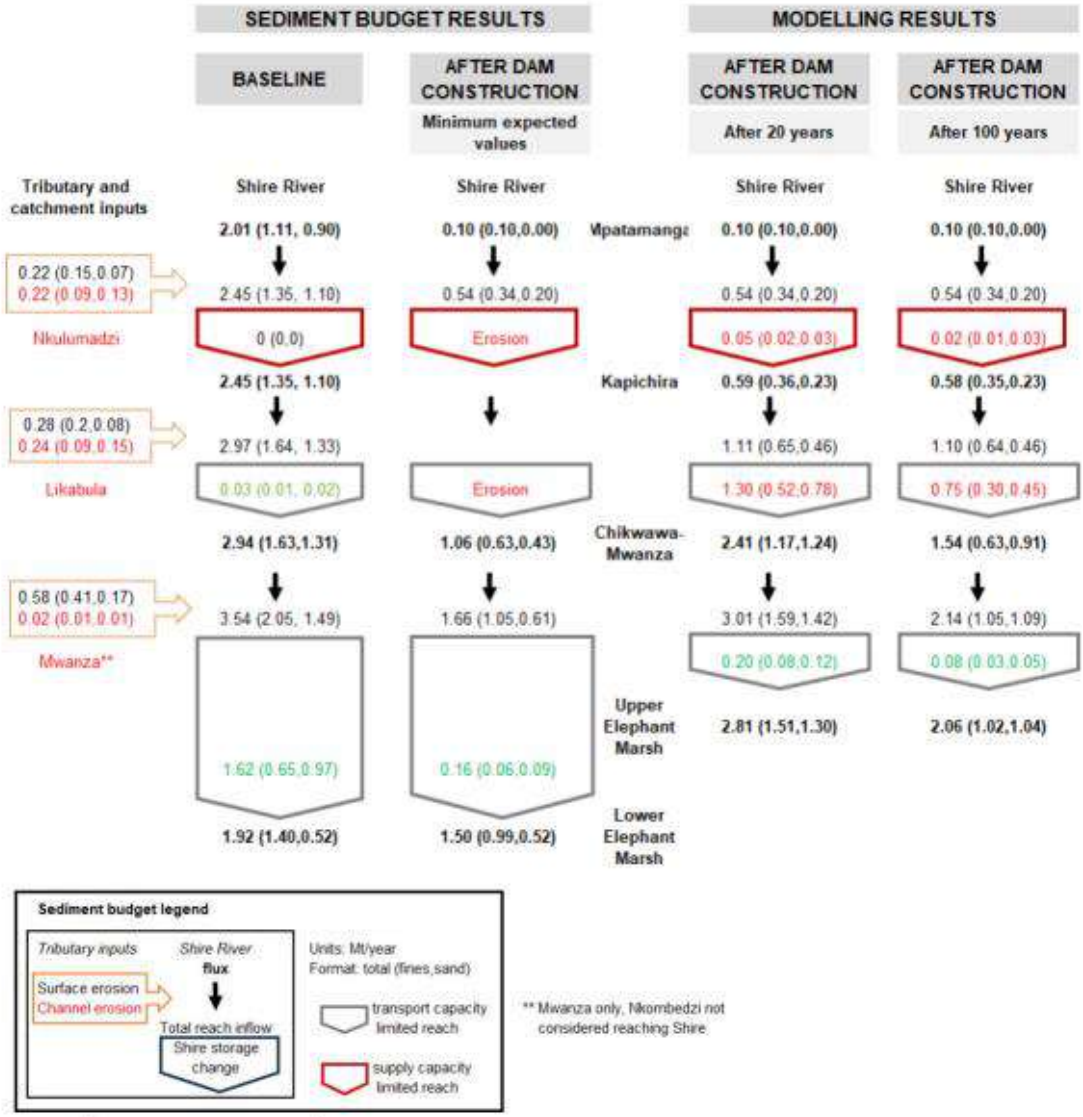
The sediment budget assessment considers: i) the period immediately after the main dam construction (assuming no downstream erosion); ii) 20 years after the main dam construction; and iii) 100 years after the main dam construction.

In summary:

- The Shire River between the regulating dam and Kapichira Reservoir will experience erosion. The total amount is expected to be small due to the presence of rock outcrops in the reach.
- In the first 20 years, the Shire River between Kapichira Reservoir and Chikwawa Bridge will experience high rates of channel erosion and, as such, will become a main source of sediment for the Upper Elephant Marsh reach (starting 14 km downstream of the Mwanza confluence).
- After 20 years, the rate of channel erosion between Kapichira Reservoir and Chikwawa Bridge will progressively reduce due to a reduction in available in-channel sediment.

The study highlights that there is considerable uncertainty in the available data to support any sediment budget estimation, especially a quantitative estimation. Therefore, the values presented here should be considered as indicative rather than absolute.

Figure 6-8: Predicted change in sediment budget and downstream erosion and deposition



Source: Sediment Impact Assessment and Sediment Management Plan (HR Wallingford, 2024) cited in Mpatamanga HPP ESIA, SLR, 31 July 2024

- Impact of Mpatamanga during the reservoir filling on the hydrological regime in Shire River

During the filling of Mpatamanga reservoir, Mpatamanga ESIA states that:

- 90% of incoming flow will be released downstream.
- Any potential impacts due to reservoir filling will be minimised through Shire River flow management operations. That is: i) if in 'dry conditions' request an additional release from Kamuzu Barrage; and ii) if in 'wet conditions', advise downstream users of reduced downstream flow.

- Impact of Mpatamanga on the hydrological regime in Shire River during Mpatamanga operation

A key assumption of the Mpatamanga ESIA is that the variation in sub-daily water level and flow downstream of Kapichira HPP is associated with the operation of Kapichira Reservoir and that any flow alteration (daily and sub-daily) generated downstream of the regulating reservoir due to the Mpatamanga HPP operation will only be felt in the reach between the regulating reservoir dam wall and Kapichira Reservoir. Any flow variations downstream of the Kapichira Reservoir are attributed to the operation of the Kapichira HPP, not to the Mpatamanga regulating reservoir operation.

- Increase of pressure on the biodiversity

Mpatamanga reservoir will inundate up to 28 km of the remaining rocky habitat in the Middle Shire River, as well as destroy the rocky instream habitat in Mpatamanga Gorge. In addition, the continued increase in the number of people depending directly on the natural resources of the Lower Shire River, leading to habitat destruction, mainly to construct croplands, and harvesting pressure on all natural resources, including plants, birds and fish, continues to increase. Under these circumstances, ecosystem structure and functioning become so compromised that the river ceases to become a resource for people.

6.5.2.4. CUMULATIVE IMPACTS OF PAST, PRESENT AND FUTURE SCENARIOS ON A SELECT SET OF VALUED ECOSYSTEM AND SOCIAL COMPONENTS BASED ON DEVELOPMENT IN THE SHIRE RIVER BASIN

This chapter summarises the content of the Cumulative Impact Assessment (CIA) of the Mpatamanga Hydropower Project on the Shire River study undertaken by Multiconsult in 2024. The CIA is conducted for the Shire River Basin downstream of Lake Malawi to its confluence with the Zambezi River, focusing on the area from the Kamuzu Barrage to the Mozambique border (meaning including Kapichira HPP project).

This CIA for the Mpatamanga HPP meet CIA requirements set out in the World Bank Environmental and Social Framework (World Bank 2017), IFC Performance Standards (IFC 2012) and the guidance in the IFC Good Practice Handbook on Cumulative Impact Assessment and Management (IFC 2013). The CIA is also undertaken following relevant national and international standards.

While the study primarily targets this specific region, it also considers some drivers and impacts on Valued Ecosystem and Social Components (VECs) that extend beyond these boundaries, such as long-term water level fluctuations in Lake Malawi. These broader factors are included in the assessment. However, they are assessed at a broader level of detail than the primary drivers and stressors within the CIA's main focus area, such as infrastructure development, deforestation due to charcoal and firewood production, and demographic changes and migration.

An eco-social model, called DRIFT-Shire-ESM, will be used to predict potential aquatic ecosystem changes linked to the use, development and management of the Shire River Basin as captured in nine scenarios that vary in terms of developments, operation, management approaches and/or climate. In DRIFT-Shire-ESM, the eco-social aspects of the aquatic ecosystems are represented by nine disciplines:

- Geomorphology
- Riparian and instream vegetation
- Macroinvertebrates

- Benthic algae
- Fish
- Herpetofauna
- Waterbirds
- River-related mammals
- Social-use.

The main input data to DRIFT-Shire-ESM are 30-year daily time-series of hydrological, hydrodynamic and hydraulic and sediment, and simulations of how these are expected to change with infrastructure and its operation, abstractions, social use and climate change with the estimated baseline (2022/3) ecological status. Other input data include:

- Land use
- Human population
- Hunting, cropping and harvesting levels
- Fishing regulations for gear and off-seasons
- Ambient temperature
- Protected areas
- Effluent quality.

DRIFT-Shire-ESM is being set up for 18 sites/zones in the Shire River Basin. Five sites on the Shire River and six sites on tributaries, two floodplain lakes and five zones in the Elephant Marsh. Each ecological discipline is represented by between five and ten indicators at each site.

6.5.2.5. CUMULATIVE IMPACTS MANAGEMENT MEASURES AND MONITORING WITH MPATAMANGA PROJECT

The Mpatamanga cumulative impact assessment described a combination of measures classified into a mitigation hierarchy comprising four main categories (avoid, minimize, restore, and offset) to mitigate the impacts of hydropower and other infrastructure developments. This hierarchy helps limit negative effects on the environment and human well-being from development projects.

Catchment-scale mitigation measures relevant to the sustainable development of the Shire River Basin are listed below:

- Create a joint dam operation for the dams along the Shire River (Liwonde, Nkula, Mpatamanga and Kapichira);
- Implement catchment rehabilitation programs that includes rehabilitation and reforestation of targeted erosion hotspot areas;
- Support the enhancement of tourism and protection management of protected areas enhancement;
- Participate in the sustainable land use enhancement and energy source transition;
- Support the implementation of conservation agriculture, farmer-managed natural regeneration and agroforestry;
- Participate in the institutional strengthening of NWRA, including a Stakeholder co-management platform for the Shire River;
- Implement Payment for Ecosystem Services Lisungwe Catchment;

- Implement sustainable fisheries management plans from Chikwawa to Chiromo (i.e. the extent of the Elephant Marsh modelled in the Cumulative Impact Assessment);
- Implement hyacinth and mimosa proliferation management plan in the Elephant Marsh; and
- Implement of community conservation areas in the Elephant Marsh.

All these measures are taken into account for Kapichira ESMP.

6.5.3. Cumulative impact with SVTP

The Shire Valley Transformation Program (SVTP) is an integrated development program. The project objectives are to provide access to reliable gravity fed irrigation and drainage services, secure land tenure for smallholder farmers, and strengthen management of wetlands and protected areas in the Shire Valley. The SVTP aims at irrigating about 43 370 ha of land in Chikwawa and Nsanje Districts, with three main canals of a total length of about 133 km to increase their economic prospects and food security.

The SVTP irrigation infrastructure is implemented in stages. The construction of the first stage (SVTP-I) included the irrigation intake structure located at the western embankment of the Kapichira reservoir. This infrastructure will provide water by gravity to over 22 000 ha, including over 10 000 ha new irrigation area.

The use of water for irrigation (SVTP) and energy (Kapichira HPP) should consider the environmental flow required to maintain the biological environment downstream the dam.

After the rehabilitation of Kapichira dam, the 1,2 km access road to the SVTP intake will be used occasionally by EGENCO. However, the land will be given back to African Parks. A memorandum of understanding must be put in place to define the rules of access and the responsibilities of each party in maintaining the road.

6.6. Summary table of impacts

The following table summarizes the significance of impacts for the project.

Overall, no major negative impacts have been identified for this project. However, the significance of some negative impacts after mitigation measures (avoidance and reduction) requires compensation measures for the biological and human environment.

Major positive impacts have been identified, with improvement measures to increase the benefit of these impacts.

Table 6-4: Summary of impacts for the dam rehabilitation project

Sources of positive impact	N°	Positive Impact	Type of environment	Duration	Extension	Intensity	Importance before mitigation measures	Importance after mitigation measures
Construction phase								
• Site setup and construction works; • Presence of workers	1	Employment opportunities	H	Temporary	National	Low	Minor	**Moderate**
Operation phase								
• Operation of the rehabilitated HPP • Sediment management	2	Reduced disaster risk due to the presence of emergency spillway	P,B,H	Long-lasting	National	High	Major	**Major**

P : Physical ; B : Biological; H : Human

Sources of impact	N°	Negative risk or impact	Type of environment	Duration	Extension	Intensity	Importance before mitigation measures	Importance after mitigation measures
Construction phase								
• Site setup and construction works • Transport and traffic related to the construction activities • Exploitation of the quarry and borrow sites • Dismantling of all temporary construction facilities	1	Dust and gas emission - deterioration in air quality	P, H	Temporary	Regional	Medium	Moderate	**Minor**
• Site setup and construction works • Transport and traffic related to the construction activities • Exploitation of the quarry and borrow sites • Dismantling of all temporary construction facilities	2	Increase in noise level	P, B, H	Temporary	Regional	Medium	Moderate	**Minor**
• Site setup and construction works • Transport and traffic related to the construction activities • Exploitation of the quarry and borrow sites • Dismantling of all temporary construction facilities • Presence of workers	3	Soil and water pollution by liquid or solid waste	P , B	Temporary	Regional	Low	Minor	**Minor**

Sources of impact	N°	Negative risk or impact	Type of environment	Duration	Extension	Intensity	Importance before mitigation measures	Importance after mitigation measures
• Site setup and construction works • Transport and traffic related to the construction activities • Exploitation of the quarry and borrow sites • Dismantling of all temporary construction facilities • Presence of workers	4	Light Pollution	P , B, H	Temporary	Regional	Low	Minor	**Minor**
• Site setup and construction works • Transport and traffic related to the construction activities • Exploitation of the quarry and borrow sites • Dismantling of all temporary construction facilities	5	Risk of erosion and modification of the physicochemical properties of the soil	P	Temporary	Regional	Medium	Moderate	**Minor**
• Site setup and construction works • Presence of workers	6	Pressure on water resources	P, B, H	Temporary	Local	Low	Minor	**Minor**
• Site setup and construction works	7	Modification of flow conditions on the Shire River	P, B, H	Temporary	Regional	Low	Minor	**Minor**
• Site setup and construction works	8	Disaster risk due to flooding	P,B,H	Temporary	National	High	Moderate	**Minor**
• Site setup and construction works	9	Increase of sediments in the reservoir	P	Temporary	Local	Low	Minor	**Minor**
• Site setup and construction works • Exploitation of quarries • Transport and traffic related to the construction activities	10	Loss, fragmentation and degradation of natural habitats and flora	B	Long-lasting	Local	Medium	Moderate	**Moderate**
• Site setup and construction works • Exploitation of the quarry and borrow sites • Transport and traffic related to the construction activities • Dismantling of all temporary construction facilities	11	Disturbance of wildlife and risk of mortality	B	Temporary	Regional	High	Moderate	**Minor**
• Site setup and construction works • Exploitation of the quarry and borrow sites • Transport and traffic related to the construction activities • Dismantling of all temporary construction facilities	12	Spread of flora invasive species	B	Long-lasting	Regional	Low	Moderate	**Minor**

Sources of impact	N°	Negative risk or impact	Type of environment	Duration	Extension	Intensity	Importance before mitigation measures	Importance after mitigation measures
• Site setup and construction works • Exploitation of the quarry and borrow sites • Transport and traffic related to the construction activities • Dismantling of all temporary construction facilities	13	Risk of human - wildlife conflict	B	Temporary	Regional	High	Moderate	**Minor**
• Site setup and construction works • Exploitation of the quarry and borrow sites • Transport and traffic related to the construction activities • Dismantling of all temporary construction facilities	14	Risk of increased poaching	B	Temporary	Regional	High	Moderate	**Minor**
• Site setup and construction works • Exploitation of the quarry and borrow sites • Transport and traffic related to the construction activities • Dismantling of all temporary construction facilities	15	Risk of aquatic mortality and loss of aquatic habitats	B	Long-lasting	Regional	Low	Moderate	**Minor**
• Site setup and construction works • Exploitation of the quarry and borrow sites • Transport and traffic related to the construction activities • Dismantling of all temporary construction facilities	16	Impacts on Critical Habitat	B	Temporary to Long-lasting	Regional	Low / Medium / High	Moderate	**Minor**
• Site setup and construction works	17	Spontaneous migration	H	Temporary	Regional	Low	Minor	**Minor**
• Site setup and construction works • Exploitation of quarries • Transport and traffic related to the construction activities • Presence of workers	18	Disturbance of local communities	H	Temporary	Regional	Low	Minor	**Minor**
• Site setup and construction works • Exploitation of quarries • Transport and traffic related to the construction activities	19	Health and safety risks for workers	H	Temporary	Local	Low	Minor	**Minor**
• Site setup and construction works • Presence of workers	20	Risk of violence based on gender	H	Temporary	Regional	Medium	Moderate	**Minor**
• Site setup and construction works • Exploitation of the quarry and borrow sites	21	Risk of damage on the cultural heritage	H	Irreversible	Local	Medium	Moderate	**Minor**

Sources of impact	N°	Negative risk or impact	Type of environment	Duration	Extension	Intensity	Importance before mitigation measures	Importance after mitigation measures
• Site setup and construction works • Exploitation of the quarry and borrow sites • Presence of workers	22	Loss of land due to the construction facilities (such as temporary campsite), quarry site...	H	Long-lasting	Local	Medium	Moderate	**Moderate**
• Site setup and construction works • Exploitation of the quarry and borrow sites • Presence of workers	23	Change in land use due to the construction facilities	H	Long-lasting	Local	Medium	Moderate	**Moderate**
Operation phase								
• Operation of the rehabilitated HPP • Sediment management	24	Disturbance of sediment balance and erosion of the Shire river	P	Long-lasting	Regional	Medium	Moderate	**Minor**
• Operation of the rehabilitated HPP • Sediment management	25	Siltation of the Shire River downstream of the dam	P	Long-lasting	Regional	Medium	Moderate	**Minor**
• Operation of the rehabilitated HPP • Sediment management	26	Risk of trapped fauna between in the island between the main spillway and emergency spillway	B	Long-lasting	Local	High	Moderate	**Minor**
• Operation of the rehabilitated HPP • Sediment management	27	Risk of disturbance of aquatic wildlife	B	Long-lasting	Local	Medium	Moderate	**Minor**
• Operation of the rehabilitated HPP • Maintenance of Kapichira rehabilitated equipment	28	Risk of human - wildlife conflict	B	Long-lasting	Regional	Medium	Moderate	**Minor**
• Maintenance of equipment	29	Risk of invasion of the site by invasive exotic species	B	Long-lasting	Regional	Low	Moderate	**Minor**
• Operation of the rehabilitated HPP • Sediment management.	30	Reduction of downstream nutrient load	B	Long-lasting	Regional	Low	Moderate	**Moderate**
• Operation of the rehabilitated HPP • Sediment management.	31	Impacts on Critical Habitat	B	Temporary to Long-lasting	Local to Regional	Medium	Moderate	**Minor**
• Operation of the rehabilitated HPP • Sediment management.	32	Impacts on Critical Habitat: reduction of downstream nutrient load for Elephant Marsh primarily associated species	B	Long-lasting	Regional	Medium	Moderate	**Moderate**
• Operation of the rehabilitated HPP • Maintenance of Kapichira rehabilitated equipment	33	Health and safety risks for the employees	H	Long-lasting	Local	Low	Minor	**Minor**
• Presence of new equipment at the Kapichira dam • Maintenance of Kapichira rehabilitated equipment	34	Health and safety risks for divers	H	Temporary	Local	Low	Minor	**Minor**
• Operation of the rehabilitated HPP	35	Health and safety risks for the communities	H	Long-lasting	Regional	Low	Moderate	**Minor**

P : Physical ; B : Biological; H : Human

7. ANALYSIS OF ALTERNATIVES

7.1. Introduction

This chapter compares feasible alternatives to the proposed project site, technology, design, and operation, including the "without project" situation, in terms of their potential environmental and social impacts.

For this project, after the assessment with “no project”, the analysis was carried out for the following alternatives:

- Alternative construction technologies:
  - For the emergency spillway,
  - For the permanent intake,
  - With the training dyke.
- Alternatives for construction activities:
  - For the quarry site,
  - For the temporary construction’s campsite,
  - For the borrow site.

7.2. Alternative with « No project »

If Kapichira dam rehabilitation project is not implemented, the dam, damaged by the tropical storm Ana, would suffer the following consequences:

- The emergency spillway will not be rehabilitated with the risk of disaster leading to uncontrolled complete or partial emptying of the reservoir as the lack of emergency spillway does not permit to discharge the floods during extreme weather conditions. According to the climate change assessment, the percentage increase on the current design flood varies from 42% to 117% depending on the scenario for the 20-year return period flood.
- The long-term maintenance of the main spillway would have been expensive for EGENCO considering the issues of the hoisting system due to breaking of ropes.
- The sediment management will not be improved or strengthened with the negative downstream impacts on the biological and human environment, including the Elephant Marsh Ramsar site.
- The risk of dam break due to sediment accumulation in the reservoir and climatic event will not be reduced.

7.3. Alternative « with project »

7.3.1. Alternative construction technologies

7.3.1.1. ALTERNATIVES FOR THE EMERGENCY SPILLWAY

The following three emergency spillway alternatives were studied in the Preliminary Design Report from the Owner Engineer (Studio Pietrangeli, preliminary Design report, November 2024).

- FUSE GATE alternative
- TOPS GATE alternative
- FLAPS GATE alternative

The study of alternatives was carried out to assess the most promising layout from a technical, economic and environmental point of view. The following table compares the alternatives in terms of impact to the environment.

Table 7-1: Comparision of alternatives for the emergency spillway

Type of gate	PRO	CON
FUSE GATE	/	• Impact downstream due to sudden large flow releases when they tip • Vulnerable to sediments and floating debris • No flow management
TOPS GATE	• Debris and sediment management • Flow management	/
FLAPS GATE	• Management of sediment and debris transport • Flow management	• Risk of oil contamination

The fuse gate alternative shows negative impacts in terms of sediment and flow management. This alternative has also a downstream negative impact because of the sudden large flow releases.

The TOPS gate alternative allows debris and sediment management as well as a low management. No negative impact on the environment has been identified.

The flaps Gate alternative is like the TOPS gate alternative in terms of environmental impact except that it can induce risk of oil contamination and takes less time for construction than the TOPS gate (24 months against 18 months)

Therefore, the TOPS gate is the most suitable for the emergency spillway from an environmental point of view.

7.3.1.2. ALTERNATIVES FOR THE PERMANENT INTAKE

For the permanent intake, two alternatives layout have been identified:

- Two automatic SELF-REGULATING gates
- One automatic SELF-REGULATING gate and two MECHANICAL RADIAL GATE

The SELF-REGULATING gates option is the most suitable alternative based on the cost of construction, technical issues and environmental aspects. In case of outage of one gate, the other gate can regulate the flow.

7.3.1.3. ALTERNATIVES WITH THE TRAINING DYKE

No training dyke was included in the first layout.

Three different scenarios have been analyzed by the Owner Engineer (Studio Pietrangeli, hydraulic and sedimentation study report, July 2024).:

- Training dyke current layout,
- Training dyke moved downstream towards the dam,
- Absence of training dyke.

In all scenarios, it was considered the removal of the cofferdam and pre-cofferdam actually on site for allowing the temporary intake construction and the removal of the great amount of material in the area between the existing training dyke and the dam and the establishing of a bed level of 136 m asl.

A 2D model was run with the daily average year as inflow, in order to provide a clear understanding of the main area of sediment deposition in the reservoir as well as about the role of each alternative to reduce the amount of sediment deposition and to protect the outlet works, such as irrigation intake and emergency spillway.

The result shows that the construction of a training dyke in the reservoir allows to reduce the deposition into the reservoir in a range of 12-20% (0.33 Mm^3/year of deposited sediment with training dyke compared to 0.37 Mm^3/year without training dyke).

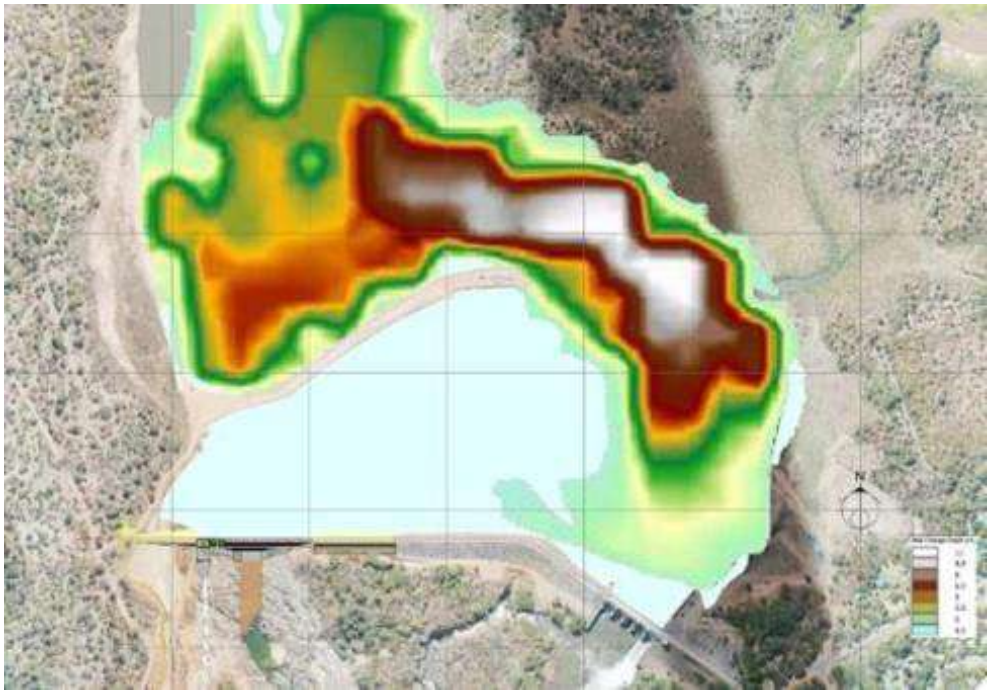


Source: Studio Pietrangeli Consulting Engineers, 130GENRSP002A, Hydraulic and sedimentation study Report, July 2024

Figure 7-1: Kapichira reservoir bed elevation modification - Section downstream the training dyke

The above figure shows that the sediment deposition in the reservoir close to the dam:

- is almost nil with the current layout of the training dyke,
- increases significantly on left side and has almost tripled in the right side with the modified layout of the training dyke (moved downstream),
- increases on one order of magnitude with the removal of training dyke.



Source: Studio Pietrangeli Consulting Engineers, 130GENRSP002A, Hydraulic and sedimentation study Report, July 2024

Figure 7-2: 2000-2004 model simulation with current layout of training dyke with reservoir bed elevation in March 2003

According to the above results, the best alternative is the current layout of the training dyke due to the following advantages:

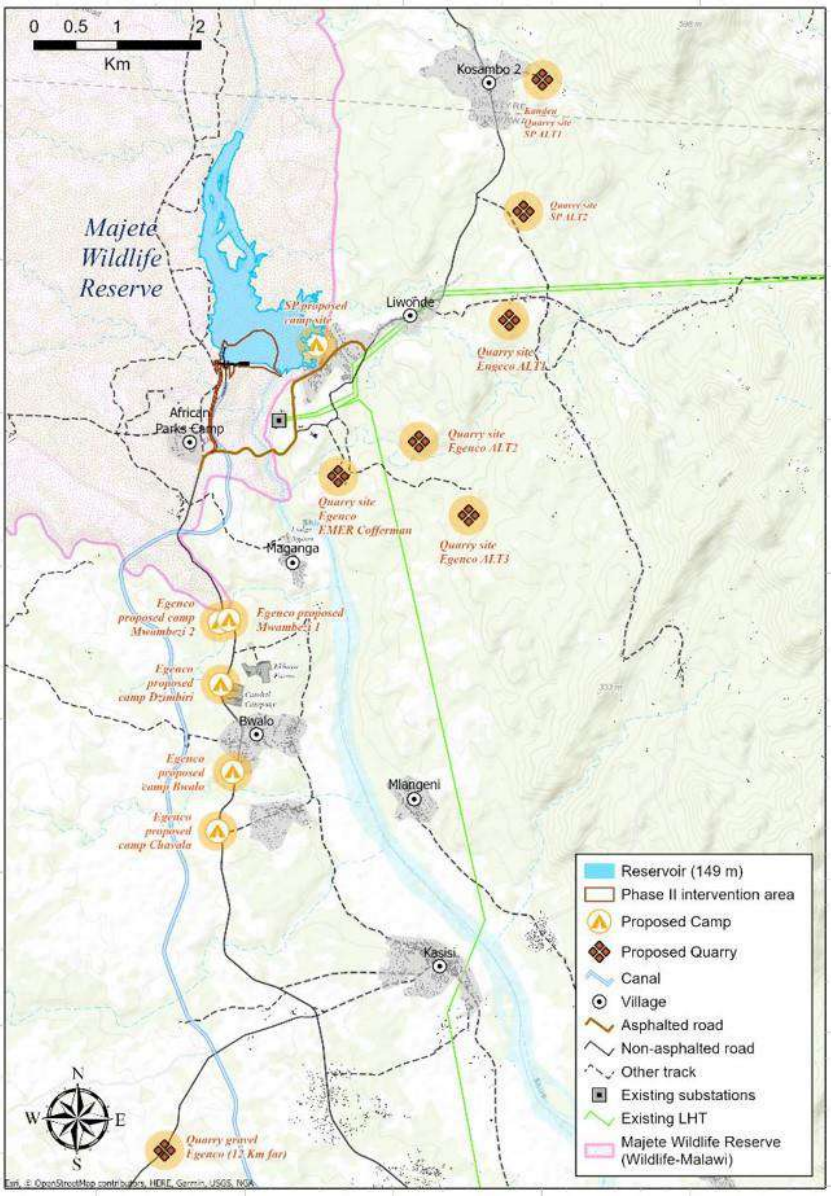
- Keep the area upstream the outlet works free from significant sediment deposition,
- Facilitate the dredging operation as the deposition occurs mainly in a confined area of the reservoir upstream the training dyke,
- Lead to higher velocity in case of flushing operation as the main flow path is confined in a narrow channel located in the left side of the reservoir.

7.3.2. Alternatives for construction facilities

7.3.2.1. INTRODUCTION

The alternatives were about the quarry site and the temporary camp site as shown on the following figure, as well as the borrow (clay) site.

Figure 7-3: Location for quarry and temporary camp site alternatives



7.3.2.2. QUARRY SITE

Four different options were considered for the location of the quarry that would provide the material needed for the Rehabilitation of the Kapichira dam. The main requirement was that the quarry can provide the quantity and quality needed for the rehabilitation which is 96,000 m^3. The main characteristics of the four alternatives are presented in the table below. All four alternatives are good quality and a quantity of gneiss to respond to the needs of the rehabilitation.

Table 7-2: Alternatives for the quarry site

Alternative	Description	Coordinates		Distance from Kapichira dam
		East (m)	South (m)	Km

Alternative	Description	Coordinates		Distance from Kapichira dam
Alternative_1	SP April 2024	690'865	8'245'375	6.85
Alternative_2	SP October 2024	690'579	8'243'824	5.30
Alternative_3	EGENCO site 1	690'500	8'242'463	4.70
Alternative_4	EGENCO site 2	689'299	8'241'001	2.75

The criteria used to rate the quarries' alternatives are as follows:

- Accessibility to the site
- Distance to the construction site
- Distance between quarries and first villages
- Distance to the Majete wildlife reserve
- Loss of community assets
- Administrative context
- Land use and loss of agricultural lands.

For each criterion, the rating was out of a total of 4, with 1 being the least favourable option for the criterion studied and 4 being the most favourable option.

Table 7-3: Multi-criteria analysis about quarry alternatives

Selection	Alternative 1	Score	Alternative 2	Score	Alternative 3	Score	Alternative 4	Score
Administrative context	Blantyre District		Chikwawa District					
Distance to Kapichira dam	6.85 km	1	5.30 km	2	4.70 km	3	2.75 km	4
Number of villages crossed by the access road to the dam	2	1	1	2	1	2	0	4
Distance with village	150 m from the Kandeu Village	1	1 km from Kandeu Village	3	Less than 200 from a village	2	1.5 km North-West	4
Distance to the Majete wildlife reserve	3.5 km	3	4.0 km	4	3.0 km	2	1.5 km	1
Loss of assets	Yes at Kandeu	1	No	4	No	4	No	4
TOTAL on 20		**7**		**15**		**13**		**17**

Based on the characteristics for the quarry's alternatives, the Alternative 4 is the most suitable for the quarry from an environmental point of view: it is the closest one to the construction site:

- avoiding issues of transport crossing villages.
- There is no village at the immediate vicinity of the quarry and the access road.
- Reducing the greenhouse gas impact (fuel use and CO_2 per tonne of material moved) as the distance to the dam site is 40% less than the Alternative 3, 48% less than the Alternative 2, 60% less than the Alternative 1.

7.3.2.3. TEMPORARY CONSTRUCTOR'S CAMPSITE

This section describes the different alternatives proposed for the campsite for the Contractor's workers for Kapichira dam rehabilitation.

In the first preliminary design report, the owner's engineer proposed a localization for the campsite adjacent to the existing residential areas of EGENCO on the left bank of Kapichira. This campsite would be divided in two sites of 10,200 m^2 and 6,200 m^2 respectively. This alternative was declined by EGENCO because of the proximity with the EGENCO residential areas. The consultation carried out by the consultant confirmed this decision (see chapter 9.4).

The owner's engineer proposed five other alternatives (see the following table) that were compared and submitted to a multi-criteria analysis to determine the optimal option based on environmental criteria.

Table 7-4: Location of the alternatives for the temporary constructor campsite

Alternative	Name of Camp	Coordinates		Distance from Kapichira dam
		East (m)	South (m)	Km
Alternative_1	Mwambezi 1	687'134	8'238'834	4.3
Alternative_2	Mwambezi 2	687'013	8'238'795	4.3
Alternative_3	Dzimbiri	686'946	8'238'071	5.1
Alternative_4	Bwalo	687'094	8'237'045	6.2
Alternative_5	Chavala	687'059	8'236'412	6.8

The evaluation was based on the following criteria:

- Accessibility to the camp from the main road
- Distance from the dam site
- Distance to the closest village
- Distance to national or international recognised natural protected area (here, the Majete Wildlife Reserve)
- Distance to water bodies
- Land use.

For each criterion, the rating was out of a total of 3, with 1 being the least favourable option for the criterion studied and 3 being the most favourable option.

Alternatives	Mwambezi 1		Mwambezi 2		Dzimbiri		Bwalo		Chavala	
	Alternative 1	Score	Alternative 2	Score	Alternative 3	Score	Alternative 4	Score	Alternative 5	Score
Land ownership	Customary land of village Maganga				Land belongs to one owner					
Distance from the dam site	3 km	3	3 km	3	4 km	2	5 km	1	5.5 km	1
Distance to the closest village	750 m from Maganga	3	900 m from Maganga	3	100 m from Dzimbiri Primary school	1	60 m to Bwalo	1	180 m to Chavala	2
Number of villages crossed by the access road to the dam	0	3	0	3	0	3	1	1	1	1

Alternatives	Mwambezi 1		Mwambezi 2		Dzimbiri		Bwalo		Chavala	
Distance to the Majete Wildlife	300 m	1	350 m	1	1.0 km	2	2.2 km	3	2.8 km	3
Distance to water bodies (temporary river)	100 m	2	80 m	1	800 m	3	60 m	1	350 m	3
Land use	Farmland (maize cultivation)	3	Trees and shrubs (Acacia species)	2	Dense tree cover	1	Dense tree cover	1	Farmland, trees and shrubs	2
TOTAL		**15**		**13**		**12**		**8**		**12**

Table 7-5: Multicriteria analysis of the temporary campsite alternatives

The Alternative 1 was selected as the best option due to the following criteria:

- the closest location to the dam site (reducing the greenhouse gas impact such as fuel use and CO^2 per worker from dam site to camp site).
- No close water source (<100m of temporary river and 1 km from the Shire River) reducing the risk of pollution.
- Presence of an existing access road (avoiding new access road).
- No village between the camp site and the dam site, avoiding traffic issues and social risk (Community gender-based violence risk).
- No village or communities' facility at the vicinity of the camp site (more than 750 m).
- No school between the campsite and the dam site.
- No cultural heritage in the vicinity.
- No greenfield land: The alternative 1 is already use for agriculture purpose with no equipment.
- No biodiversity issue: No conservation flora and fauna species were recorded in the site. The vicinity of the Majete Wildlife reserve was considered as not an issue as the reserve is well fenced.

7.3.2.4. BORROW SITE

This section describes the different alternatives proposed for the clay site for Kapichira dam rehabilitation based on the Borrow area assessment Report (Studio Pietrangeli Consulting Engineers, borrow area assessment report, Ref: 100 GEN R SP005A) from the owner's engineer.

The owner's engineer proposed four alternatives (see the following figure) that were compared and submitted to a multi-criteria analysis to determine the optimal option based on environmental criteria.

Table 7-6: Alternatives for the borrow site

Alternative	Description	Coordinates		Technical comments
		East (m)	South (m)	

Alternative	Description	Coordinates		Technical comments
Alternative_1	Upstream Kapichira dam on the left abutment	N.A.	N.A.	Used for the cofferdam construction. Location not found. In the Majete Wildlife Reserve
Alternative_2	Upstream of the training dyke on the right abutment	587’100	8’242’500	In the reservoir
Alternative_3	Kipula close to Chikwana village	691’899	8’233’337	Downstream on the left side of the River. Too far from dam site.
Alternative_4	Bwalo close to Bwalo labour camp	687’974	8’237’728	Used for the dam construction. Not appropriate for impervious core material.
Alternative_5	Kasisi			New site. 9 km from dam site. Not appropriate for impervious core material.
Alternative_6	Njerenza			New site. 10 km from dam site. Appropriate for impervious core material

No commercial alternative was found as well.

The alternative 6 was the only technical alternative found suitable for the project.

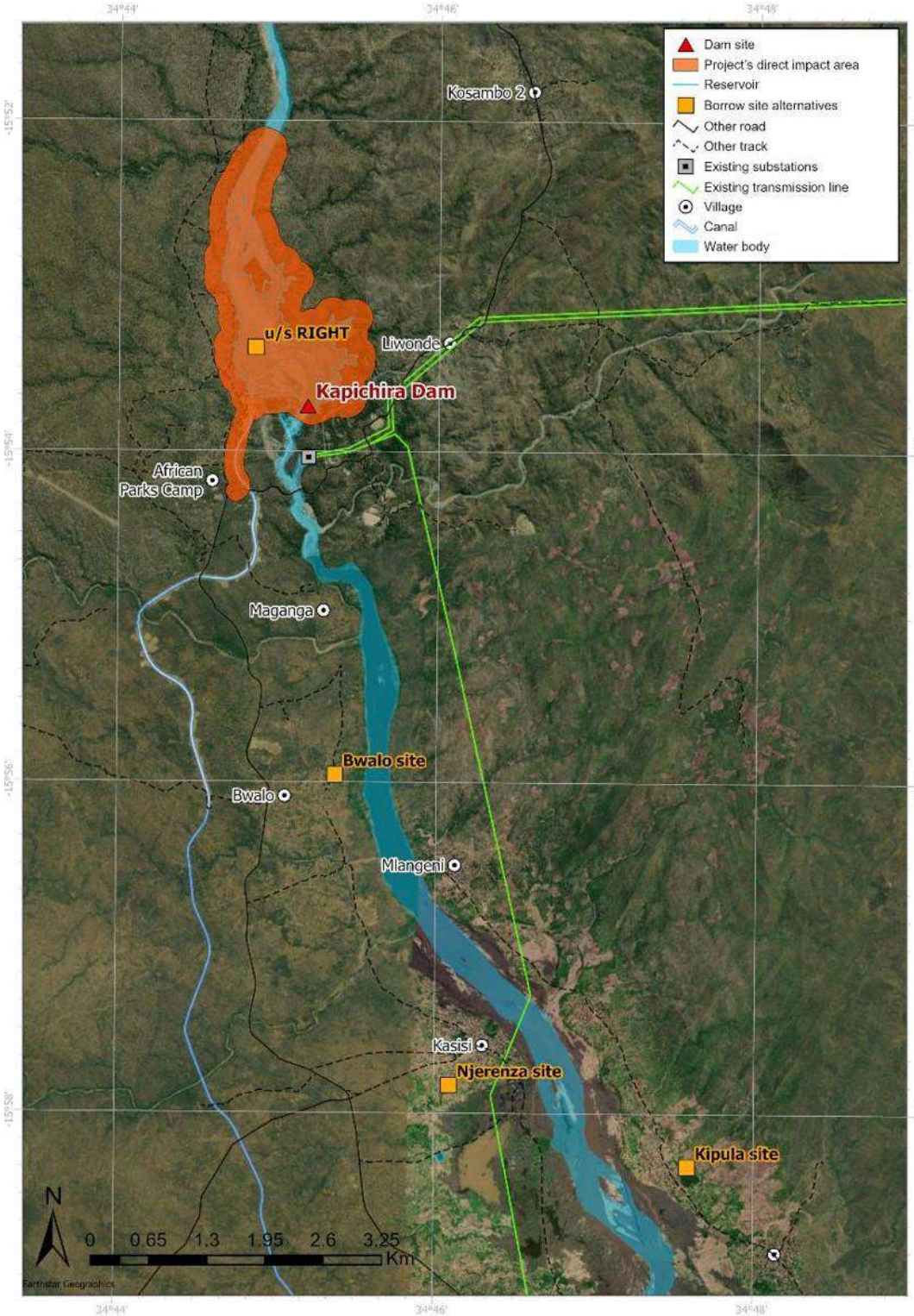


Figure 7-4: Location of borrow sites alternatives

The assessment carried out by the Consultant shows that there is no major environmental and social impacts although some impacts must be considered during the project based on the following evaluation:

- Necessity of a new access road (1 km long from the T416 main road, using partly an existing access road).
- One village (Bwalo) between the borrow site and the dam site, as well as the vicinity of Njereza village to consider for traffic issues;

- At the vicinity of Njereza village (less than 100 m) with social risk (Community gender-based violence risk).
- No cultural heritage in the vicinity.
- There is no close water source (>1 km from the Shire River) reducing the risk of pollution.
- No greenfield land: The alternative 1 is already use for agriculture purpose with no equipment or building.
- No biodiversity issue: No conservation flora and fauna species were recorded in the site. The Majete Wildlife reserve is located at 10 km from the site

8. PUBLIC CONSULTATION AND STAKEHOLDER ENGAGEMENT

8.1. Introduction

Effective stakeholder engagement can improve the environmental and social sustainability of projects, enhance project acceptance, and make a significant contribution to successful project design and implementation. The Environmental and Social Standard ESS10 applies to all projects supported by the World Bank through investment project financing such as this project.

It should be noticed that the construction activities are located within the existing footprint and reservoir of Kapichira Hydropower plant and reservoir. However, access to the different sides of the construction site will be through local villages and Majete Wildlife Reserve, and the SVTP project site, as well as through EGENCO'S Kapichira HPP property.

The chapter includes:

- The objective of the public consultation and stakeholder engagement;
- The process of stakeholder engagement during the ESIA;
- The initial public consultations;
- The main findings from consultations during the ESIA;
- The stakeholders' views and concerns on the proposed project;
- The summary of final consultations;
- The grievance redress mechanism.

8.2. Objective

Stakeholder consultation process refers to Malawi's regulations on public consultation during environmental and social impact studies, as well as the requirements of the World Bank's Environmental and Social Framework. Especially the Environmental and Social Standard (ESS) 10 "Stakeholder Engagement and Information Disclosure."

The main objectives of these consultations are to gather thematic information and concerns of the population, as well as to involve at an early stage of the studies all the affected population. These consultations promote better concertation and a constructive relationship with stakeholders from the beginning of the project.

Stakeholders are people, groups or institutions who are directly or indirectly affected by a project, as well as those who may have interests in a project or the ability to influence its outcome, either positively or negatively. The stakeholders can be grouped into "affected parties" and "interested parties", and according to the degree of their interest and influence.

In the context of Kapichira rehabilitation dam project, the stakeholders are:

- National companies which have an interest in the Project.
- Administrative and customary authorities.
- People at the vicinity of the construction area living downstream and upstream the dam, who are affected parties.

In line with ESS 10, the engagement must be “early, open, inclusive and continued through the life cycle of the Kapichira HPP”.

This chapter provides the results of the stakeholder engagement carried out during the ESIA process in line with the Stakeholder engagement plan, prepared for this project in accordance with the World Bank’s ESS10 and described in greater detail in the ESMP (Volume 2 of the ESIA - Appendix A).

8.3. Process of stakeholder engagement during the ESIA

A meeting with EGENCO MEPRP Implementation Unit in Blantyre on the 18th of May 2024 set a concrete plan for engaging with the stakeholders.

The process starts with Institutional consultations with District committee, Council officials and Companies in charge of environmental conservation followed by public consultations in May 2024.

Initial public consultations were followed by interviews with key village stakeholders’ actors, as well as Focus Groups with men, women, youth and fishermen in seven villages.

The process for the purpose of this ESIA ended with Institutional consultations with District committee, Council officials and African Parks followed by public consultations in November 2025.

The public consultations were adapted to the customary context, with final oral summary of the discussion.

8.4. Initial public consultations

8.4.1. Objectives

The objectives of the Initial public consultations were as follows:

- Make contact with project stakeholders.
- Present or describe project activities to stakeholders.
- Present or describe the ESIA activities to the various stakeholders.
- Present and explain the legal and institutional framework for public consultation to the local population.
- Gather people's points of view, concerns and assessments about the project.
- Involve local people in all phases of the project Anticipate future environmental and socio-economic problems that may arise from the project and incorporate the views of local people.
- Acquire local knowledge.

- Gather people's points of view, concerns and assessments about the project.
- Involve citizens in projects that concern them, by providing them with comprehensive information, listening to their expectations and fears, and engaging in discussion and debate.
- Anticipate future environmental and socio-economic problems that may arise from the project, and to incorporate the public's points of view.

8.4.2. Main findings

Main findings per consultation are summarized in the table below.

Tableau 8-1 : Initial public consultations at the start of the study

Date	Location	Number of Participants	Personalities in attendance	Main findings
22/05/2025	Bwalo village	Approximatively 100 (about 20 women and 80 men)	TA of Kasisi GVH Njeleza, VH Bwalo, VH Chavala. VH Chapananga VH Katsekera	They welcome the project and will support it. Impacts of first phase: fishing activities were disturbed; farming areas submerged, and loss of lands led to disturbance of commercial activities; marriage disruptions; sexual exploitation of women; miscommunication with leaders; high level of theft. Proposed mitigations: leaving the structure used by the contractor for the community; the Welfare community should be more active; need proper introduction by the people carrying out the project to community; extension of operating hours at the clinic (at night especially).

Date	Location	Number of Participants	Personalities in attendance	Main findings
23/05/2024	Liwonde village	Approximatively 50 (about 10 women and 40 men)	GVH Kandeu; VH Liwonde; VH Patrick; VH Maganga 2	Same issues than Bwalo village. Impacts of first phase: noise and air pollution due to heavy machinery and vehicles; majority of workers were not from the community; the land that belonged to the community was taken away from them and turned into public land. Benefits from the station's project: small-scale business thrive; opportunity in the development of the community. Proposed mitigations measures: need to have enough provisions of PPE (Personal Protective Equipment); the community offered to provide firewood for the contractors and offer space for a camp site; there should be a suggestion box for the laborers. Before the dam was built, there was a graveyard. No formal ceremony was held to calm the spirits. A spirit-oriented ceremony needs to be conducted to calm them down and seek permission for the restoration of the dam.



Figure 8-1: Public consultation at Bwalo - 22 May 2024



Figure 8-2: Public consultation at Liwonde - 23 May 2024

8.5. Main findings from consultations during the ESIA

8.5.1. Consultations with institutional stakeholders

The following table presents a summary (from Appendix L) of the information collected and concerns of the institutional stakeholders consulted during the ESIA.

Tableau 8-2 : Consultation with institutionnal stakeholders

Date	Location	Number of Participants	Personalities in attendance	Main findings
20/05/2024	Kapichira hydropower station	37	EGENCO; Chikwawa District Council; Village Heads; Conduril; Head teachers of Schools; Officers of Majete Reserve and African Park; Chikwawa Police	The District Commissioner thanked EGENCO for the corporate social responsibility in areas such as health, education and transport. The council is **ready to support the project** both administratively and technically. The traditional leaders expressed their support for the phase two, **looking forward to the employment opportunities** it will bring to their communities. They also promised to support the project by providing areas for material extraction. TA Kasisi is still waiting for the project Kwa Neba Kuwale to begin. They are also asking the contractor to level the road where the gravel was extracted.

Date	Location	Number of Participants	Personalities in attendance	Main findings
20/05/2024	Kapichira hydropower station	19 (4 women & 15 men)	Social Welfare Committee of employees at Kapichira Power Station	During the first phase, double shifts were implemented, meaning families did not spend much time together. Both the school and the clinic serve the residents of the power station and those in the surrounding communities. Generally, people speculate and build structures that may be useful to project workers during the project construction period. Social concerns: Cultural differences in choice and preparation of food; risk of social interactions between female residents and contractor workers. Suggestions to the project: The Constructor must provide for the campsite: separate water tank, transport facility and other social amenities; if the contractor resides in the compound they should have their own workshop facilities; put danger warning signs (for children) along the roads; management should take part in designing structures of permanent houses for contractor; needs a holistic approach, a cost benefit analysis may be applied.

Date	Location	Number of Participants	Personalities in attendance	Main findings
21/05/2024	Kapichira Hydropower station	15 (4 women & 11 men)	Conduril; KRC JV	The campsite was borrowed freely from Dzimbiri Primary School and involved some social corporate responsibility (painting school blocks, etc.). It is now rent with a MK9 million rental fee. The medical aid clinic was not used by the community. There have been accidents involving workers and animals from the Wildlife Reserve. There have also been incidents involving livestock from neighbouring villages. The restoration plan for the quarry mining site is still under development and Conduril emphasized that the agreement was not to restore the site to its exact former state, but near it. There is a need to engage with the council on land and labour, and the need for firm agreements on land acquisition and use for campsites as well as for extraction of construction materials.
21/05/2024 and 08/08/2024	Majete Wildlife reserve	13 (4 women & 9 men)	African Parks of Majete Wildlife Reserve	They welcome any measures that will restore power and provide access to the road through their park 24 hours a day. **Communities around the reserve have become more conscious of preserving wildlife and habitats** and are supportive of wildlife conservation. They carry out various livelihood activities (handicrafts, honey production, sustainable fishing, etc.). TA also have collaboration with African Parks on management of the reserve. The environmental impacts reported from the first phase included: **Noise** from construction vehicles when reversing (this noise was loudest at night and was a big disturbance to residents and tourists in the reserve); **dust** flying into the reserve; **lights** in the construction area illuminating the sky; **accidents with animals** because of gates unmanned/not closed. Request: SVTP to restore the landscapes with a 1 meter layer of topsoil; African park to revegetate the area; having gates always manned. They are concerned that the Mpatamanga dam will affect river flow and aquatic life, and that people working on the dam will cut down their trees.

Date	Location	Number of Participants	Personalities in attendance	Main findings
22/05/2024	Chikwawa district council hall	41 (16 women & 25 men)	Officers of Chikwawa District Environmental Sub Committee (DESC)	Challenges implementing the first phase: High numbers of potholes; speeding vehicles near school; transfer of skill not well addressed and implemented. Proposed mitigations: Upholding contractor agreements; proper waste management to not affect pollution downstream; DESC to be involved in community sensitization on influence of migrant workers; more local people should me employed; the project should result in decentralization; sources of quarry should result in permanent land acquisition for the council. EGENCO should provide information and spread awareness on how far downstream the impacts of the dam rehabilitation are anticipated to reach.
06/08/2024	Elephant Marsh at Thangadzi River Conservancy/ Kaombe Sugar	5 (5 men)	Officers in charge of Elephant marsh	Since 2020, the level of water is higher than before. Thus, no cultivation of rice and maize in the marsh as recession agriculture these last years. Thus, wet conditions have a positive effect on the ecosystem, but a negative effect on livelihoods. Silt deposition is an issue.



Figure 8-3: Meeting in Elephant Marsh - August 2024

8.5.2. Consultations with key informant interviews

Key informant interviews were conducted during this study. Main findings from these Key informant interviews (detailed in Appendix L) are summarized in the table below.

Date	Personality	Main findings
24/09/2024	**Assistant District Labour Officer**	Major labour concern: Engaging worker without a signed contract; overtime not paid; sexual exploitation; lack of payment; trafficking in person (especially with women for prostitution); child labour (especially with cattle farmers). Mechanisms in place to prevent these concerns: Carry labour inspection; do referrals to the industrial relations court (but takes time); sensitization on trafficking in person; conduct awareness meetings in the workplace on GBV and SEA (Sexual Exploitation and Abuse); make sure that there are Grievances Mechanism. Suggestions: Any company that employs many people should have a labour union; human resources management should have the local context knowledge; encourage employers to follow a normal procedure in the recruitment process; advertise for the job recruitment in public.
-	**District Social Welfare Officer**	Prevalent social welfare issues: Men abandoning their families, leading to a lack of income, therefore school dropouts and more early marriages; GBV cases (the CCJP – Catholic Commission for justice and Peace is the GBV service provider for the SVTP; food insecurity. Mechanisms in place to prevent these issues: Existence of a District Grievance Redress Committees for GBV cases at all TA level but not fully constituted at Group Village Level; advocate with other stakeholders on the Child Protection Technical Working Group; collaborate with other stakeholders (especially those supporting vulnerable communities). Cyclone Anna and social issues: Most households lost their identity documents, livelihood resources, houses, cattle, cultivation land; infrastructure of school completely damaged. Suggestions for the Project: Putting in place GBV and SEA prevention measures; prevent child labour and abuse (put in place code of conduct); putting in place an active grievance redress mechanism.

Date	Personality	Main findings
26/09/2024	**District Labor Officer**	Major labour concerns: Increase of small-scale business leading to child labour (families put their child at work); employers soliciting sexual favours from jobseekers; employers not reporting accidents to the labour office. Mechanisms in place: Employers are sensitized on labour requirements and need for adherence; the labour office conducts labour inspections. Suggestions: Companies need to register with the district labour office as they are setting up their work premises to get a workplace certificate; make sure that employers have workers committee; the contractor need to have a safety committee; ensure that all accidents are reported to the labour office; make sure that workers have insurance and pension; ask the labour office the database of jobseekers.
26/09/2024	**District Environmental Officer**	Changes during the past 3 years: Areas like Gola and Changoima are heavily degraded due to charcoal business; increase of illegal mining such as blue aglet. Mechanisms in place: Working with communities, village leaders and governments departments (such as DODMA – Department of Disaster Management Affairs); conducting community sensitization to discourage cultivating the riverbank to prevent siltation. Suggestions for the Project: Working with the community in environmental restoration and reforestation activities; prioritizing employments of locals to help take pressure off the natural resources; look at rehabilitation of borrow pits.
28/09/2024	**District Land Officer**	Cyclone Anna's impacts: The council had to relocate homeless people to a safer location, which led to migration. Suggestion to the Project: When acquiring land, the project should go through the land district office. Then the council will oversee the land acquisition process to ensure that all laws are followed and that land disputes are prevented. The Project will have to pay compensation to the landowners and all agreements will be signed in due course. Facilities for constructor work can be used after for community or public benefits (for example: clinics, kindergarten schools or public schools).

Date	Personality	Main findings
28/09/2024	**Docteur of Kapichira Clinic**	The clinic treats more than 50 patients per day, for common cases as malaria, diarrhoea and pneumonia. The clinic does not have a maternity. Over the lats 5 years, there has been an increase in communicable and waterborne diseases probably due to the establishments of more businesses (Ng'ona lodge, Zua lodge, etc.) and the SVTP. There has also been an increase in HIV / AIDs and STIs (Sexually Transmitted Infection) over the last 3 years due to an increase in workers in the area. There has also been an increase in occupational injuries with the coming in of several construction projects. Lung disease caused due to dust inhalation has also been common at the clinic following some previous construction projects. Recommendations for the Project: The Project should ensure that first aid facilities and a trained first aider are in place, as well as the procurement of a properly stocked ambulance with all the necessary emergency equipment. The clinic should be involved in workplace inspections.
28/09/2024	**Fisheries Officer**	Cyclone Anna's impacts: M1 road at Mthumba was cut off; the water was concentrated with ethanol waste (molasses) which caused deaths of fish; fishermen lost their equipment and tools. Mechanisms in place: Cultural centers (for example Domasi) in aquaculture making, fish breeding; research on what foods are convenient for fish; approved technologies to be used by farms thanks to the research are deployed to extensions (EPA – Extension Planning Area) for fish farmers; monthly site assessment survey to check fish death rates; resource monitoring through surveys, enforcement patrols, gear inspections; committees are being formed comprising of community members to select a site to implement a conservatory area through ecotourism. Recommendations for the Project: Being informed when the gates of the dam open (during "flashing"); having a better communication between the fisheries department and Kapichira workers and affected communities.
24/11/2025	**Manager of Ng'ona lodge at Maganga 1**	They were present when the dam burst. No damage on the buildings, except the swimming pool that has filled with sediment. Well informed before the flood. Not informed about the works since the flood, except from international engineers coming to their lodge. No direct impact from the works. Request to get more information about construction activities when it starts.
28/11/2025	**Manager of Zua Safari lodge at Maganga 1**	Delay to open the lodge due to Ana flood. Request to get more information about construction activities when it starts.

8.5.3. Consultations with village heads

Main findings from consultations with village chiefs and key village stakeholders are summarized in the following table.

Tableau 8-3 : Consultations with village heads and key village stakeholders

Date	Group Village	Location	Personalities in attendance	Main findings
27/09/2024	Kandeu	Liwonde	Village Head	Only practicing rainfed cultivation as they no longer have irrigable land (maize, millet). They are doing livestock farming (goats, cows, pigs and chicken) as well as charcoal making and selling. There is a complaint to EGENCO regarding compensation for the relocation of the village during construction of the dam about 23 years ago. The Village Head emphasizes that they would like to have one kindergarten school.
25/09/2024	Njereza	Maganga1	Village Head	They practice both rainfed agriculture and irrigation. For maize and sweet potatoes.
25/09/2024	Njereza	Maganga2	Village Head	They rely on farming (maize, nandolo, etc.) and are also doing some piece work at EGENCO and Majete. There is an increase of dropout school due to the distance of the secondary school, that is resulting in women and girls being more vulnerable to be coerced into sexual behavior.
24/09/2024	Njereza	Njereza	Group Village Head, Traditional Authority Kasisi	Mainly livestock farming (goats, chicken, pigs, ducks and cattle). Crops have been affected by cyclones and El Nino, and raising level of Lake Malawi included raising level of Shire River. There is also a declining number of fish species due to the HPP cleaning process, that flushes away dirty muddy water. Inhabitants of Bwalo village were caught stealing construction materials from Synohydro contractor. They would like the Project to ensure that the findings of the studies are disclosed at community level.
23/09/2024	Kandeu	Kandeu 1	Group Village Head (GVH)	Nearly impossible to harvest due to the droughts, that also led to riverbank erosion. They are food insecure every year. Few disagreements about land boundaries. They are very welcome and thank EGENCO for their assistance in education, health, etc.
23/09/2024	Njereza	Bwalo	Village Head	They are farmers but now sell vegetables that come from the main market. Crops that still resist the weather: sorghum, millet, maize.

Date	Group Village	Location	Personalities in attendance	Main findings
				Problem: reliable farms have been washed away by the floods.
01/10/2024	-	Kavalo	Senior of the GVH	Lots of Europeans come to visit the ancient grave of the first Britain explorer in Malawi. They would like the Project to employ members of the community.

8.5.4. Consultations with the focus groups discussions

Focus groups were organized in September and October 2024. Additional meetings were organized in September 2025. Local populations of villages situated around the Kapichira project were able to answer questions about their way of life, sharing their opinions, fears and expectations regarding the rehabilitation of Kapichira project.

The following table summarizes the location, date and number participants of the focus groups.

Tableau 8-4 : Focus groups

Date	Group village	Location	Focus group	Number of Participants	Total per village
25/09/2024	Njereza	Bwalo	Men	16	30
			Women	14	
27/09/2024	Kandeu	Liwonde	Men	11	22
			Women	11	
			Fishermen	/	
25/09/2024	Njereza	Maganga 1	Men	9	27
			Women	13	
			Fishermen	5	
14/09/2025			Youth	14	14
30/09/2024	Kandeu	Maganga 2	Men	9	23
			Women	14	
23/09/2024	Njereza	Sekela	Men	18	40
			Women	22	
24/09/2024	Njereza	Njereza	Men	8	20
			Women	12	
01/10/2024	Kavalo	Mlangeni	Men	8	28
			Women	10	
			Fishermen	10	

The following table summarizes the outcome of these focus groups concerning the Kapichira Rehabilitation Project.

Tableau 8-5 : Main findings of the focus groups by category

MEN	WOMEN
Activities The men of Bwalo had farming land along the Shire River but most of it has been submerged. Men of Mlangeni were also cultivating cotton but stopped sue to the prices too low. It is difficult to get meals every day in the absence of irrigation farming. Few villagers get jobs now with EGENCO (for example: less than 5 people from Liwonde are employed by Kapichira or Majete companies). As a consequence, they are doing piece work (such as farming for other farms, making charcoal, etc.).	**Activities** Usually engaged in small business (selling charcoal, tomatoes, etc.) and practice both crops (rainfed and irrigated), livestock farming, firewood fetching and selling fish. Some of the women of Bwalo practice bee keeping. Some of them practice small scale fishing, pieces of work (laundry, cleaning houses, etc.) at EGENCO and Majete. They are also involved in cultural events (initiation ceremonies).

MEN	WOMEN
MEN	**WOMEN**
The men of Maganga 1 can fetch dry wood or timber for housing, as well as herbs from the buffer zone forest. They have a committee with Majete Wildlife Reserve. **Consequences of the dam break** Farmlands were washed away, and men could not harvest for two years. Therefore, a lot of villages (especially Njereza) are deforesting communal land to make charcoal. There is more siltation. Animals of Majete Reserve are eating crops (monkeys, antelopes, etc.) and cause accidents with people. There are as well crocodiles. The children of Sekela need to go around a longer route to access the school, which is resulting in many dropping out of school. Men knew about sexual exploitation for women but didn't know where to report these issues. Men of Maganga 1 feel management of EGENCO and other companies have colonialist behaviors. **Suggestions** Construction activities should seriously look at the issue of employing laborers from nearby villages, without bribes. All menial jobs should employ locals. The employer should ensure that all workers have the full PPE. Involve the youth in projects. Avoid use of intermediaries for the recruitment process due to risk of corruption. Men from Sekela are asking for the finalization of the construction of the junior school. Men of Mlangeni are asking the management of Kapichira dam to notify community downstream whenever they plan to open the gates of the dam.	**Consequences of the dam break** They are facing food insecurity and loss of income because of the flood. The farms and irrigable lands were washed away. There is as well an increase of theft of livestock. The presence of crocodiles now makes crossing the river by canoe dangerous or the use of water from the river. The women are not considered for the employment opportunities. Thus the household economic status is not improved. Workers offer money in exchange for sex, leading to an increase in cases of HIV/AIDS and STIs. Girls or women who become pregnant are then left without any support to provide for their children. Women are sometimes reluctant to report these issues because of fear of reprisal. There is an increase in school dropout rates (due to lack of school fees and sexual assault). The women states about the issues of transport to work (in particular from EGENCO who have cars). The increase in traffic can be dangerous for the children. Women of Mlangeni (on the left bank of the River) can't cross easily the river to access to services at the district headquarter. **Suggestions** The project should put in place measures to enhance equal employment opportunities for men and women, as well as to tackle sexual exploitation and avoid child labor. The project should have well adapted PPE (not only PPE adapted for men). The project should support them with agriculture inputs, to have enough food supply. The project should allow villagers to be transported when they meet them on the road. The project should sensitize their workers not to disturb marriages and not to engage in promiscuity behaviors. Girls should also be sensitized to prevent being cheated by the project workers (especially the one from Chikwawa District Secondary School as workers target them on their way to/from school). As well as to be sensitized to HIV/AIDS. The women of Liwonde hope for proper road safety measures (especially on the way to school). The women of Maganga 2 want a new borehole and less restrictions to enter to the Kapichira campus for health facilities. The women of Njereza are asking the Project to

MEN	WOMEN
	ensure they have adequate sanitation facilities to prevent Cholera.
FISHERMEN	**YOUTH**
Activities They had free access to the river downstream the dam. They had skills to locate the fish in the river. But now they have no access to the gates. EGENCO doesn't set off the alarm anymore, so it is very risky. They have multiple techniques: using fishing nets (*chavi, chasa, matchera, mbedza, ukonde*) or fishhooks. They are also farmers. Fish prices have gone up due to scarcity of fish on the market. **Consequences of the dam break** Some breeding sites have been washed away. Fish catches have declined due to silting (that also led the river shallow). Therefore, they reduced the size of the nets. The fishermen of Mlangeni have turned to the mountains to cut down trees to sell or to make charcoal. The project has hired people from outside the community, which worries them, not to be well considered by the project.	Young people are in particular worry about job opportunities and fear about workers coming from other districts leading to increase of crime, price of goods and services. Young people request to be informed about the opening of dam gates during construction and operation.



Figure 8-4 : Focus group discussion with women in Liwonde village – 27/09/2024



Figure 8-5 : Focus group discussion with men in Sekela village – 23/09/2024



Figure 8-6 : Fishermen at Maganga 1 using the chavi

8.6. Stakeholders' views and concerns on the proposed project

8.6.1. Consequences of the dam break

Initial impacts from effect of cyclone Ana were submerged arable lands that have now turned into marshes hence affecting cropping pattern and choices, and loss of power to the communities (as well as the whole country). Crops were washed away, and the consequence of the dam break removed the almost only stable source of income in the villages. This caused an increase if food insecurity in the region.

Other impacts were loss of livestock to the flood, loss of road transport to Chikwawa due to road cutting off at Milala bridge. It was also reported that the cyclone Ana affected water supply in some villages as some of the boreholes were submerged in waters, a situation which communities highlighted paused health risks to them.

The phenomena of siltation observed in water course after the dam break causes a difficulty for fishermen, who notices a decrease in fish catch over the last three years. The local people also noticed that the flow is superior since the dam break which also contributes to the decline of fish catch.

Because of the food insecurity, some people must practice illegal fishing and can be arrested for this.

It is harder for women to keep working in small businesses since the Kapichira dam break and an increase of school dropouts has been notified.

Learning from the first phase, which was operationalized internally to get power generation back as soon as practicable, EGENCO management and Kapichira Power Station worked throughout the clock. The impact of this on the staff welfare is presented under social welfare committee remarks. On the part of management, power generation restarted three months earlier than planned to demonstrate hard work and resilience. With around 400 workers on the compound, management sourced workers from other power station to support in various tasks.

8.6.2. Issues concerning employment opportunities

Local communities had expressed the support for employment for the SVP project as well as improve their skills in various areas of construction. This was amplified by sensitization meetings on the SVTP works and implications for the local communities. However, communities were unsatisfied by numbers of local people who were employed (Bwalo had three members who told that they had worked for the contractors concerning SVTP, particularly carpentry and brick laying works). The communities stated that unskilled labourers migrated from other districts. It was a choice from the Malawians who were responsible for recruiting casual and unskilled labourers.

Communities' members that are downstream from the power station like Maganga 2 and Bwalo state that they do not benefit from the job opportunities compared to the communities close to the power station like Liwonde and Kandeu.

Bwalo village requests more job opportunities in the second phase. They stated that they would be stealing items for project work if they are not satisfied with being involved in the project. A proposed suggestion was to recruit them based on quota allocation per village.

8.6.3. Natural resources and environmental issues

The community members pointed out that firstly the construction campsite must be cleared and become bare. Therefore, they recommend restoring any pits and redirect any runoff that may accumulate due to roofing and other structures to avoid any issues as previous camp.

The community members noted that migrant contractors would use gas and electricity for their energy needs. However, migrant workers will increase demand for wood or charcoal in the area. This will lead to more forest clearing to satisfy domestic cooking energy which affect women and girls in charge of firewood.

Communities also highlighted issues to the environment that may arise from inconsiderate waste disposal by contractors. During construction farmlands become dumpsites of different things, which can be harmful to the soils.

The communities stated that important natural trees were cut down with the replacement of less valuable trees. They stated as well that the construction activities destroy farmlands such as “Using of farming lands to dispose of sand or other things destroys fertility of the land making it hard for cultivation of crops.” (FGD with men of Maganga village).

To mitigate environmental pollution, communities suggested that:

- The village leaders would like the contractors to be briefed by them as soon as they arrive, to avoid any problems arising from a lack of knowledge.
- The farming areas should be considered by the contractors. The village leaders should be consulted for the use of land before commencement of works.

8.6.4. Violence based on gender

The outcome of the focus groups with women is that the violence based on gender are a real issue in the Chikwawa district. They were not equally treated as men in job opportunities, and they were often confronted to sexual exploitation and sexual favours against job opportunities. They also told that men who got jobs in construction works often used their money for alcohol and other women.

Some other aspects were:

- The non-adequate protective equipment on construction site.
- The non-adequate job activities such as heavy weights to carry

The community members suggested that:

- equal employment opportunities for men and women, with adequate work considering the gender aspects.
- The adequate protective equipment for women (as it is for men)
- The ban of sexual exploitation.
- To provide gender trainings for workers.
- To provide gender sensibilisation to communities in particular the girls (especially the one from Chikwawa District Secondary School targeted by workers on their way to/from school).

8.6.5. Concerns about the project

The major issue concerns the employment and the conditions of payment:

- The communities request to be consulted first for the non-skilled employment.
- Concerning the payments, some issues were reported such as employers not paying terminal benefits to employees, issues of compensation, denial of sick leave.
- Local people are concerned that children would be at risk of child labour to get sand for example or for domestic works during school times.
- The timing with the general election could be an issue for the employment due to political aspects by influencing recruitment of workers.

The other concerns are about the following aspects:

- To be informed before a flushing due to the disturbance of fish catches.
- To get access to the EGENCO health centre.
- To raise awareness the constructor about child labour, sexual harassment and trafficking in persons.
- To erect speed humps and signage in order to limit the speed of the trucks on the road close to their village.
- To limit the demand for firewood due to the limited availability of wood for charcoal in the area.

8.7. Summary of final consultations

8.7.1. Introduction

The consultations aim to inform stakeholders about the progress and content of the ESIA, gather the opinions of those affected by the project on development choices, and present the results of the study to them in order to gather their opinions on the proposed measures. The expected outcome of the activity was the inclusion of the opinions gathered during the consultations in this study.

The public consultations are a source of information common to the various components of the study. Indeed:

- They provided the public with extensive information on the project, its progress with the change in the location of the workers' camp and the quarry site, and the provisional schedule for the works.
- They made it possible to specify the avoidance measures implemented, such as the absence of physical resettlement of people.
- They made it possible to assess the attitude of the populations towards the sites necessary for construction (workers ‘camp, quarry, clay borrow site.).
- They made it possible to submit the proposed mitigation measures to the populations and to gather their opinions.

It should be noted that consultations are, by definition, ‘advisory’ in nature, which means that the opinions expressed during these meetings are not binding, but rather guide the conclusions as closely as possible in the interests of those affected.

The Consultant, with the participation of EGENCO, conducted public consultations meetings located within the construction influence area between 26-27 November 2025. Key stakeholders meetings with the Chikwawa District Environmental Sub-Committee and the African Parks were organised on 25 November 2025 (See Appendix M about the public consultation report).

8.7.2. Consultations with key stakeholders

8.7.2.1. CHIKWAWA DISTRICT ENVIRONMENTAL SUB-COMMITTEE

Following the presentation given at Chikwawa District Council, the main questions concerned the monitoring of measures implemented in the ESMP, mainly the water of the River downstream. The engagement of the communities during the study was also well appreciated.

8.7.2.2. AFRICAN PARKS

African Parks highlighted SVTP's failure to meet its commitments and the general gap between the report and implementation of the ESMP.

The main impacts highlighted by African Parks concern road condition, dust, light and noise that could affect the activities in the Majete Wildlife Reserve.

African Parks requested:

- a clear responsibility between SVTP and Kapichira for the rehabilitation of Majete Wildlife Reserve area;
- that any new offsets / net-gain commitments explicitly acknowledge and seek to correct or compensate for legacy biodiversity damage where feasible;
- a specific road and lighting management plan;
- a strengthened environmental auditing framework.

8.7.3. Public consultations in the construction influence area

8.7.3.1. ORGANISATION

In the presence of EGENCO, the Consultant's team included a facilitator fluent in the local dialect, the sociologist who had participated in socio-economic surveys, the international environmental experts (biodiversity and social) and a meeting note taker.

The date and time of the meeting had been agreed in advance with the village chief, taking into account the farming season.

All residents of the invited village were invited to the meetings. The presence and participation of women and young people was strongly encouraged, as was that of men.

The consultation, chaired by the village chief, proceeded as follows:

- Introduction of participants;
- General presentation of the project and its progress;
- Detailed presentation of the project's impacts on the village consulted;

- Presentation of the main measures of the ESMP;
- Gathering of the population's concerns, expectations and opinions.

The consultations were conducted in the local language (Chichewa).

A report was produced for each consultation, detailing the views, expectations and fears of young people, women and men. A photo was taken at each consultation and a list of representatives of each village was compiled.

8.7.3.2. RESULTS OF PUBLIC CONSULTATIONS IN THE CONSTRUCTION INFLUENCE AREA

Four public consultations were organised from 26 to 27 November 2025 (see Appendix M). In general, the consultations proceeded without any significant problems.

Tableau 8-6 : Final public consultations

Date	Location	Number of Participants	Personalities in attendance
26/11/2025	Bwalo	138 (57 women and 81 men)	Bwalo Head Maganga 1 Head
	Liwonde	102 (47 women and 55 men)	Liwonde Head Maganga 2 Head Kandeu Head
27/11/2025	Njereza	99 (63 women and 36 men)	TA Kasisi Head Njeresa 2 Head Njeresa 3 Head Njeresa 4 Head

8.7.4. Main lessons learnt from the consultations

The consultations mainly highlighted:

- concerns about employment during construction activities in particular from the villages at the vicinity of Kapichira dam:
  - ➔ Explanations were provided for the low number of jobs created by this type of rehabilitation project compared to a new infrastructure project.
  - ➔ Explanations regarding the requirement in the contractor's labour management plan.
  - ➔ Explanations about Grievance redress mechanisms in particular for GBV cases.
- Concerns about waste and pollution
- Questions about the start of construction:
  - ➔ Information on the commencement of works in mid-2026.

Specific questions were asked:

- At Liwonde: about the change of the location of the workers' campsite, originally planned on EGENCO's property, which would have been a good business opportunity for the village.
    - ➔ It was explained that the presence of migrants could lead to a general risk of social tensions that EGENCO wished to avoid with the proximity of workers to EGENCO households or any other village.
- At Njereza: the schedule for the use of the clay borrow site was requested.

8.7.5. Main management measures to address the key concerns raised by consulted stakeholders

The consultations mainly highlighted:

- concerns about employment during construction activities in particular from the villages at the vicinity of Kapichira dam:
    - ➔ The labour management plan (CP1) in the ESMP (volume 2 of the ESIA) was drawn accordingly with measures for boosting the local job market.
- Concerns about waste and pollution:
    - ➔ The waste management plan (CP2) and the resource efficiency and pollution prevention and management plan (CP4) in the ESMP (volume 2 of the ESIA) were drawn accordingly
- Questions about the start of construction:
    - ➔ The stakeholder engagement plan (Appendix A of the ESMP (volume 2 of the ESIA)) was drawn accordingly.

Specific questions were asked:

- At Liwonde: about the change of the location of the workers' campsite, originally planned on EGENCO's property, which would have been a good business opportunity for the village.
    - ➔ The labour management plan (CP1) in the ESMP (volume 2 of the ESIA) was drawn with measures for boosting the local job market.
- At Njereza: the schedule for the use of the clay borrow site was requested.
    - ➔ The stakeholder engagement plan (Appendix A of the ESMP (volume 2 of the ESIA)) was drawn accordingly.

8.8. Grievance redress mechanism

A Project-level grievance redress mechanism (GRM) was developed as part of the Project Stakeholder Engagement Plan (Volume 2 of the ESIA – Appendix A) to receive and address concerns and complaints related to the Project, considering the existing grievance redress mechanism.

The Project level GRM defines the overall procedure to manage grievances, including three possible levels of resolution:

(i) the first is the Community Village Grievance Redress Committees,

(ii) the second is the District Grievance Redress Committee, and,

(iii) the third is the National Grievance Redress Committee.

There will also be a Workers Grievance Redress which shall be responsible for all employment related grievances between the Contractor and their Workers.

At each level of Grievances Redress Committee, there will be a Grievance Log and Resolution Form to record the complaint. The Project GRM Procedure considers communities' literacy levels and focuses on in-person interaction with complainants using Chichewa, and/or other relevant local languages, in addition to English, to ensure that processes, decisions, and outcomes are clearly understood.

All community and stakeholder feedback received will be screened to determine the appropriate management procedure. Community and stakeholder feedback received will be reviewed to identify general stakeholder concerns that should be addressed through ongoing engagement.