CONSULTANCY SERVICES FOR PREPARING FEASIBILITY STUDIES OF STP MINI HYDROPOWER PROJECTS

STRATEGIC ENVIRONMENTAL ASSESSMENT OF THE HYDROELECTRIC POTENTIAL IN SÃO TOMÉ

FINAL REPORT

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1 SUMMARY

At present, energy production in Sao Tomé and Príncipe (STP) relies almost exclusively on diesel - imported, expensive and polluting - and the estimated percentage of energy of renewable origin in the country is only 5%.

Consequently, as a way of reducing the country's dependence on fossil fuels and simultaneously improving the financial aspects of the energy sector, the Government of Sao Tome and Principe intends to implement its *Least Cost Development Plan (LCDP)*, proposing to increase the participation of renewable energy in the energy matrix to around 50% by 2030.

The overall objective of the Mini-Hydro Programme in São Tomé and Príncipe is to ensure the sustainable development of STP's energy system and promote green growth by supporting the implementation of the LCDP.

In this context, a contract was signed between DGRNE and AQUALOGUS entitled "*Consultancy Services for Preparing Feasibility Studies of STP Mini Hydropower Projects*".

During the development of this work, it was decided to include in the contract the carrying out of a Strategic Environmental Assessment (SEA) of São Tomé's Hydroelectric Potential, which will serve as a support tool for decision-making on the development of the hydroelectric projects included in the development plans for the energy sector.

The SEA has the following specific objectives:

- the definition of environmental and sustainability priorities in the strategic dimension underlying the hydroelectric potential of São Tomé Island, and its environmental plausibility in a sustainability context;
- the ranking of hydroelectric power plants based on their viability from an environmental, social and sustainability point of view;
- the identification of opportunities and risks for the environment and for the sustainability of the strategic options considered in defining the hydropower schemes.

In this sense, SEA considers the relevant environmental, social and sustainability factors that help in planning the needs of hydropower schemes, considering environmental and sustainability objectives as well as context factors, and not limiting itself to exclusively technical objectives and criteria.

Thus, the assessment is focused on a few, but priority, Critical Decision Factors (CDF) that will ensure the integration of environmental and sustainability dimensions; the main risks and opportunities arising from the CDF analysis are also identified.

The CDFs considered in this case were:

- **CDF#1 Territorial Planning** (where the area of the Obô de São Tomé Natural Park (PNOST) and the respective zoning are considered);
- **CDF#2 Land Use** (where the occurrence of the different types of forest on the island is considered: Native Forest, Secondary Forest and Shade Plantations);
- **CDF#3 Critically Endangered Bird Species** (where the polygons of occurrence of three endemic species are considered: São Tomé Ibis *Bostrychia bocagei*, Newton's Fiscal *Lanius newtoni* and São Tomé Grosbeak *Crithagra concolor*).

Thus, the following eight watersheds were superimposed on the CDFs (mapped for the entire island of São Tomé), containing 33 potential locations for hydropower plants (HPPs):

- Iô Grande,
- Abade,
- Manuel Jorge,
- Ouro,
- Cantador,
- Lembá,
- Quija,
- Xufexufe.

At the same time, a baseline characterisation of the CDFs was carried out in the areas where the various HPPs under study are expected to be located, as well as a preliminary assessment of the expected environmental impacts.

The SEA also carried out an assessment of sensitivities, applying a set of criteria associated with the Critical Decision Factors and also introducing energy criteria. For each of the ecological criteria a point system was created based on a weighting of the different DCF.

The application of the aforementioned criteria was organised in an evaluation matrix that resulted in a weighting of the hydropower schemes, grouped into 4 increasing levels of constraints:

1. **LIGHTLY CONDITIONED**
2. **CONDITIONED**
3. **VERY CONDITIONED**
4. **ADVISED AGAINST**

This assessment also suggested more sustainable alternatives to some hydropower schemes that may pose substantial risks to the environment and foresees the residual effects that the adoption of a hydroelectric energy production strategy will inevitably imply.

Having consulted various *stakeholders*, collected their perspectives and concerns, and categorised the HPPs according to the African Development Bank's Safeguards System, it was possible to carry out a ranking of the projects by level of constraints, which is summarised in **Table 1**.1.

Table 1.1- Summary table of the HPPs by level of constraints.

Level of constraints		Hydroelectric Power Schemes	
		Quant.	Name
	Lightly conditioned	17	Ouro 1 to Ouro 5 (including Agostinho Neto); Abade 1 to Abade 4; Manuel Jorge 1 to Manuel Jorge 4 (including Guegué); Cantador 1; Lembá 1
	Conditioned	2	Iô Grande 1; Iô Grande 2; Ouro 6
	Very conditioned	2	Quija 1; Cantador 2
	Advised against	12	Iô Grande 3 a Iô Grande 6; Lembá 2 a Lembá 4; Xufexufe 1 and 2; Cantador 3; Quija 2

Finally, the SEA - which should under no circumstances replace the necessary Environmental Impact Assessment (EIA) to be carried out for each scheme intended to be implemented - makes a series of recommendations regarding the next stages in the implementation of the HPPs, which can be summarised as follows:

- Proceed, with the appropriate EIA, with the *lightly conditioned* schemes,
- Carry out specific studies, in the EIA phase, for the *conditioned* schemes decided to be implement,
- Not to implement, for the time being, the schemes classified as *very conditioned* or *advised against*, and, should it be decided to implement them in the future, to base any decision beforehand on dedicated and in-depth environmental studies.

2 INTRODUCTION AND BACKGROUND

2.1 INTRODUCTION

This document is the **Final Report** of the Environmental Assessment (EA) of the Hydropower Potential in São Tomé, under the contract - *Consultancy Services for Preparing Feasibility Studies of STP Mini Hydropower Projects* - established between the Ministry of Public Works, Infrastructure, Natural Resources and Environment - Directorate General of Natural Resources and Energy (DGRNE), hereinafter referred to as Client, and AQUALOGUS, Engenharia e Ambiente, Lda. (AQUALOGUS), hereinafter referred to as the Consultant.

The EA adopts a Strategic Environmental Assessment (SEA)methodological approach in which the SEA assumes a facilitating role in the planning process, drawing attention to situations of risk or opportunity with a view to sustainability, according to the Critical Decision Factors (DCF) identified in this report.

Consequently, the analyses carried out and the recommendations made are valid as long as these realities remain, and therefore no perennial and immutable guidelines of unchanged relevance should be drawn from this Strategic Environmental Assessment.

2.2 BACKGROUND

The Government of São Tomé and Príncipe aims to achieve 100% population access to electricity by 2030. Currently about 70% of the population has access. However, the electricity infrastructure shows signs of degradation and ageing and the services provided are of low quality and unreliable. One consequence of these circumstances is that most business economic activity depends, at least partially, on self-generation, using diesel generators.

At present, in fact, energy production in Sao Tome and Príncipe (STP) relies almost exclusively on diesel - imported, expensive and polluting - and the estimated percentage of energy of renewable origin in the country is only 5%.

Consequently, as a way of reducing the country's dependence on fossil fuels and simultaneously improving the financial aspects of the energy sector, the Government of São Tomé and Príncipe intends to implement its *Least Cost Development Plan (LCDP)*, proposing to increase the participation of renewable energy in the energy matrix to around 50% by 2030.

The overall objective of the Mini-Hydro Programme in São Tomé and Príncipe is to ensure the sustainable development of STP's power system and promote green growth by supporting the implementation of the LCDP. This will involve diversifying the country's electricity matrix, increasing power generation capacity based on renewable energy, enhancing the reliability of the power system and promoting the sustainable and efficient use of electricity.

In this context, and following a tender process, a contract (DGRNE / SEFA / 01/2019) was signed between MOPIRNA-DGRNE (Ministry of Public Works, Infrastructure, Natural Resources and Environment - Directorate General of Natural Resources and Energy) and AQUALOGUS, Engenharia e Ambiente Lda. This contract provides for the provision of services divided into two lots, with the following objectives:

- Lot 1: Based on the existing studies for the Iô Grande and Abade rivers, collect the necessary technical and environmental analyses, as well as economic-financial analyses and model simulation, in order to establish the necessary specifications for the Government of São Tomé and Príncipe to prepare and launch a tender for a BOT contract with private sector operators;
- Lot 2: Carry out technical, environmental, economic and financial feasibility studies for the rivers Ouro, Lembá and Xufexufe; assess the main environmental and social impacts, economic and financial simulations, and establish the necessary specifications for the Government of São Tomé and Príncipe to prepare and launch a 2nd phase tender for a BOT contract with private sector operators.

The original scope of services under the current contract for Lot 1 was based on the existence of reliable project documentation and environmental information relevant to the establishment of the BOT tender specifications.

According to the official information available, there was a belief that there were no potential environmental impacts that could hinder the development of the projects, particularly with regard to Iô Grande. This confidence was further strengthened by the fact that an Environmental Impact Assessment (EIA) had already been carried out and had concluded favourably for the projects. Some of these projects were also included in the LCDP.

During the analysis of existing studies, weaknesses were found in the Dona Eugenia EIS produced in 2014, which reduced the degree of confidence in that study and, in addition, concerns were raised about the possible impact of these hydropower schemes on a number of endemic and highly threatened bird species. As these concerns have wide territorial display and therefore can be extended to several of the planned schemes, it was advisable to carry out an integrated analysis of the potential interference of the hydroelectric projects analysed and recommended with the most relevant environmental values and likely to be represented geographically.

Thus, it was decided to include in the contract the carrying out of a Strategic Environmental Assessment (SEA) of São Tomé's Hydroelectric Potential, which will serve as a support instrument for decision-making on the development of the hydroelectric projects included in the development plans for the energy sector. This SEA will therefore enable environmental aspects to be considered, in addition to those addressed by the technical and economic viability of the projects.

It is important to highlight that the social component of the evaluation, although not explicit in the selection of the Critical Decision Factors, was considered throughout the process, and was always present, since social aspects are a fundamental component of the Operational Safeguards of the African Development Bank that guided the adopted Strategic Reference Framework (see **Item 5.2**).

However, if one considers the typology of human settlement on the island of São Tomé, as well as the configuration of the watersheds and the locations studied for the installation of Hydroelectric Power Plants, the possibility of resettlement can be considered low, and even remote if physical resettlement is considered (i.e. some schemes may give rise to some type of economic resettlement).

Thus, and since it was methodologically intended to focus the analysis on a few but priority Critical Decision Factors (DCF), the selection of these factors fell on aspects of a more environmental (and even ecological) nature since, as will be seen in this document, these will be the determining aspects - in view of the projects under consideration - in the selection of the most sustainable hydroelectric generation solutions in São Tomé.

3 OBJECTIVES AND METHODOLOGY

3.1 OBJECTIVES

The objective of the Strategic Environmental Assessment (SEA) is to establish the environmental and sustainability conditions that must accompany the development of the strategic options that are placed on the exploitation of São Tomé Island's hydroelectric potential. In this sense, SEA considers the relevant environmental and sustainability factors that help in the planning of the needs of hydropower generation, taking into account environmental and sustainability objectives as well as context factors, and not limiting itself to exclusively technical objectives and criteria. In this way, SEA assesses, in a strategic and anticipated manner, what may otherwise be possible significant effects on the environment resulting from the implementation of a plan or programme.

The SEA also has, as specific objectives:

- the definition of environmental and sustainability priorities in the strategic dimension underlying the hydroelectric potential of São Tomé Island, and its environmental plausibility in a sustainability context;
- the prioritisation of hydroelectric schemes based on their viability from an environmental and sustainability perspective;
- the identification of opportunities and risks for the environment and for the sustainability of the strategic options considered in defining the hydropower schemes.

3.2 METHODOLOGY

To meet the objectives set out above, and since the object of the assessment will correspond to the hydropower schemes already identified in the "*Study of the Hydroelectric Potential of São Tomé and Principe*" (HIDRORUMO, 1996), an assessment methodology is adopted where the integration and validation functions are developed above all; It assumes a strategic approach in the assessment, i.e., it considers a systemic and long-term perspective and fits the SEA in a sustainability context; the assessment is focused on few but priority Critical Decision Factors (CDF) that ensure the integration of environmental and sustainability dimensions; the main risks and opportunities arising from the CDF analysis are also identified.

Thus, once the baseline characterisation of the potential HPP has been carried out with regard to the CDFs considered, these CDFs are weighted, assigning values relative to the interference generated by each potential development, which enables these HPPs to be ranked according to the sensitiveness assessment carried out.

This assessment also suggests more sustainable alternatives to some hydropower schemes that may pose substantial risks to the environment and anticipates the residual effects that the adoption of a hydroelectric energy production strategy will inevitably imply.

3.3 SCOPE

The main reference of the object of assessment is the "*Study of the Hydroelectric Potential of São Tomé and Príncipe*", elaborated by HIDRORUMO in 1996, which presents sites with technical viability for the construction of hydropower schemes in the islands of São Tomé and Príncipe.

The HIDRORUMO's study collected all the information available from previous studies and hydroelectric exploitation projects developed for São Tomé and Príncipe, as well as elements from other studies, namely topographic, hydrological and geological. It also estimated the hydroelectric potential of São Tomé and hierarchized the hydropower schemes considering their potential, energy production, estimated investment cost and location. For the purpose of this SEA, it was admitted that the conclusions of this work remain valid in terms of hydroelectric potential.

However, the HIDRORUMO study lacks a feasibility analysis from the environmental and sustainability point of view.

In this sense, the **object of assessment** of the SEA comprises the different potential hydropower schemes identified in the "*Study of the Hydroelectric Potential of São Tomé and Príncipe*", applied to the territory of the São Tome island.

3.4 STRUCTURE

This report consists of **15 Chapters**.

Chapter 1 is a summary of the work carried out. **Chapter 2** (this one) presents the background of the Strategic Environmental Assessment process. **Chapter 3** includes the objectives and working methodology. **Chapter 4** presents the Governance Framework. **Chapter 5** presents a strategic framework of some important factors for the assessment process, characteristic of São Tome & Principe. **Chapter 6** describes the object of assessment and details the hydropower schemes under analysis. **Chapter 7** characterises the Critical Decision Factors to be used and **Chapter 8** presents the baseline situation of each scheme with regard to these factors. This analysis enables a preliminary impact assessment to be carried out in **Chapter 9.** All these analyses will form the basis of the sensitivity assessment in **Chapter 10.** The assessment chapter is complemented by **Drawing 01** that contains the project overview. **Chapter 11** presents some configuration alternatives to be considered for some hydropower schemes and compares these alternatives. **Chapter 12** refers to public and institutional involvement. **Chapter 13** categorises each site according to the AfDB Safeguards System. In **Chapter 14**, based on the above, a ranking of the projects is carried out. Finally, **Chapter 15** presents the conclusions and recommendations of this assessment.

It should be noted that all the analyses carried out and explained in this document must necessarily be understood and contextualised in the present time. Indeed, they are based on a set of values that portray the currently existing realities both in terms of environmental values, human occupation and other infrastructures present in the territory.

4 GOVERNANCE FRAMEWORK

The institutional framework for governance is a relevant dimension of SEA. It relates to levels of responsibility of key actors, power and opportunity relationships and the capacity for stakeholder involvement.

In order to identify the institutional capacity in the process of assessing the hydroelectric potential in São Tomé, it was necessary to identify the relevant actors as well as the responsibilities and competences defined. This exercise allows the identification of the existing institutional framework on the island of São Tomé for the development of the energy sector and gaps, or overlapping, of existing responsibilities.

The following interest groups have been identified:

- Multilateral organisations;
- Public administration;
- Public business sector;
- Economic agents;
- Non-Governmental Organisations;
- Media;
- Other stakeholders.

Each interest group currently has specific responsibilities in relation to the planning process and development of the hydroelectric potential. In **Table 4.1**are represented the duties and competences of the relevant stakeholders, derived from their responsibilities in the accomplishment of the hydroelectric sector development strategy for the island.

Table 4.1- Relevant stakeholders and their responsibilities.

Interest Groups		Attributions and Competences
Multilateral organizations	African Development Bank (AfDB) United Nations Development Programme (UNDP)	Ensure compliance and provide appropriate technical assistance in the different areas, safeguards, monitoring and supervision of the project. Review and comment on safeguard instruments. Monitor and support the implementation of the safeguard instruments.
Public Administration	Ministry of Public Works, Infrastructure, Natural Resources and Environment (MOPIRNA)	Political coordination of project implementation. Participate, with other entities, in the planning which is directly related to the Ministry's attributions. Promote and support the development of projects of national interest within the ministry's sphere of action. Participate, with other entities, in the management of energy production. Participate, with other entities, in the management of compensation for non-consumed energy production.
	General Regulatory Authority (AGER)	Disseminate information regarding the energy sector and increase the transparency of activities undertaken. Regulate and supervise the energy sector, advising the government and defending consumers. Establish properly defined rules and procedures to ensure the balanced protection of the various stakeholders. Participate, with other entities, in the management of energy production. Participate, with other entities, in the management of compensation for non-consumed energy production.
	Directorate General for Natural Resources and Energy (DGRNE)	General coordination of project implementation. Support the participation of MOPIRNA; Support the Government in taking decisions; Carry out enforcement actions; Participate, with other entities, in the management of energy production. Raise awareness among citizens about the importance of investment in the country's energy sector, informing them about ongoing projects and disseminating their results.

Interest Groups		Attributions and Competences
	Directorate General for the Environment (DGA)	Coordinate and administratively manage the Environmental Impact Assessment (EIA) procedures for hydropower schemes to be developed. Appoint the Evaluation Committee for each Environmental Impact Study (EIS) and chair it. Prepare the proposal for the environmental exploitation licence and submit it for approval to the member of the Government competent for the environment; Conduct the environmentla follow-up of the project, including reviewing monitoring reports and conducting inspections and audits. Promote and guarantee public participation, environmental citizenship and access to information in decision-making processes concerning the environment. Propose and monitor, in conjunction with the Obô Natural Park of São Tomé, nature conservation and biodiversity policies, ensuring compliance with the objectives resulting from the regimes relating to these policies.
	Obô de São Tomé Natural Park	Actively participate in the territory's planning and development processes. Ensure the protection and promotion of natural, landscape and cultural values, particularly in areas considered to be priority areas for nature conservation. Ensure the active participation in the management of the Park of all public and private entities, in close collaboration with the resident communities. Promote the management and enhancement of natural resources, enabling essential ecological systems and ecosystem services to be maintained, ensuring their sustainable use, the preservation of biodiversity and the recovery of depleted or overexploited resources. To frame human activities through the rational management of natural resources, with a view to simultaneously promoting economic development and improving the quality of life of the populations living in the surrounding areas in a sustainable manner. To raise the awareness of the population, agents and organisations in the area of nature conservation and biodiversity and forests, increasing collective awareness of the importance of natural values. Ensure good inter-institutional coordination.
Public Business Sector	Water and Electricity Company (EMAE)	Meet the collective needs of the population. Develop assignments in the fields of: a) Transport and distribution of energy; b) Maintenance and management of the energy supply system; Adjust local and regional needs, favouring direct contact and the promotion of energy projects. Organise and disseminate information of interest to the people in the field of its activity. Disseminate information on legislation, regulations and standards, the use of natural resources and successful projects already implemented.

Interest Groups		Attributions and Competences
Economic Agents (Private)	Representatives of the energy consuming sectors (industry, tourism, trade, ...)	Actively participate in the territory's planning and development processes. Analyse the island's economic and social situation from the perspective of companies and workers, proposing to the decision-making bodies the measures that are deemed appropriate to resolve the issues identified. Strengthen investor confidence for local economic development.
	Investors	Mobilise private capital to finance investment in hydroelectric schemes as independent power producers. Design and detail the technical solutions of the Hydropower Schemes to be invested in. Develop Environmental Impact Studies on Hydropower to be invested in. Carry out, in conjunction with other entities, the sale of the energy produced. Guarantee the social, economic and environmental sustainability of the activities implemented by the project, respecting the cultural values of the communities, the legislation in force, good environmental and social practices, and gender equality.
Non-Governmental Organisations (NGOs)		Actively participate in the territory's planning and development processes. Promote critical awareness on the sustainable management of natural resources and the conservation of biodiversity. Promote the search for joint solutions to improve problems.
Communication Organs	Newspapers, Radio, Social Networks	Dissemination of information to all existing agents.
Other stakeholders	Communities, including vulnerable groups	Actively participate in the territory's planning and development processes. Ensure compliance with the various national and local policies (rules and regulations for their areas of activities).

5 GENERAL FRAMEWORK AND STRATEGIC REFERENCE FRAMEWORK

5.1 GENERAL FRAMEWORK

São Tomé and Príncipe is an archipelago composed of two main islands that give the name to it and also includes a group of small islanders that, for the most part, have no human occupation.

The archipelago is one of the smallest states in the world and the second smallest on the African continent, being strongly marked by insularity. However, its geographical position gives it a geostrategic advantage, particularly in terms of the international political context and energy potential.

The archipelago is of volcanic origin and has a rugged terrain. It has a number of natural areas of great territorial expression and high ecological and conservationist importance, with the Ôbo Natural Park of São Tomé (PNOST) with 195 km^2 standing out.

It is also noteworthy that, in terms of nature conservation and biodiversity, São Tomé and Príncipe represents a remarkable case on the African continent with potential to leverage a number of initiatives promoting sustainable development - the rainforest of the archipelago is the second, out of 75 African forests, most priority in terms of bird conservation, and the World Wildlife Fund (WWF) has included it in the Global 200 list for being considered one of the two hundred most important areas worldwide in terms of biodiversity.

However, São Tomé and Príncipe's insularity and small expression (geographic and demographic) place economic and political constraints on the country that have been one of the main impediments to its development.

Thus, and despite increasing efforts, São Tomé and Príncipe continues to be closely associated with high levels of dependence on the outside world, both financially and in terms of human resource needs to leverage economic and social development. In addition, the country lacks a set of infrastructures that are indispensable to the creation of a minimum level to alleviate situations of poverty and economic recovery.

With regard to the socio-demographic context, the "São Tomé and Príncipe Human Development Report", prepared in 2014, concluded that:

- despite several structural and conjunctural challenges, and an apparently unfavorable economic framework, the average achievement in the human development of STP was among the most robust on the African continent, with an HDI that qualified it with average human development;

- women and men enjoyed the different dimensions of human development differently, and inequality was fundamentally felt in the labor market and in decision-making bodies;
- from the poverty point of view, although 2/3 of the Santomean population lived in poverty, only 21% was deprived of access to basic services such as education, health, water supply, which was reflected in the level of malnutrition, low survival rates, precarious health conditions, etc.;
- in the context of the Millennium Development Goals, the STP progress towards the goals remained modest, being the most critical indicators those related to the eradication of extreme poverty and hunger, as well as the promotion of gender equality;
- youth constituted a huge segment of the Santomean society (2/3 of the economically active population), with great potential for the workforce.

Regarding the energy sector, data from the National Institute of Statistics (INE) for 2012 indicated that, at a national level, a little more than half of the accommodations (57.9%) had electricity. Nevertheless, the electricity coverage rate has been increasing in recent years and the reinforcement and requalification of the electricity system is a governance priority, having been the target of several studies and investments in recent years. A sustainable energy policy is indispensable to guarantee, at the same time, the satisfaction of growing demand, the optimization of costs and quality of service, and the well-being of the population and attraction of investment.

In terms of electricity production, as opposed to today and until about three decades ago, hydroelectricity accounted for more than half of the energy produced. Today, the energy production system in São Tomé and Príncipe consists mostly (94.5%) of non-renewable energy sources, in particular thermoelectric plants with diesel generators, with imported fuel.

With regard to electricity consumption, there has been an exponential growth over the last few years, which has justified the constant reinforcement and investment in energy production through thermoelectric plants. According to EMAE records, in 2016 63.527.052 kWh were billed, corresponding to approximately 62.4% of the total volume of electricity emitted in the grid, with extremely high losses (37.6%).

Losses in transmission and distribution are essentially due to identified problems in the grid quality and structure. In addition, there are commercial losses due to fraud and clandestine connections, for which the creation of appropriate legislation and legal-institutional support that eliminate them definitively becomes indispensable.

Considering the above, the exploitation of renewable resources in São Tomé and Príncipe becomes fundamental. This, besides contributing to the minimization of fossil fuel consumption and to a greater environmental sustainability, also contributes from an economic point of view, in the sense that it helps the country to reduce its external energy dependence and guarantee the security of supply.

The "*Study of the Hydroelectric Potential of São Tomé and Príncipe*", prepared by HIDRORUMO (1996), recorded the existence of 33 sites with potential for hydroelectricity production, none of which were under exploration (the Contador Scheme had already been built at the time).

Below is a SWOT analysis applied to the territory of São Tomé and Príncipe that addresses the various areas mentioned above (environmental, social and economic).

Table 5.1 – SWOT analysis. Adapted from: São Tomé and Príncipe National Spatial Planning Plan - Plan Proposal.

Strengths	Weaknesses
– The geographic location of São Tomé and Príncipe has always been considered strategic for both maritime and air routes connecting Africa, Europe and America; – Cooperation partnerships with donor countries in areas of strategic interest for the Sao Tome and Principe economy; – Progress over time in terms of some socio-demographic indicators, despite the complex and vulnerable framework in several areas; – Territory with a strong presence of younger generations with potential to absorb new values and concepts, and to implement the necessary changes to promote sustainability and preserve existing cultural and natural values; – Protected areas with strong expression in the country, such as the Obô Natural Park of São Tomé; – Presence of water bodies with structuring character in the territory; – Significant increase in the rate of electrification, although not yet covering the entire population; – High hydroelectric potential in the country, although highly unexploited.	– Strong expression of the characteristics of small island countries (low demographic weight; limited routes for trade with neighboring countries; limited internal market; weak dynamism of demand; weak diversification of the productive base, ...); – Small and fragile economy, which conditions investments in the various sectors of activity and in the adequate infrastructure of the country; – Narrow base of human capital skills in various strategic professional profiles; – About 2/3 of the population is poor and situations of extreme poverty reach about 12% of the population; – Prevalence of difficult conditions of habitability and comfort; – Various pressures on predominantly natural areas, which result in the degradation of resources and landscape quality; – Weaknesses in systems and networks: • Lack of exploitation of the existing water potential; • In terms of electrical energy, the power with guaranteed availability is only 60% of the total installed power; – Commercial losses and technical leaks that represent a very high portion in relation to production. Non-existence of a control and loss reduction program, and little modernized commercial management system with the absence of metering equipment in most of the clients; – Lack of qualified workers and lack of adequate means for equipment and infrastructure maintenance; – 94.5% of the total energy produced is from non-renewable sources, using imported fuel.
Opportunities	**Threats**
– Development of cooperation agreements and conventions with foreign countries and other international donors; – Dissemination of existing successful projects in terms of environmental, recycling and nature conservation actions, raising awareness among municipalities and the population; – Important reserve of human resources (very young population) and, consequently, high potential for renewal of the active population; – Increasing awareness on the protection, conservation, enhancement and promotion of natural and landscape values; – Water resources with high potential; – Reduced territorial dimension of the country facilitating the implementation of infrastructure needs; – Political priority in requalifying and extending the electric network, and investment in increasing the capacity of energy production to accompany the exponential consumption and the grids extension, although at the expense of non-renewable energies.	– Price variations in raw materials and energy markets; – Progression of poverty levels, with repercussions on the internal market structuring; – Increased trends in the reduction of public development aid; – Strong dependence on international aid and imports; – Growth of the young population becoming a potential problem in the long run because of the difficulties it creates in terms of job creation, housing, transport, health and education; – Evolution of climate change with serious implications for water resources; – Waste of hydroelectric potential due to lack of investment in its exploitation; – Increase in the levels of atmospheric pollution caused by the operation of the thermoelectric plant in the urban center of São Tomé; – Absence of a tariff policy considered fair and sustainable, which can cover at least the operating costs of the electric power supply; – Increasing inefficiency of infrastructure management and control systems and/or increased technical commercial losses; – Deficit of public awareness of the need to manage their water resources.

5.2 STRATEGIC REFERENCE FRAMEWORK

The exploitation of the hydroelectric potential constitutes a very relevant opportunity for the environmental, economic and social sector of São Tomé. To this end, and in order to strategically frame this document, the Sustainable Development Goals (SDG) and the Operational Safeguards (OS) of the African Development Bank (AfDB) have been identified in a Strategic Reference Framework (**Table 5.2** –) that determines the referential for the assessment of the hydroelectric potential of the island of São Tomé.

The objectives and goals here identified constitute the environmental and sustainability referential from which the development of the hydropower schemes under consideration should be evaluated.

Table 5.2 – Strategic Reference Framework.

2030 AGENDA FOR SUSTAINABLE DEVELOPMENT
SDG 1 – End poverty in all its forms everywhere
– Implement appropriate social protection systems and measures for all and achieve substantial coverage of the poor and the vulnerable, ensuring equal rights to economic resources, as well as access to basic services, natural resources and appropriate new technology. – Build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters.
SDG 6 – Ensure availability and sustainable management of water and sanitation for all
– Substantially increase water-use efficiency across all sectors, ensure sustainable withdrawals and supply to address water scarcity, and substantially reduce the number of people suffering from water scarcity; – Protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.
SDG 7 – Ensure access to affordable, reliable, sustainable and modern energy for all
– Ensure universal access to affordable, reliable and modern energy services; – Increase substantially the share of renewable energy in the energy mix; – Double the global rate of improvement in energy efficiency; – Promote investment in energy infrastructure and clean energy technology; – Expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries.

2030 AGENDA FOR SUSTAINABLE DEVELOPMENT

SDG 9 – Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

- Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support.

SDG 12 – Ensure sustainable consumption and production patterns

- Achieve the sustainable management and efficient use of natural resources;
- Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production.

SDG 13 – Take urgent action to combat climate change and its impacts

- Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters.

SDG 15 – Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reserve land degradation and halt biodiversity loss

- Ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forest, wetlands, mountains and drylands;
- Promote the implementation of sustainable management of all types of forests, halt deforestation and restore degraded forests;
- Ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development;
- Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and protect and prevent the extinction of threatened species;
- Take urgent action to end poaching and trafficking of protected species of fauna and flora;
- Introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems.

SDG 16 – Promote peaceful and inclusive societies for sustainable development and build effective, accountable and inclusive institutions at all levels

- Develop effective, accountable and transparent institutions at all levels;
- Ensure responsive, inclusive participatory and representative decision-making at all levels.

AFRICAN DEVELOPMENT BANK - OPERATIONAL SAFEGUARDS

OS 1 – Environmental and social assessment

- Identify and assess the environmental and social impacts and risks – including those related to gender, climate change and vulnerability – of Bank lending and grant-financed operations in their areas of influence;
- Avoid or, if avoidance is not possible, minimize, mitigate and compensate for adverse impacts on the environment and on affected communities;
- Provide for stakeholders' participation during the consultation process;
- Ensure the effective management of environmental and social risks in projects during and after implementation.

OS 2 – Involuntary resettlement: land acquisition, population displacement and compensation

- Avoid involuntary resettlement where feasible, or minimize resettlement impacts where involuntary resettlement is deemed unavoidable after all alternative project designs have been explored;
- Ensure that displaced people are meaningfully consulted and given opportunities to participate in the planning and implementation of resettlement programs;
- Ensure that displaced people receive significant resettlement assistance under the project, so that their standards of living, income-earning capacity, production levels and overall means of livelihood are improved beyond pre-project levels;
- Provide explicit guidance to borrowers on the conditions that need to be met regarding involuntary resettlement issues in Bank operations to mitigate the negative impacts of displacement and resettlement, actively facilitate social development and establish a sustainable economy and society;
- Guard against poorly prepared and implemented resettlement plans by setting up a mechanism for monitoring the performance of involuntary resettlement programs in Bank operations and remedying problems as they arise.

OS 3 – Biodiversity, renewable resources and ecosystem services

- Conserve biological diversity and ecosystem integrity by avoiding or, if avoidance is not possible, reducing and minimizing potentially harmful impacts on biodiversity;
- Endeavour to reinstate or restore biodiversity, including, where some impacts are unavoidable, through implementing biodiversity offsets to achieve "not net loss but net gain" of biodiversity;
- Protect natural, modified, and critical habitats;
- Sustain the availability and productivity of priority ecosystem services to maintain benefits to the affected communities and sustain project performance.

OS 4 – Pollution prevention and control, hazardous materials and resource efficiency

- Manage and reduce pollutants resulting from the project – including hazardous and nonhazardous waste – so that they do not pose harmful risks to human health and the environment;
- Set a framework for efficiently using all of a project's raw materials and natural resources especially energy and water.

AFRICAN DEVELOPMENT BANK - OPERATIONAL SAFEGUARDS
OS 5 – Labor conditions, health and safety

- Protect workers' rights;
- Establish, maintain, and improve the employee-employer relationship;
- Promote compliance with national legal requirements;
- Align Bank requirements with the ILO Core Labor Standards, and the UNICEF Convention on the Rights of the Child, where national laws do not provide equivalent protection;
- Protect the workforce from inequality, social exclusion, child labor, and forced labor;
- Establish requirements to provide safe and healthy working conditions.

6 GENERAL DESIGN FEATURES OF THE HPPS SITES

6.1 GENERAL REMARKS

The main reference of the object of assessment is the "*Study of the Hydroelectric Potential of São Tomé and Príncipe*", elaborated by HIDRORUMO in 1996, which presents sites with technical viability for the construction of hydropower schemes in the islands of São Tomé and Príncipe.

The HIDRORUMO's study collected all the information available from previous studies and hydroelectric exploitation projects developed for São Tomé and Príncipe, as well as elements from other studies, namely topographic, hydrological and geological. It also estimated the hydroelectric potential of São Tomé and hierarchized the hydropower schemes considering their potential, energy production, estimated investment cost and location. For the purpose of this SEA, it was admitted that the conclusions of this work remain valid in terms of hydroelectric potential.

However, the HIDRORUMO study lacks a feasibility analysis from the environmental and sustainability point of view.

In this sense, the **object of assessment** of the SEA comprises the different potential hydropower schemes identified in the "*Study of the Hydroelectric Potential of São Tomé and Príncipe*", applied to the territory of the São Tome island.

6.2 HYDROPOWER SCHEMES UNDER ANALYSIS

6.2.1 River basins

The hydropower schemes under consideration are distributed over eight river basins, namely Iô Grande, Abade, Manuel Jorge, Ouro, Cantador, Lembá, Xufexufe and Quija. Next, it is presented the graphic georeferencing and the main characteristics of each hydropower scheme considered, organized by hydrographic basin.

6.2.2 Iô Grande river

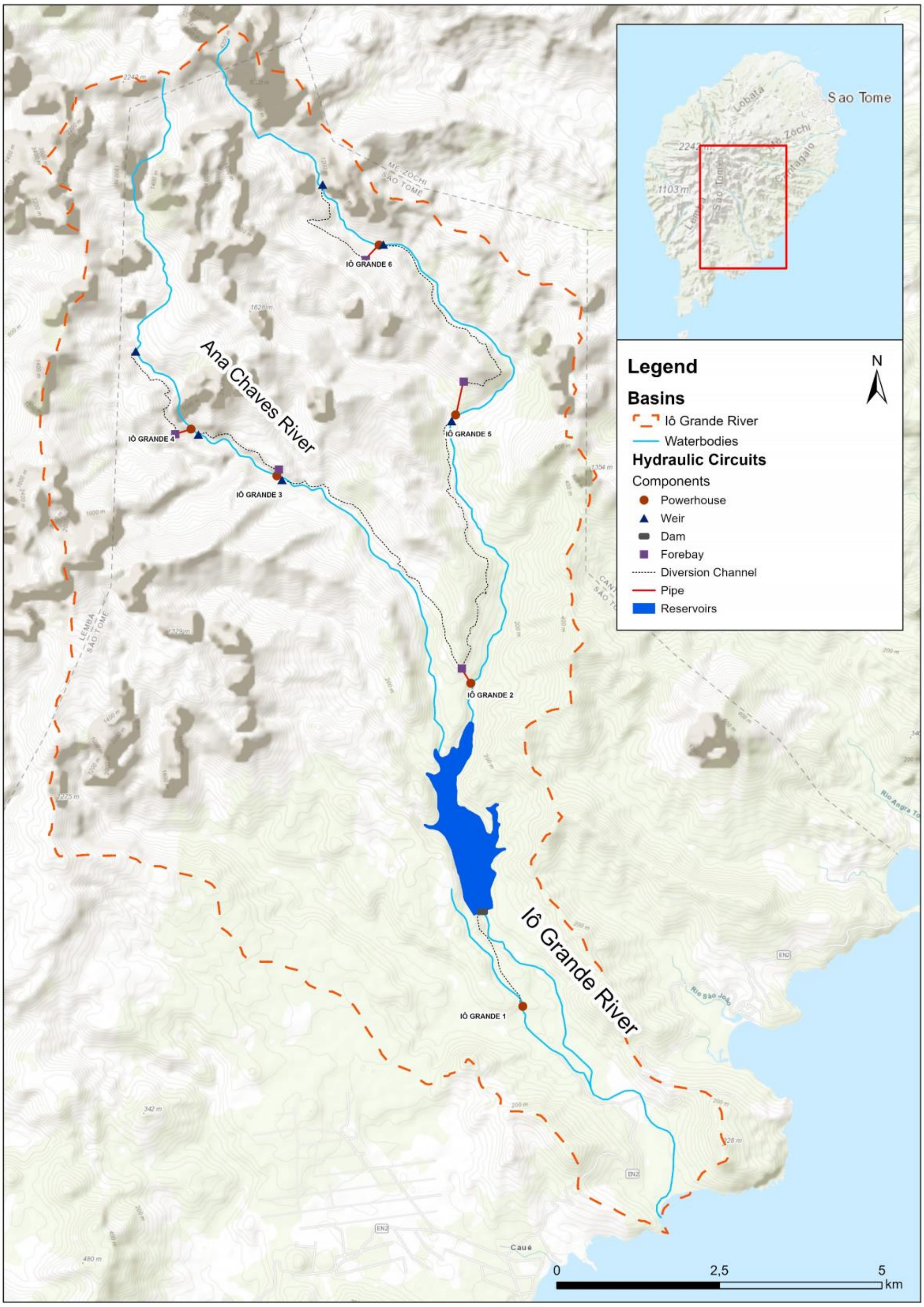

Figure 6.1 – Location of the Iô Grande river basin and hydropower schemes in the area under consideration.

Table 6.1 – Main characteristics of the recommended classes for the Iô Grande river.

Schemes	Iô Grande 1	Iô Grande 2	Iô Grande 3	Iô Grande 4	Iô Grande 5	Iô Grande 6
Location of the water intake(s)	Iô Grande	Iô Grande /Ana Chaves	Ana Chaves	Ana Chaves	Iô Grande	Iô Grande
Location of the outfall	Umbugu	Iô Grande	Ana Chaves	Ana Chaves	Iô Grande	Iô Grande
Water intake level	74	200	300	500	400	600
Outfall level	15	90	200	300	210	400
Gross head (m)	59	110	100	200	190	200
Modular flow rate (m^3/s)	9,5	4,5	2,2	0,7	1,0	0,4
Power (MW)	6,9	5,9	2,8	1,8	2,7	1,0
Energy produced in average year (GWh)	26,5	23,2	10,6	6,9	10,3	3,9
Storage capacity[1] (days)	13,2	--	--	--	--	--

[1] Estimated based on the relationship between the useful volume of the reservoir and the dimensioning flow of the hydropower scheme.

6.2.3 Abade river

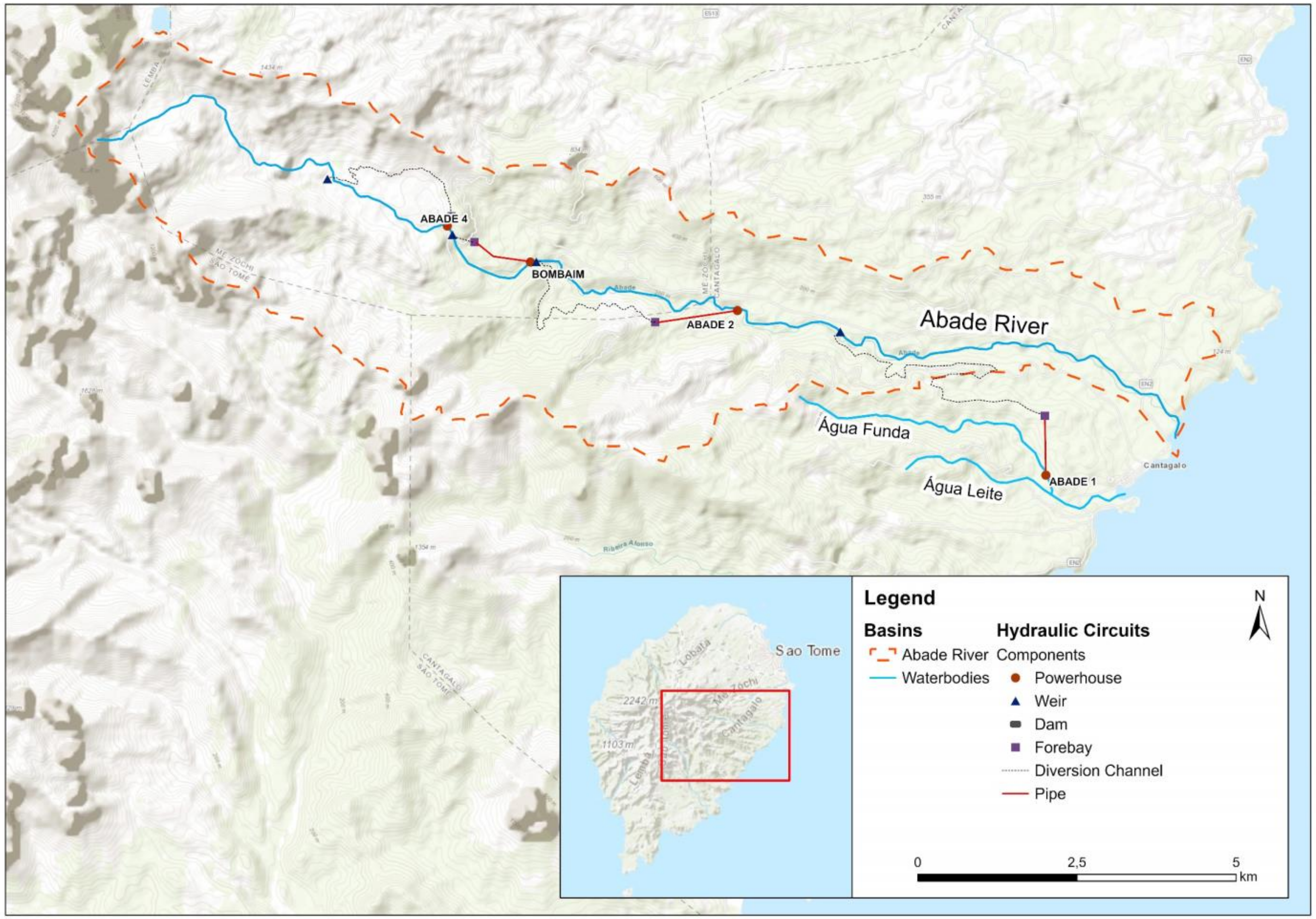

Figure 6.2 – Location of the Abade river basin and hydropower schemes in the area under consideration.

Table 6.2 – Main characteristics of the recommended classes for the Abade river.

Schemes	Abade 1	Abade 2	Abade 3 / Bombaim	Abade 4
Location of the water intake(s)	Abade	Abade	Abade	Abade
Location of the outfall	Água Funda	Abade	Abade	Abade
Water intake level	120	290	475	620
Outfall level	15	120	288	475
Gross head (m)	105	170	187	145
Modular flow rate (m^3/s)	1,8	1,2	0,8	0,7
Power (MW)	2,4	2,4	1,8	1,2
Energy produced in average year (GWh)	9,1	9,4	7,7	4,6
Storage capacity[2] (days)	--	--	--	--

[2] Estimated based on the relationship between the useful volume of the reservoir and the dimensioning flow of the hydropower scheme.

6.2.4 Manuel Jorge river

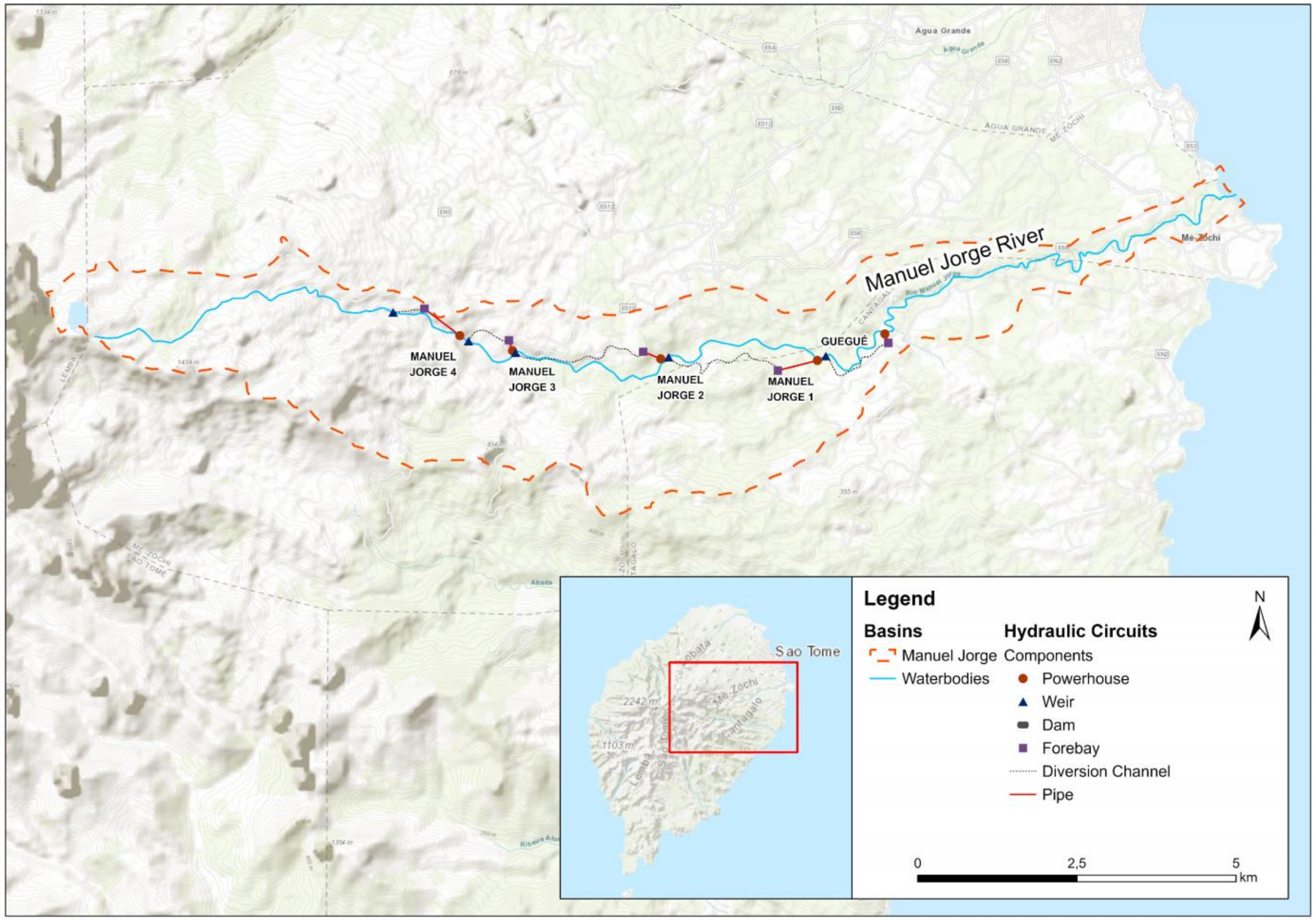

Figure 6.3 – Location of the Manuel Jorge river basin and hydropower schemes in the area under consideration.

Table 6.3 – Main characteristics of the recommended classes for the Manuel Jorge river and the existing scheme (Guegué).

Schemes	Guegué	Manuel Jorge 1	Manuel Jorge 2	Manuel Jorge 3	Manuel Jorge 4
Location of the water intake(s)	Manuel Jorge	Manuel Jorge	Manuel Jorge	Manuel Jorge	Manuel Jorge
Location of the outfall	Manuel Jorge	Manuel Jorge	Manuel Jorge	Manuel Jorge	Manuel Jorge
Water intake level	170	250	400	510	730
Outfall level	115	174	250	400	510
Gross head (m)	55	76	150	110	220
Modular flow rate (m^3/s)	0,75	0,62	0,38	0,35	0,34
Power (MW)	3,2	0,4	0,8	0,5	0,9
Energy produced in average year (GWh)	1,0	1,8	3,5	2,2	3,8
Storage capacity[3] (days)	--	--	--	--	--

[3] Estimated based on the relationship between the useful volume of the reservoir and the dimensioning flow of the hydropower scheme.

6.2.5 Ouro river

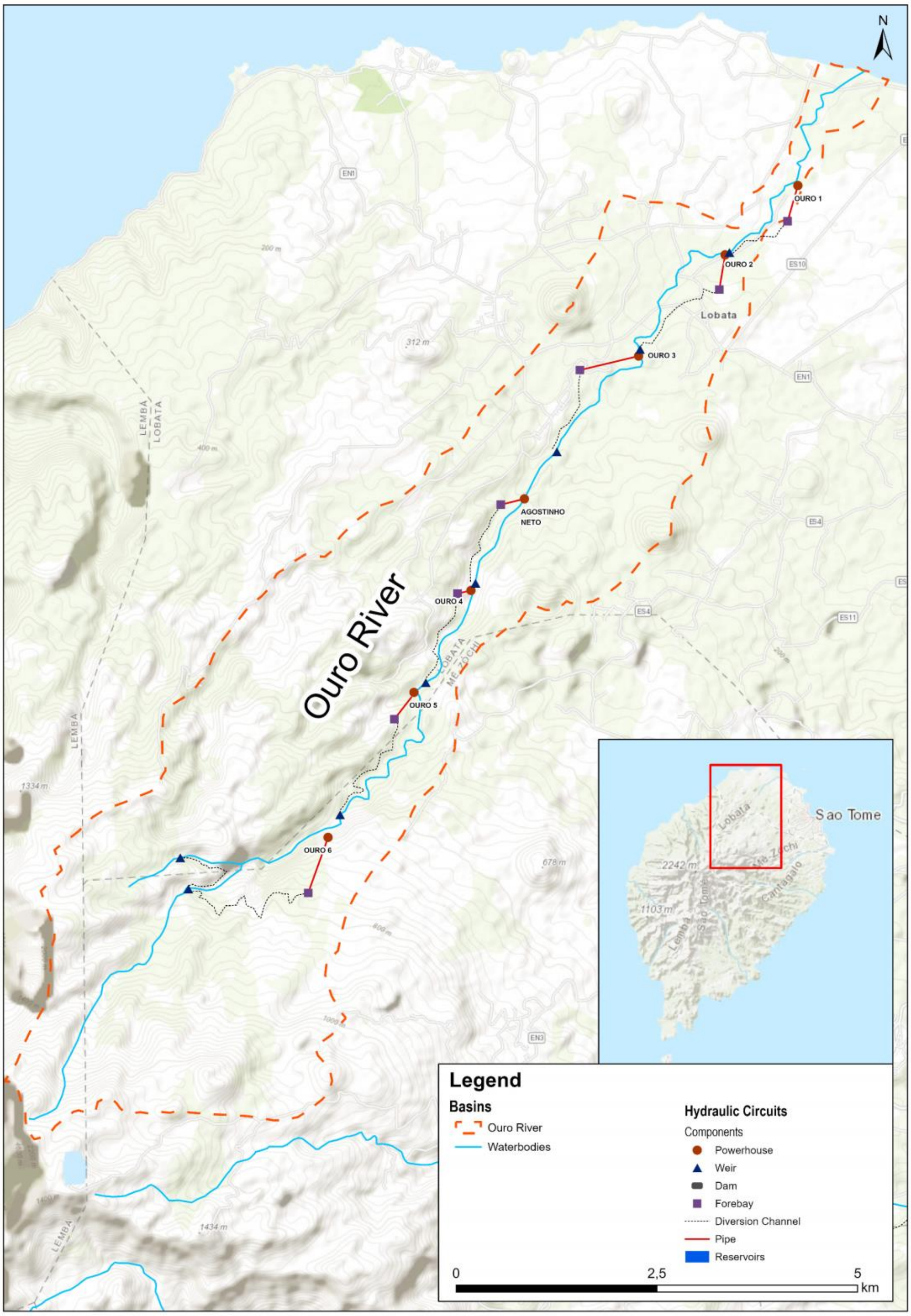

Figure 6.4 – Location of the Ouro river basin and hydropower schemes in the area under consideration.

Table 6.4 – Main characteristics of the recommended classes for the Ouro river and the existing scheme (Agostinho Neto).

Schemes	Ouro 1	Ouro 2	Ouro 3	Agostinho Neto	Ouro 4	Ouro 5	Ouro 6
Location of the water intake(s)	Ouro	Ouro	Ouro	Ouro	Ouro	Ouro	Ouro
Location of the outfall	Ouro	Ouro	Ouro	Ouro	Ouro	Ouro	Ouro
Water intake level	35	80	165	230	315	450	700
Outfall level	12	35	80	175	230	315	450
Gross head (m)	23	45	85	55	85	135	250
Modular flow rate (m^3/s)	1,0	0,9	0,8	0,8	0,8	0,7	0,3
Power (MW)	0,2	0,5	0,8	0,4	0,9	1,1	1,3
Energy produced in average year (GWh)	0,9	2,0	3,2	0,1	3,4	4,4	5,0
Storage capacity[4] (days)	--	--	--	--	--	--	--

[4] Estimated based on the relationship between the useful volume of the reservoir and the dimensioning flow of the hydropower scheme.

6.2.6 Cantador river

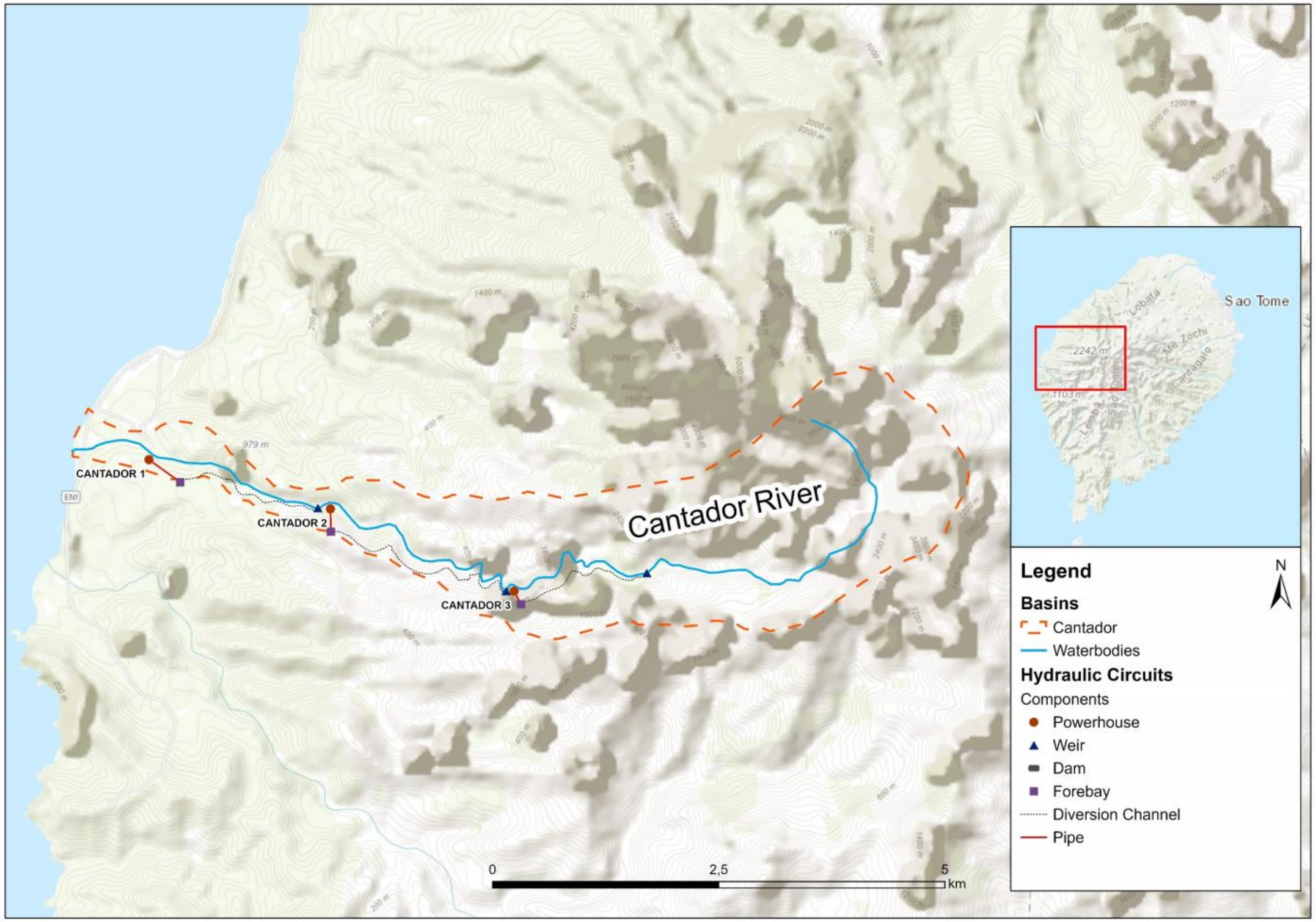

Figure 6.5 – Location of the Cantador river basin and hydropower schemes in the area under consideration.

Table 6.5 – Main characteristics of the recommended classes for the Cantador river.

Schemes	Cantador 1	Cantador 2	Cantador 3
Location of the water intake(s)	Cantador	Cantador	Cantador
Location of the outfall	Cantador	Cantador	Cantador
Water intake level	100	300	500
Outfall level	20	100	300
Gross head (m)	80	200	200
Modular flow rate (m^3/s)	5,3	2,2	0,7
Power (MW)	1,1	2,0	1,3
Energy produced in average year (GWh)	4,3	7,6	5,0
Storage capacity[5] (days)	--	--	--

[5] Estimated based on the relationship between the useful volume of the reservoir and the dimensioning flow of the hydropower scheme.

6.2.7 Lembá river

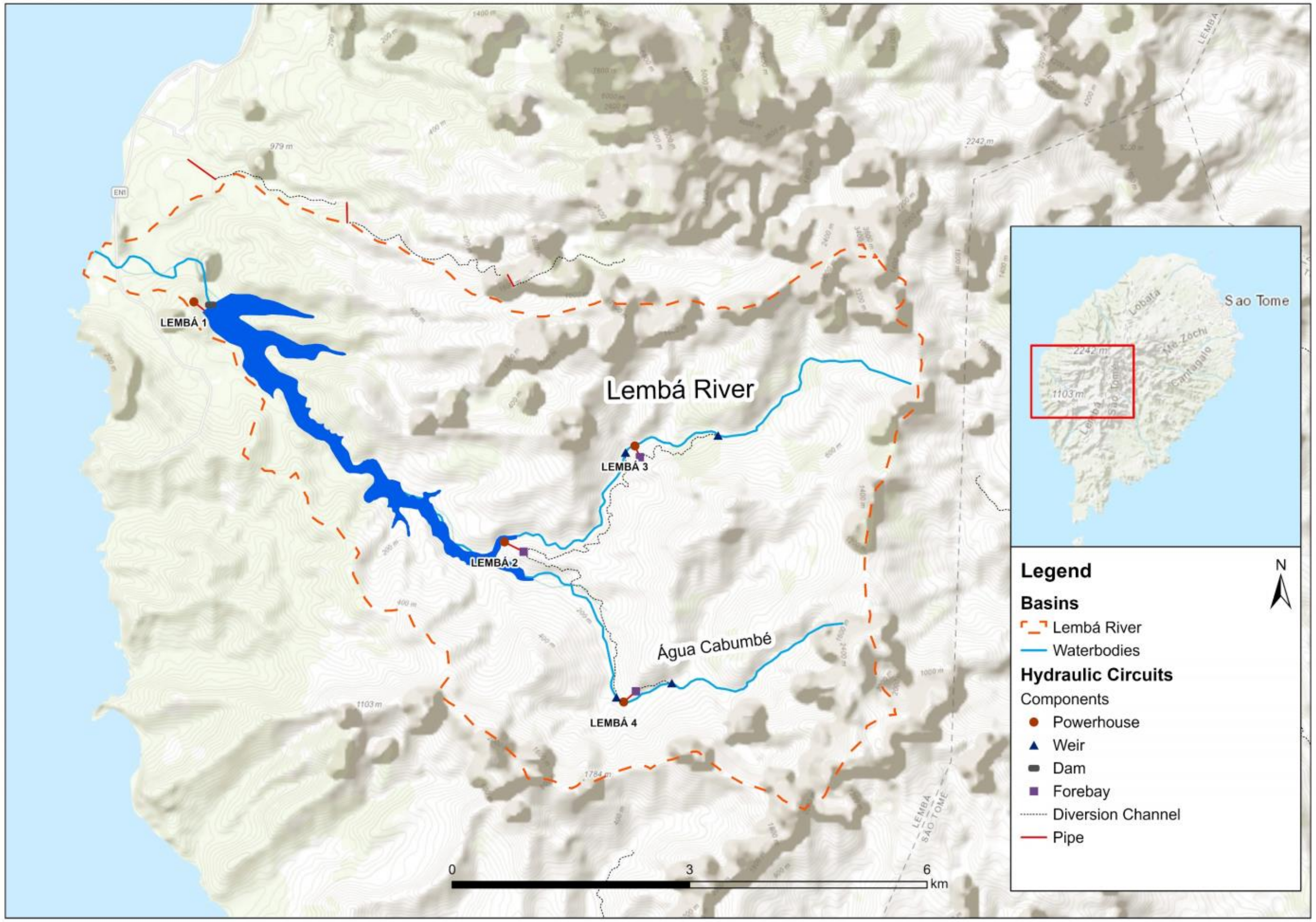

Figure 6.6 – Location of the Lembá river basin and hydropower in the area under consideration.

Table 6.6 – Main characteristics of the recommended classes for the Lembá river.

Schemes	Lembá 1	Lembá 2	Lembá 3	Lembá 4
Location of the water intake(s)	Lembá	Água Cabumbé / Lembá	Lembá	Água Cabumbé
Location of the outfall	Lembá	Lembá	Lembá	Água Cabumbé
Water intake level	100	200	300	300
Outfall level	20	100	200	200
Gross head (m)	80	100	100	100
Modular flow rate (m^3/s)	5,3	2,2	0,7	0,7
Power (MW)	5,5	2,8	0,8	0,8
Energy produced in average year (GWh)	21,2	10,9	3,2	3,2
Storage capacity[6] (days)	49,1	--	--	--

[6] Estimated based on the relationship between the useful volume of the reservoir and the dimensioning flow of the hydropower scheme.

6.2.8 Xufexufe river

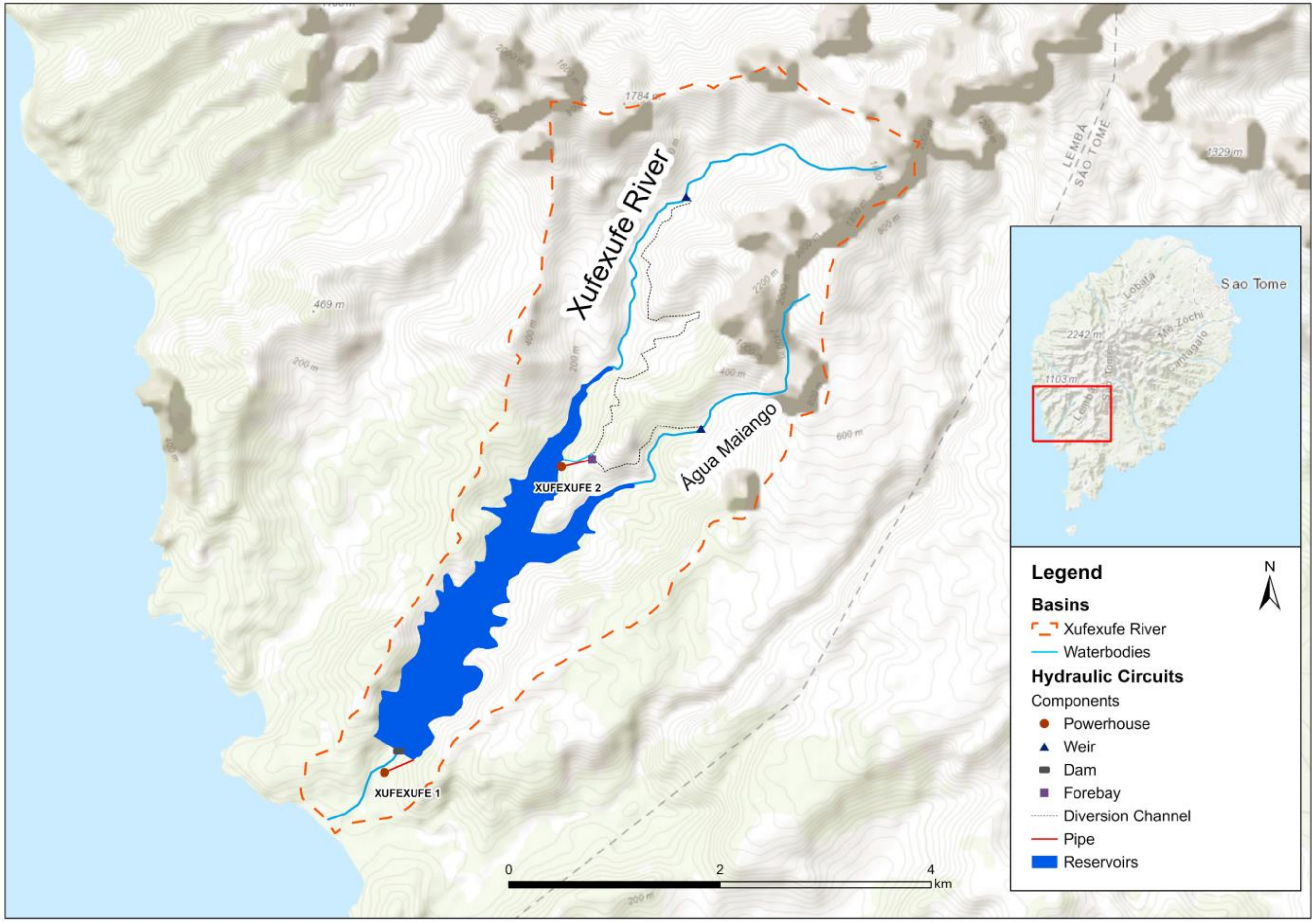

Figure 6.7 – Location of the Xufexufe river basin and hydropower schemes in the area under consideration.

Table 6.7 – Main characteristics of the recommended classes for the Xufexufe river.

Schemes	Xufexufe 1	Xufexufe 2
Location of the water intake(s)	Xufexufe	Xufexufe / Água Maiango
Location of the outfall	Xufexufe	Xufexufe
Water intake level	100	200
Outfall level	10	100
Gross head (m)	90	100
Modular flow rate (m^3/s)	2,6	1,1
Power (MW)	3,0	1,2
Energy produced in average year (GWh)	11,6	4,8
Storage capacity[7] (days)	95,0	--

[7] Estimated based on the relationship between the useful volume of the reservoir and the dimensioning flow of the hydropower scheme.

6.2.9 Quija river

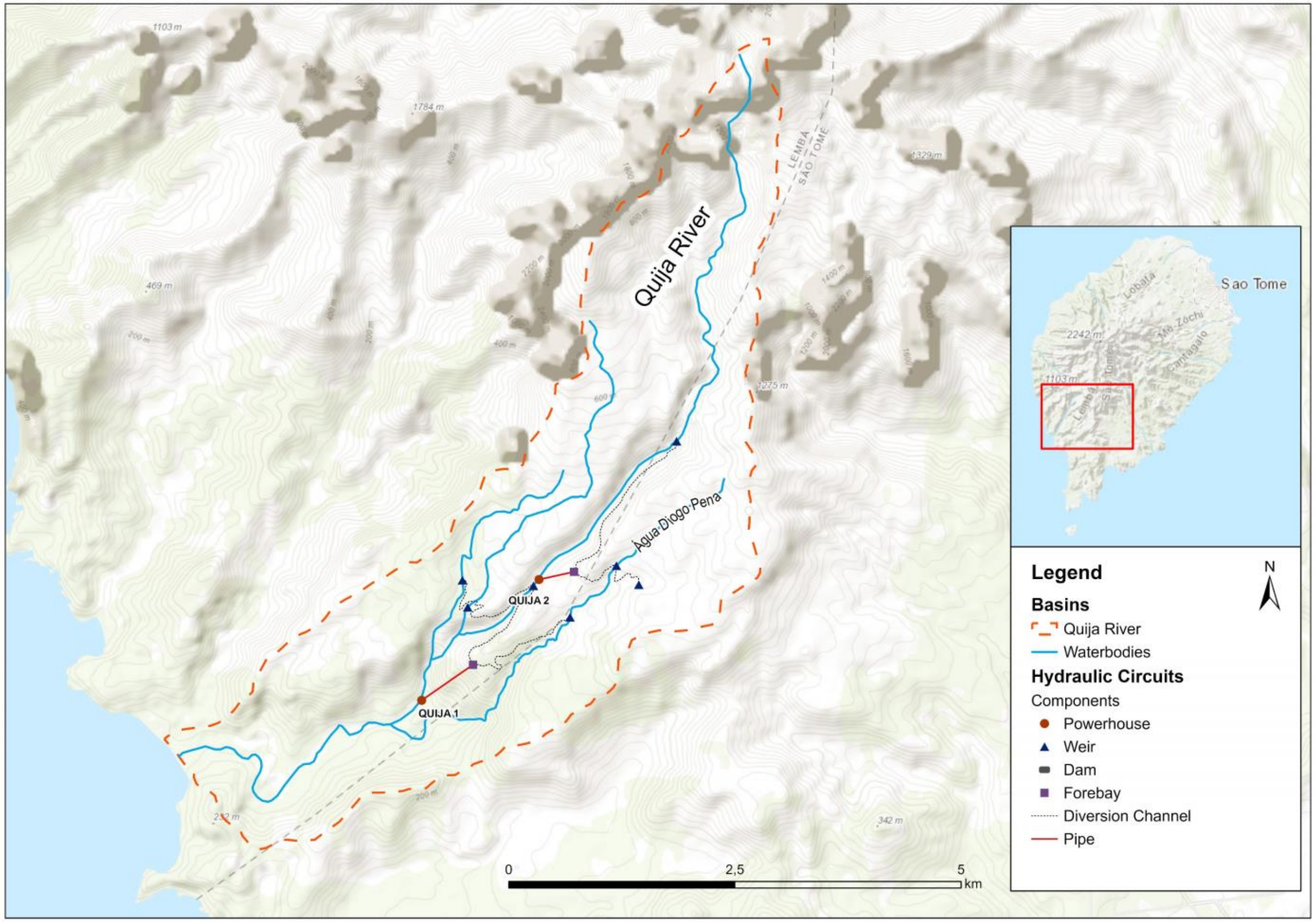

Figure 6.8 – Location of the Quija river basin and hydropower schemes in the area under consideration.

Table 6.8 – Main characteristics of the recommended classes for the Quija river.

Schemes	Quija 1	Quija 2
Location of the water intake(s)	Quija's tributary/ Quija / Água Diogo Pena	Quija / Água Diogo Pena
Location of the outfall	Quija	Quija
Water intake level	300	400
Outfall level	20	300
Gross head (m)	280	100
Modular flow rate (m^3/s)	1,25	0,5
Power (MW)	4,4	0,6
Energy produced in average year (GWh)	17,1	2,3
Storage capacity[8] (days)	--	--

[8] Estimated based on the relationship between the useful volume of the reservoir and the dimensioning flow of the hydropower scheme.

7 CRITICAL DECISION FACTORS

7.1 GENERAL REMARKS

As mentioned in **Chapter 3**, the environmental assessment will focus on Critical Decision Factors (CDF) that result from an integrated analysis of strategic base elements, taking into consideration the nature and geographic implementation of the hydropower schemes. The three CDF in the assessment framework are:

- **CDF#1 Spatial Planning**
- **CDF#2 Land Use**
- **CDF#3 Critically Endangered Bird Species**

The CDF are presented in this report as the windows of observation to focus attention on what matters for assessment. CDF establish the focus of SEA and may be reviewed during the course of the SEA, if so justified, depending on the public and institutional consultations to be carried out, the planning circumstances and the information available. The justification and objectives of each of the CDF are presented below.

7.2 CDF #1 SPATIAL PLANNING

In order to protect the forest areas around Pico de São Tomé and its representative ecosystems, the Obô Natural Park of São Tomé (PNOST) was created in 2006 under the Law No. 6/2006.

The PNOST does not have permanent human settlements, in part due to the relief, the high rainfall, the difficulty of access and the inaptitude of the soils for agricultural activities in general. These are the factors that, globally, have ensured the absence of major negative impacts by human action, although the management of these areas is of extreme importance, given the increase in activities that deplete their natural heritage, such as illegal and unregulated hunting, oil palm plantations and illegal and disorderly logging.

The boundaries of the PNOST are clearly established, as well as its two protection zones provided in the zoning system of the PNOST Management Plan, delimited in accordance with the resident population. The zoning aims at the division of the territory seeking to maximize its use, according to the potential of each zone, from a perspective of sustainable development of natural resources. In this context, the zoning system of the Park establishes:

- **Integral preservation areas**: constituted by the central, primitive or intangible areas that function as natural reserves within the Park, being prohibited the activities that imply an anthropic alteration of the biota (fauna and flora), with the exception of:

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- Public visits, to be carried out under the conditions foreseen in the Park's internal regulations;
- Scientific observation activities, studies or application of management measures necessary for the conservation objectives;
- Works necessary to carry out the activities foreseen in the previous points.

– **Controlled exploration areas**: these areas admit a moderate and self-sustaining use of fauna and flora, regulated in order to ensure the maintenance of natural ecosystems, and may be dedicated to ecotourism and non-agricultural forms of economic development that benefit the Park's resident communities.

– **Buffer zones**: privileges the harmonious integration of human communities in the natural environment, cushioning the impacts of human action on the ecosystems of the Natural Park and promoting sustainable economic activities.

Table 7.1 – PNOST zoning and its characteristics.

<table>
<tr><td rowspan="2">Integral Preservation Zone</td><td>Type I Total Protection</td><td>Areas with flora and vegetation of exceptional value - endemism; avifauna of exceptional value - endemism.</td></tr>
<tr><td>Type II Total Protection</td><td>Areas with flora and fauna of very high or exceptional value (medium sensitivity); primary forest samples or secondary forest in evolution; areas of potential presence of natural values, lacking more studies (birds, fish, other biological groups).</td></tr>
<tr><td rowspan="2">Controlled Exploration Zone</td><td>Type I Partial Protection</td><td>Some of the ecosystems that have been, or currently are, used by the communities in conflicting activities with the biodiversity conservation, but whose recovery is fundamental to the management objectives of the most important areas of the Park.</td></tr>
<tr><td>Type II Partial Protection</td><td>Some of the ecosystems that are, currently, sustainably used by the communities, but enclose relevant interest for nature, biodiversity and landscape conservation.</td></tr>
</table>

In the sensitivity analysis, the assessment criterion will be the intersection of the hydropower schemes with the Natural Park, differentiating whether this intersection occurs in a zone of Integral Preservation, Controlled Exploration or Buffer Zone. For this purpose, a map with the limits of the PNOST and respective zoning, water bodies and hydropower schemes under analysis was elaborated (**Figure 7.1**). The baseline information regarding the boundaries of the Park was extracted from the *World Database on Protected Areas* (UNEP-WCMC, 2020).

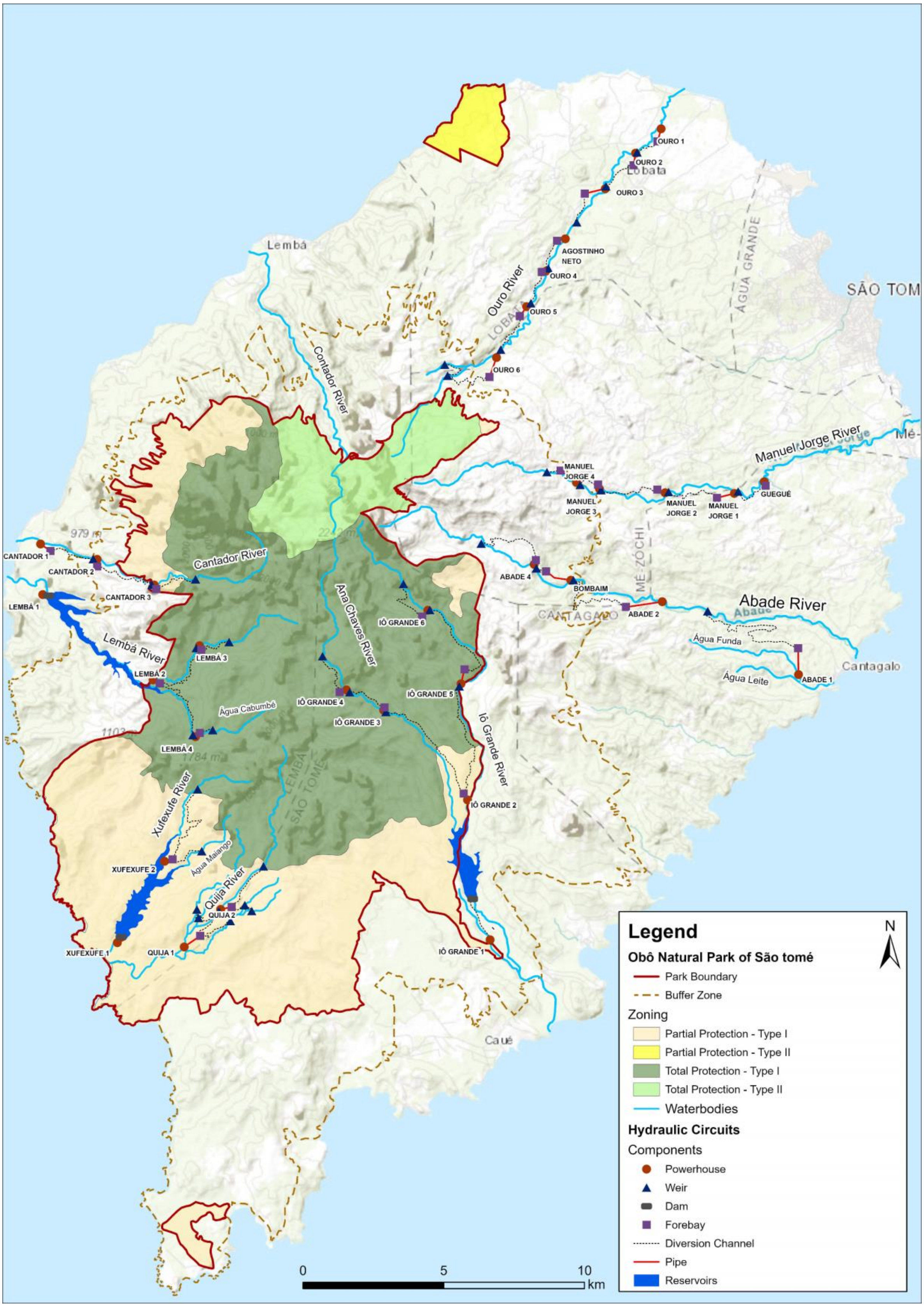

Figure 7.1 – PNOST boundaries and zoning.

7.3 CDF #2 LAND USE

The island of São Tomé has a rugged topography consisting of steep slopes and embedded valleys, with rivers punctuated by large waterfalls. This topography explains the climatic gradient, characterized by high levels of humidity and frequent rainfall, brought by strong winds from the southwest of the island, which contrast with the semi-arid northeast.

The strong climatic gradient has been shaping the distribution of the island's ecosystems, but the landscape originally dominated by forest has undergone changes since the human settlement of the island. Lowland areas are the most affected, consisting mostly of non-forested areas such as savannas and cultivated areas. Lowland forests have been replaced by shade plantations with exotic trees such as coffee, cocoa and palm trees. The native forest, the best preserved, is today restricted to mountainous areas in the center and southwest of the island, surrounded by secondary forest, which resulted mainly from regeneration with native species from abandoned shade plantations.

Despite the humanized landscape, São Tomé maintains a very diverse flora and fauna with a very high number of endemism. Its forests are of enormous conservation interest, having been identified as the third most important in the world for the conservation of species of forest birds.

The study conducted by Soares, F. (2017) concludes that the type of land use (among other environmental criteria considered, such as topography, precipitation, slope, altitude, accessibility and distance from the coast) was identified as the most important variable to explain the presence of species on the island: endemic species tend to occur preferentially in the forest, in more remote areas of high altitude and precipitation, and non-endemic species, in turn, prefer non-forested and more humanized areas.

The highly forested landscape of São Tomé generally allows for the dominance of endemic species on the island. Many of these endemic species are threatened, which highlights the need to protect forest habitats.

In the sensitivity analysis the assessment criterion will be the intersection of the hydropower schemes with the different land uses (namely Native Forest, Secondary Forest and Shade Plantation). For this purpose, a map was elaborated with the land use, water bodies and hydropower schemes under analysis (**Figure 7.2**).

The baseline information regarding land use was taken from the study "*Modelling the distribution of São Tomé bird species: ecological determinants and conservation prioritization*" (Soares, F., 2017).

Figure 7.2 – Land Use (Native Forest, Secondary Forest and Shade Plantation).

The study is based on a robust interpretation of data with several origins, and it can be assumed with high confidence - for the scale of analysis used, and given the recent period in which it was conducted - that the reality on the ground is faithfully characterized in the classes used.

Furthermore, the data collected and used in the classification of land uses are information on flora and vegetation that, in principle, have some ecological stability and temporal permanence.

It should be noted that there is some overlap between the areas legally classified in a more restrictive way and directed towards nature conservation and the areas of native forest.

This coincidence, although to be expected, effectively stems from two distinct processes - one of legislative/procedural origin and the other of academic origin - that consider diverse realities.

Thus, even though the two CDF may present a somewhat concordant spatial distribution, they are, in their origin, sufficiently diverse to consider their separate consideration valid and coherent.

7.4 CDF #3 CRITICALLY ENDANGERED BIRD SPECIES

São Tomé holds 20 endemic bird species, including the little known and ‘Critically Endangered’ São Tomé Ibis *Bostrychia bocagei*, São Tomé Fiscal *Lanius newtoni* and São Tomé Grosbeak *Crithagra concolor*.

The study conducted by de Lima, R. *et al.* (2017) describes an intensive survey of central forest ecosystems on the island of São Tomé which, together with *ad hoc* observations, has been used to produce distribution maps of potential species and to identify the areas of the island that are most important for these three species.

The study confirms that all target species are strongly linked to the occurrence of native forest, indicating that the protection of this forest is critical to ensure the long-term survival of these three bird species. Habitat degradation has been identified as a key threat to their survival and suggests having a negative impact on all species.

In the sensitivity analysis the assessment criterion will be the intersection of the hydropower schemes with the polygons of occurrence of these critically endangered bird species (the polygons constitute a line around a cloud of observation points of each species). For this purpose, a map was elaborated with the polygons of occurrence of the species, the water bodies and the hydropower schemes under analysis (**Figure 7.3**).

The baseline information regarding the critically endangered species was extracted from the study "*Distribution and habitat associations of the critically endangered bird species of São Tomé Island (Gulf of Guinea)*" (de Lima, R. et al., 2017).

This study, recently conducted and scientifically robust, does not allow to know in detail the distribution of the species in question, nor the more detailed ecological factors that condition this distribution.

In addition, birds, being very mobile organisms, typically present a spatial distribution that may include some inter-annual variability. It should be noted, however, that the species under analysis are not migratory, occur exclusively on a small island (São Tomé) and present a reduced number of specimens. Thus, although the shape of the species distribution polygons should be viewed with some caution and as representatives of a specific sampling period, it is understood that the data are sufficiently reliable to support part of the analysis for this CDF.

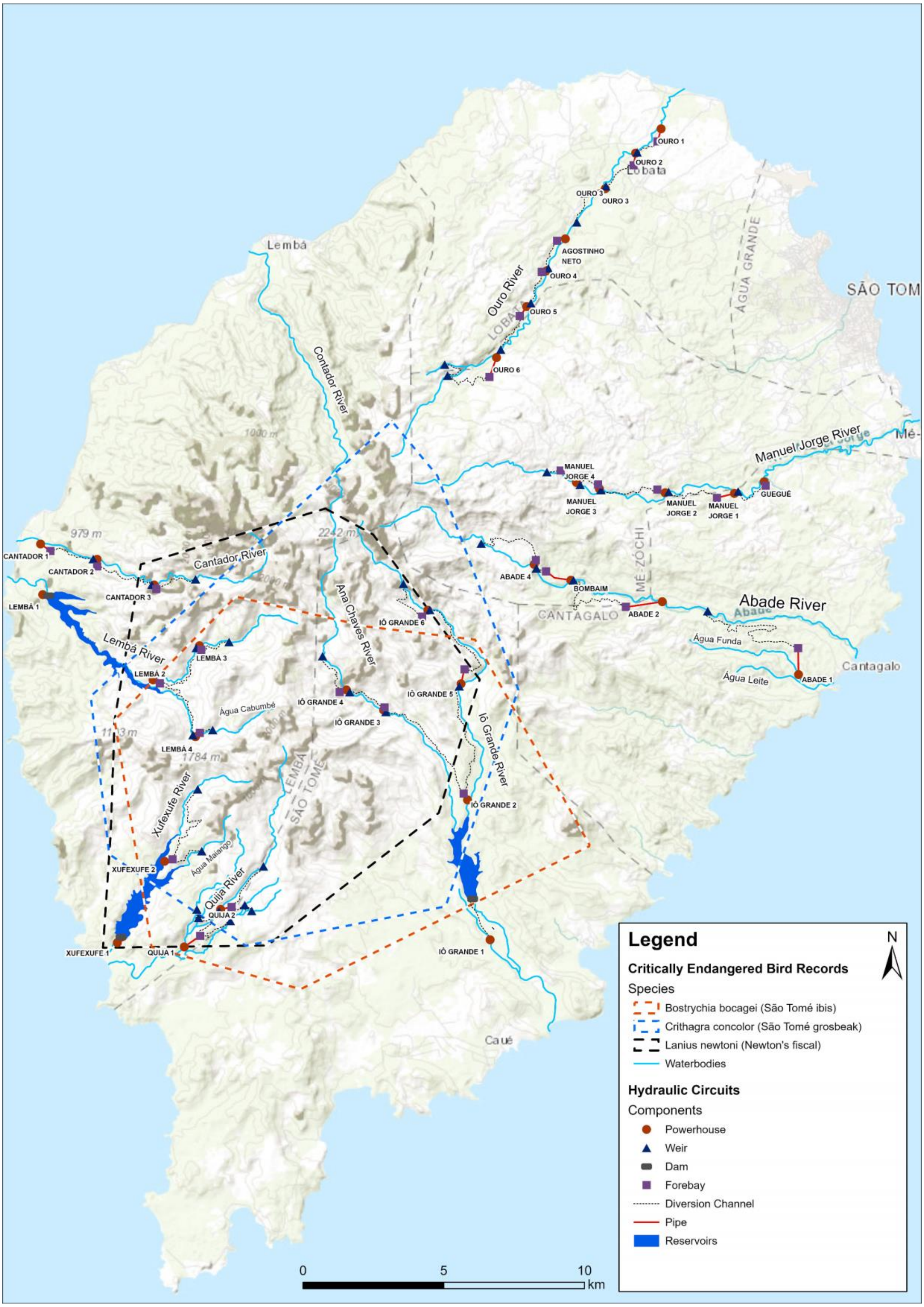

Figure 7.3 – Occurrence of critically endangered bird species.

8 ANALYSIS OF THE BASELINE SITUATION

8.1 GENERAL REMARKS

The following items present the baseline situation of the CDFs discussed in **Chapter 7** regarding the HPPs presented in **Chapter 6** with the configurations identified therein.

Thus, a characterisation is carried out about the environmental aspects selected in the area of the hydropower schemes in each watershed.

8.2 RIO IÔ GRANDE

8.2.1 Iô Grande 1 HPP

The Iô Grande 1 HPP is fully developed in the Buffer Zone of PNOST, and none of the planned works is developed inside the Park. However, the reservoir planned for this solution partially covers the Park's Type I Partial Protection area.

In terms of land use, this scheme mainly involves areas of secondary forest, with areas of shady plantations also being interfered with.

The planned works also interfere with the polygon of occurrence of *Bostrychia bocagei,* and the reservoir, cumulatively, also overlaps with the occurrence of *Crithagra concolor*.

8.2.2 Iô Grande 2 HPP

The Iô Grande 2 HPP is developed entirely within the PNOST, with the works designed to capture water and derive flows in the Iô Grande River being almost marginal to the Park, while the works planned for the Ana Chaves River are developed towards the interior of the Park. The solution is partially implemented in a Partial Protection Type I area and mostly in a Total Protection Type I area.

The Iô Grande River works are in a border zone between Native and Secondary Forest, and the elements located on the Ana Chaves River interferes mostly with Native Forest.

Regarding the perimeters of occurrence of critically endangered bird species, this HPP intersects the polygons of the three species considered.

8.2.3 Iô Grande 3, 4 and 5 HPPs

These three schemes have their planned works completely located in the PNOST Type I Total Protection Area.

Regarding Land Use, the projects cover exclusively areas of Native Forest.

The three schemes also interfere with the perimeters of the three critically endangered bird species considered.

8.2.4 Iô Grande 6 HPP

The planned works of this scheme are completely located in the PNOST Type I Total Protection Area.

Regarding Land Use, the development comprises exclusively areas of Native Forest.

The exploitation also interferes with the occurrence perimeters of *Crithagra concolor* and *Lanius newtoni*.

8.3 ABADE RIVER

8.3.1 Abade 1 HPP

The works included in this development do not interfere with PNOST or the respective Buffer Zone.

The land uses in which the hydropower scheme is developed correspond mostly to Shade Plantations, and non-forest areas are also included.

With regard to the distribution of critically endangered bird species, none of the polygons are intersected by the project.

8.3.2 Abade 2 HPP

The works included in this scheme do not interfere with the PNOST and are only partially (weir at the beginning of the circuit) located in the respective Buffer Zone.

The land uses in which the hydropower scheme is developed correspond mainly to Shade Plantations, and areas of Secondary Forest are also included.

As for the distribution of critically endangered bird species, none of the polygons are intersected by the project.

8.3.3 Abade 3 / Bombaim and Abade 4 HPPs

The works included in these schemes are developed in the Buffer Zone of PNOST, however they do not interfere with the Park itself.

The land uses in which the hydropower schemes are developed correspond mostly to Secondary Forest and also include areas of Shade Plantations.

As for the distribution of critically endangered bird species, none of the polygons are intersected by the projects.

8.4 MANUEL JORGE RIVER

8.4.1 Guegué, Manuel Jorge 1, Manuel Jorge 2 and Manuel Jorge 3 HPPs

The works included in these projects do not interfere with PNOST, nor with the respective Buffer Zone.

The land uses in which the hydropower schemes are developed correspond mostly to Shade Plantations and non-forest areas are also included.

With regard to the distribution of critically endangered bird species, none of the polygons are intersected by the projects.

8.4.2 Manuel Jorge 4 HPP

The works included in this scheme are located in the Buffer Zone of PNOST, but do not interfere with the Park itself.

The land uses in which the HPP is developed correspond, mostly, to Secondary Forest, being also included areas of Shade Plantations.

As for the distribution of critically endangered bird species, none of the polygons are intersected by the project.

8.5 OURO RIVER

8.5.1 Ouro 1, Ouro 2, Ouro 3, Agostinho Neto, Ouro 4 and Ouro 5 HPPs

The works included in these projects do not interfere with PNOST, nor with the respective Buffer Zone.

The land uses in which the hydropower schemes are developed correspond mostly to Shade Plantations, also including non-forest areas and, occasionally, Secondary Forest.

With regard to the distribution of critically endangered bird species, none of the polygons are intersected by the projects.

8.5.2 Ouro 6 HPP

The works included in this scheme are partly located within the Buffer Zone of PNOST, but do not interfere with the Park itself.

The land uses in which the HPP is developed correspond, mostly, to Secondary Forest and small areas of Native Forest are also covered.

As for the distribution of critically endangered bird species, none of the polygons are intersected by the project.

8.6 CANTADOR RIVER

8.6.1 Cantador 1 HPP

The works included in this scheme are partly located within the Buffer Zone of PNOST, but do not interfere with the Park itself.

The land uses in which the HPP is developed correspond, mostly, to Secondary Forest, being also included areas of Shade Plantations.

As for the distribution of critically endangered bird species, none of the polygons are intersected by the project.

8.6.2 Cantador 2 HPP

The works included in this scheme are partially developed in the Buffer Zone of PNOST, interfering, further upstream, with the Park itself, in a Partial Protection Type I zone.

The land uses in which the HPP is developed correspond, mostly, to Secondary Forest, being that, in the weir zone and the beginning of the circuit, areas of Native Forest are interfered.

The upstream works also interfere with the *Lanius newtoni* distribution area.

8.6.3 Cantador 3 HPP

The works included in this scheme are mainly located in the Partial Protection Area Type I of PNOST, with the works located further upstream, including the weir, in the Total Protection Area Type I of the Park.

The land uses in which the HPP is developed correspond entirely to Native Forest.

The planned works are developed completely within the *Lanius newtoni* occurrence range.

8.7 LEMBÁ RIVER

8.7.1 Lembá 1 HPP

The works planned for this scheme are developed outside the PNOST and the respective Buffer Zone. However, the reservoir planned for this solution covers both the Park Buffer Zone and even the Park's Type I Total Protection Area.

With regard to Land Use, this project is mainly developed on Secondary Forest areas, as well as on Native Forest areas (in the PNOST area), but only affected by the reservoir.

The planned work does not interfere with the polygons where the three critically endangered bird species occur. However, the reservoir will flood areas included in the three occurrence polygons concerned (*Bostrychia bocagei*, *Crithagra concolor* and *Lanius newtoni*).

8.7.2 Lembá 2, Lembá 3 and Lembá 4 HPPs

These three schemes have their planned works completely located in the PNOST Type I Total Protection Area.

With regard to Land Use, the projects cover exclusively areas of Native Forest.

The three projects also interfere with the perimeters of the three critically endangered bird species considered.

8.8 XUFEXUFE RIVER

8.8.1 Xufexufe 1 HPP

The works planned for this project, as well as the reservoir, are located entirely within the Type I Partial Protection Areas of PNOST.

Although the planned work will be located in areas of Secondary Forest, the majority of the reservoir will submerge areas of Native Forest.

The infrastructures are located within the *Lanius newtoni* occurrence area and the reservoir will also interfere with the areas of *Bostrychia bocagei* and *Crithagra concolor.*

8.8.2 Xufexufe 2 HPP

The planned works for this development are mainly located in the Type I Partial Protection zone of PNOST and the area of the Type I Total Protection zone is also interfered.

Regarding Land Use, the scheme comprises exclusively areas of Native Forest.

The scheem also interferes with the perimeters of the three critically endangered bird species considered.

8.9 QUIJA RIVER

8.9.1 Quija 1 and Quija 2 HPPs

These hydropower schemes are located entirely within the PNOST, in a Type I Partial Protection zone.

As for Land Use, the schemes essentially interfere with Secondary Forest areas, although there is also some affectation of Native Forest.

The works planned for these three projects are located within the polygons of occurrence of the three critically endangered bird species considered.

9 ASSESSMENT OF KEY IMPACTS

9.1 IDENTIFICATION OF THE MAIN ACTIONS GENERATING IMPACTS

It is important to bear in mind that the environmental assessment of each HPP now under consideration is not concluded in this SEA. In fact, in order to be duly licensed (from an environmental perspective), each hydropower scheme will necessarily be subject to an Environmental and Social Impact Assessment (ESIA) procedure, based on an Environmental and Social Impact Study (ESIS) to be developed specifically for each solution that is intended to be implemented.

At that time, not only will a detailed baseline characterisation of all relevant environmental and social factors be carried out, but, naturally, the impacts generated by the project on these factors will be assessed in detail.

In order to be able to assess the impacts generated by a given project, the first task that must be ensured is to define the project actions that will be assessed (both in the construction and operation phases) in each of the environmental and social factors considered.

Thus, the estimation of environmental impacts resulting from the implementation of the project should have as assumptions:

- the intrinsic characteristics of the project and the phase of the Detailed Design in which it will be assessed, as well as the possible aggressive actions to the environment resulting from its construction and operation;
- the characterisation of the baseline situation and the projection of that baseline situation.

At this stage the main impacts resulting from the implementation of the project's components on the biophysical and socio-economic factors under analysis should be identified and characterised.

During the construction phase, and in generic terms, the main activities considered as potentially generating impacts will be the following (notwithstanding others that may be considered relevant to define, depending on the specific characteristics of the scheme and/or its deployment area):

- Installation and activity of construction sites;
- Clearance and deforestation of scheme deployment areas;
- Earthmoving;
- Execution of the structures of the scheme;
- Construction of new access roads;

– Complementary projects:
  - Upgrading / construction of road network;
  - Execution of the electricity transmission network.

For the operation phase, the following actions (at least) are identified as potentially generating impacts:

– Presence, operation and maintenance of the hydropower scheme;

– Presence, use and maintenance of access roads;

– Changes in the flow regime of the river;

– Presence and maintenance of complementary projects:
  - road network;
  - electricity transmission grid.

9.2 ASPECTS TO CONSIDER IN THE MAIN ACTIONS GENERATING IMPACTS

Once the main actions generating impacts have been listed, a description of the aspects to be considered in each one of them is presented below. At this stage of the SEA, and since it is not technically the time to assess in detail the impacts generated by each scheme, it is important to list those that are expected to be considered the main negative effects to be generated.

CONSTRUCTION PHASE

Action: Installation and activity of construction sites

The construction sites consist of social and administrative facilities (containers / offices for the technical staff, sanitary facilities and dormitories for workers, if applicable) and infrastructures to support the building work (warehouses for tooling, parks for machinery and materials, area for equipment maintenance operations, parks for hazardous and non-hazardous waste conditioning).

As the wastewater produced in the sanitary facilities of the construction site is exclusively domestic in origin, and given the expected number of workers, the sanitary facilities will initially be removable and will have to be connected to latrines (which could/should in the future serve the facilities supporting the operation of the plant).

The construction sites should be installed in flattened locations, and the first activity to be carried out is the clearing of the area to be affected by this infrastructure, whenever justified.

The actions associated with the assembly of construction sites may involve some earthmoving and the creation of platforms for machinery and vehicle access or the laying of structures and machinery parking. Associated with the operation of construction sites, the flow of machinery and vehicles may restrict local traffic and contribute to some dust being released into the atmosphere, disturbing nearby dwellings, as well as the fauna and flora in the vicinity. The construction sites should also be properly signposted and delimited by fences.

There may also be the need to install, in addition to the main construction site, small mobile units to support the work fronts for the execution of sections of linear infrastructures that are located further away from the construction site. It should be noted, however, that these areas will serve only for temporary storage of material and/or equipment and will be deactivated/dismantled once these sections of infrastructure are completed. This action will be temporary and will affect a relatively small area.

Action: Clearance and deforestation of scheme deployment areas

These actions will be carried out using heavy machinery and will involve earthmoving, causing some local release of dust. The deforestation actions will also give origin to vegetable waste of different types (woody material, foliage, etc.). These residues should be separated by type, and preference should be given to the recovery of these materials.

In the case of ducts and power lines, clearing and deforestation will only affect linear strips of land. Deforested land will be temporarily stored in mounds along the duct course.

This action could disturb nearby houses/towns, as well as nearby fauna and flora. Water and soil contamination may also occur in the event of oil or fuel spills. Finally, this action could uncover or even interfere with heritage features present in the soil/subsoil.

In situations where the HPPs will give rise to reservoirs of some significance - Iô Grande 1, Lembá 1 and Xufexufe 1 - the option may be taken to also clear and deforest the areas to be flooded. If this option is taken, then the action will generate the same typology of impacts described above, but of much greater magnitude and significance, also presenting a character of permanence, with very significant effects on **ecology** and on **socio-economics**, in cases where these actions involve physical or economic resettlement. This is considered one of the main negative impacts generated by the projects under analysis.

Action: Earthmoving

Earthmoving includes blasting and earthmoving operations, movement of machinery and vehicles and transport of earth and other materials. This action also includes transportation and deposit of the resulting materials in appropriate places.

The deposit areas may be temporary or permanent. The temporary deposits may be areas for storing excavated earth and materials from the clearance and deforestation of the trenches, in mounds, favouring, whenever possible, the separation between the vegetal earth and the substratum, until they are reused for covering the ducts and backfilling the trenches. When the use of these areas comes to an end, they will be recovered to their original conditions.

On the other hand, the areas to be constituted as a definitive deposit of excavation materials will consider the quantity of inert materials left over from the construction work and the proximity to the area of intervention, favouring locations with a reduced slope and with close access that require landscape rehabilitation. Thus, the surplus materials from the excavation activities will be deposited in layers, according to the natural profile of the land. The last layer to be deposited will be initially stripped vegetal earth.

The use of permanent deposits implies the transport of earth (not reused in construction or landscape recovery) to an appropriate final destination. This action is associated with the circulation of vehicles and heavy machinery which, along with the movement of earth, will cause some local release of dust and atmospheric pollutants. This action may also disturb nearby houses / villages, as well as the fauna and flora in the vicinity.

The location of this type of deposit will be known during the construction phase, on the proposal of the company carrying out the work.

Action: Execution of the structures of the scheme

This constructive action will occur in a circumscribed manner in space and will involve a significant but localised movement of earth.

The execution of the works will be carried out using heavy machinery. The movement of machinery and vehicles associated with this activity will result in the release of air pollutants, especially particulate matter. This action may disturb nearby residences/populations, as well as the fauna and flora in the vicinity.

Civil construction actions, such as concreting and reinforcement works, are associated to the generation of waste such as iron, wood, plastic, concrete, etc. These wastes should be separated by type and temporarily stored in the work support yard for subsequent forwarding to the adequate services.

Regarding the evaluation of the impacts generated by this action, a differentiation will be made between the components of the hydropower operation, namely:

a) Weir / Dam

The weir or dam is a transverse infrastructure to the river and, therefore, with direct implications on it. During its construction a temporary diversion of the watercourse will be carried out.

b) Diversion circuit

The diversion circuit will connect the weir to the forebay. During the construction of this infrastructure, the most important work is the assembly of the piping (in cases where pipelines are installed) or the construction of canals (in cases where the circuit is in a canal).

The excavations for digging the trench will be carried out mechanically.

c) Forebay

The forebay will be located on the surface, on a flat area and without interfering with the water line.

d) Penstock

The penstock completes the hydraulic circuit to the hydropower plant. As in the case of the diversion circuit, during the construction of the penstock, the piping assembly work takes on greater importance, since the civil construction work is limited to the construction of the support and mooring blocks.

e) Hydropower plant

The power station is a building that will be located on the riverbank (or next to dams, in situations with dams). The return of turbined flows will be carried out immediately downstream of the power station.

Action: Construction of new access roads and upgrading of existing roads

Construction activities for new accesses and the improvement of existing accesses may include land clearing and/or deforestation, excavation and earthworks, platform widening, pavement reinforcement, construction of ditches and/or construction of hydraulic crossings.

This action will imply some earthworks causing, at local level, the release of dust. Similarly, the movement of machinery and vehicles associated with this activity will cause the release of atmospheric pollutants, especially particulate matter. This action may disturb nearby residences/populations, as well as the fauna and flora existing in the vicinity.

If the accesses cross any ditches or water courses, the continuity of the drainage must be guaranteed.

Action: Implementation of the electricity transmission network

The execution of the electricity line involves, in previously cleared areas, the installation/construction of supports - including a civil construction component - as well as the installation of the lines themselves, using appropriate machinery and techniques.

OPERATION PHASE

Action: Presence, operation and maintenance of the hydropower scheme

The presence and operation of these hydraulic structures will not cause negative effects on environmental factors, apart from the possible barrier effect that the new infrastructure may represent for some species. In most of the situations under study, the very small size of the reservoirs generated by the weirs and their short residence time will make the impacts often associated with reservoirs in tropical climates practically non-existent (Winton *et al*., 2019). In situations where larger reservoirs will be generated, the impacts on **Water Resources** (including water quality) and **Ecology** will be very significant.

The changes promoted in the flow regime by the presence and operation of waterworks will be analysed in the action of changes in the flow regime of the river.

Maintenance actions, when necessary, will always be of an occasional and temporary nature, and their effects on environmental factors will be insignificant. Even so, it is important to mention that these actions will always imply the production of different types of waste.

Action: Presence, use and maintenance of accesses

The presence of the access roads will make access to previously remote areas possible. Thus, tree felling and illegal hunting/capture of species, for example, may occur more easily. This impact will be particularly negative in cases where these accesses allow reaching very sensitive areas of the Obô Natural Park of São Tomé and in areas of Native Forest.

Maintenance actions, when necessary, will always be of a one-off and temporary nature, and their effects on environmental factors will be insignificant.

Action: Changes in the flow regime of the river

It is foreseeable that the weir and the flows that will be derived for the hydraulic circuit may promote alterations in the natural flow regimes of the river, influencing the aquatic communities downstream. These changes will result from the alteration of the natural flow regime, including solid flow, in the stretch of the river between the intake and the return.

In the vicinity of the area where the turbined flows will be restored, sudden changes in flow, known as *hydropeaking,* may also influence aquatic communities.

In situations where the construction of dams is envisaged, these changes will naturally be more substantial and more serious than in configurations where only the construction of weirs is envisaged.

Also in the rivers where the "cascade" development of hydropower schemes is recommended, there will be a cumulative effect of the various dams with negative repercussions on the aquatic communities present.

Action: Presence and maintenance of the electricity transmission grid

The presence of the power line carries risks related to accidental contact (with special relevance for some bird and bat species with threatened status), as well as human exposure to electromagnetic fields.

Maintenance actions, when necessary, will always be of a one-off and temporary nature, and their effects on environmental factors will be insignificant.

9.3 OTHER ASPECTS TO CONSIDER

In addition to the analysis of the project actions identified above, the impact assessment process should include, among other topics:

- Watersheds and areas of importance for biodiversity conservation,
- Air quality, including dust from construction and impacts on health, vegetation and wildlife;
- Noise and vibration produced by equipment during construction and risks to humans and wildlife;
- Potential loss of productive soils and watercourses used for fishing and nutrient transport to floodplains;
- Inefficient waste management during construction and maintenance, leading to excess consumption of materials and emission of pollutants as well as soil and water pollution;
- Loss, fragmentation and degradation of habitats and disruption of fauna migration routes;
- Impacts of construction on habitats and species (e.g. due to changes in drainage, soil erosion, water, soil or air pollution, introduction of invasive species, noise and human disturbance);
- Changes to existing ecosystem services;
- Identification of vulnerable populations, in particular women and children;
- Direct employment of local people in the workforce and stimulation of the local economy through demand for goods and services that enhance livelihoods and economic activity in local communities, albeit with potentially adverse effects if community relations are not well managed;

- Poor construction management practices could lead to adverse effects on safety, human health and welfare;
- The interruption of hydrogeological and underground flows due to excavation and land clearing;
- Pollution of groundwater due to accidental discharges and dumping during the construction and operational phases;
- Accidental discharges of hazardous substances during the construction and operational phases.

Finally, the interactions between the different impacts will be considered, at the level of the various environmental and social standards, and the existence of cumulative or synergetic impacts with other projects, existing or planned.

9.4 EXPECTED RESIDUAL IMPACTS

Only a formal ESIA procedure, based on an ESIS specifically developed for a specific HPP will naturally allow for the assessment of the impacts generated by the project as a whole. At that stage, the measures to minimise negative impacts considered adequate will also be proposed - which must, naturally, be especially directed to the most significant negative impacts. Therefore, it will then become possible to re-evaluate the negative impacts in question, in view of the implementation of the proposed measures.

This type of analysis, case by case, should consider only significant and very significant impacts, which are those likely to compromise the environmental viability of a given project. In fact, only significant or very significant negative impacts may jeopardise relevant values analysed in the various descriptors dealt with in the ESIS.

Not being, consequently, possible at this stage of SEA, to perform the analysis characterized above, it is still possible to highlight the following negative impacts, significant or very significant, both for the construction phase and for the operation phase of the project, organized by action and factor, as being, generically (given the type of projects in question) those that, typically, are expected to give rise to residual impacts.

Construction phase

- Surface Water Resources
    - Clearance and deforestation of scheme deployment areas
    - Earthmoving
    - Execution of the structures of the scheme
- Geology, Geomorphology and Geotechnics

- Earthmoving

– Ecology

– Clearance and deforestation of scheme deployment areas

– Production and Management of Waste and Effluents
  - Installation and operation of shipyards
  - Execution of the hydroelectric exploitation infrastructures

Exploration phase

– Surface Water Resources
  - Changes in the flow regime of the river

– Ecology
  - Presence, operation and maintenance of the hydropower scheme
  - Presence, use and maintenance of accesses

By analysing the mitigation measures and monitoring programmes that may be proposed, and taking into account the usual effectiveness of these measures in comparable circumstances, it is possible to verify that the significance of most of these impacts decreases with the implementation of these measures, namely:

– The action of clearing and/or deforestation has a negative impact on various components of the biophysical environment, particularly on **ecology,** since this action may involve cutting down native forest trees of great conservation value, in practice constituting a loss of habitat. Thus, in order to minimise this disturbance, it is recommended that the construction works be ecologically followed, that workers be periodically informed and trained about the high ecological values, and that the works be programmed in such a way as to reduce the levels of disturbance to fauna species in the construction area and its vicinity. This impact may also be subject to compensation, through the improvement of more degraded forest areas, within the limits of PNOST, of a size at least equivalent to that which will be lost through deforestation. It is considered, even so, that there will be residual impacts of this action.

– during the construction phase, the impact caused by the construction of a hydropower scheme on **surface water resources** will be minimised by the temporary diversion of the watercourse, which is considered indispensable. Thus, and along with the environmental awareness of the workers specifically regarding the care and procedures to be taken in this sensitive area, possible actions that could result in the pollution of this river will be greatly reduced. Likewise, with the implementation of the Ecological Flows Regime that is considered essential to be foreseen for this river, most of the impacts of the operation phase on this factor will see their significance reduced.

- Regarding earthmoving, with significant impacts on **surface water resources** and on **geology, geomorphology and geotechnics,** the high volume of excavation associated with this type of project stands out, with relevant consequences regarding potential instability phenomena related to the temporary and definitive excavation slopes. It should be emphasized, however, that during the planning phase, priority should be given to minimizing the heights and volumes of excavation, as well as to the appropriate and careful choice of locations for infrastructure deployment. Following the precautionary principle, it is considered that this action, due to its magnitude, will always cause some residual impacts on **geomorphology and geotechnics**, despite the application of certain minimization measures and the finite nature of the construction in time and space.
- The impacts caused by construction activities that are most likely to generate **waste and effluents** should be duly minimised through environmental training and awareness-raising activities for on-site workers, and through the implementation of an Environmental and Social Management Plan specifically developed for each development in the ESIA stage.
- The main negative impact in the operational phase occurs in terms of **ecology** and arises from the presence and use of access roads and, where applicable, reservoirs. The reservoirs translate, in practice, into the prolongation of habitat loss generated by deforestation, benefiting, therefore, from compensation actions that may be developed at this level. As for accesses, and especially in the case of structures located in more remote areas, they may facilitate access to previously untouched areas, contributing to uncontrolled exploitation (wood extraction and hunting) of areas of high conservation value. In order to minimize these potential effects, accesses should be fenced off and monitored where they enter the Natural Park area, so as to guarantee that they are only used by authorized personnel. It should also be noted that the implementation of a monitoring programme proposed for ecology will allow the evaluation of the evolution of the baseline situation and guarantee the effectiveness of the implementation of the minimisation measures. Depending on the results obtained, it may be necessary to adjust some of the proposed measures or implement complementary measures. It is considered, even so, that there will be residual impacts of this action.

Thus, it is believed that there will remain a set of significant negative impacts that are not likely to be minimised. These are, therefore, the residual impacts of these projects.

These expected residual impacts will then be:

- the impact of land clearing and/or deforestation on the **ecology** of infrastructure sites;
- the impact of earth movement on **geology, geomorphology and geotechnics**;
- the impact of the presence of reservoirs (where they exist) and the presence, use and maintenance of accesses on the **ecology** during the operational phase.

9.5 CUMULATIVE RISKS

In a SEA the analysis and evaluation of cumulative effects derives from the crossing of different planning (and policy and programming) strategies in a given territorial area and/or sector, which is part of the natural scope of evaluation in a SEA, namely by considering the strategic reference framework. It could therefore be considered that in SEA all assessments are cumulative and that therefore the consideration of cumulative effects in SEA does not need to be explicitly presented.

On the other hand, regardless of the impacts generated by each of the solutions that may be chosen, the adoption of a national strategy to reconvert the country's energy system will always entail a set of risks that will assume greater proportion as they are considered as a whole: i.e., cumulatively.

If the typology of human settlement on the island of São Tomé is considered, as well as the configuration of the watersheds and the locations studied for the installation of the hydropower schemes, the possibility of **resettlement** can be considered low, and even remote if physical resettlement is considered (in other words, some hydropower schemes may give rise to some type of economic resettlement).

As for the effects on **biodiversity,** and once again taking into consideration the specific context of the island and its particular biological wealth, namely the threatened endemisms that occur there, it can be considered that, since HPPs are typically installed in more remote and therefore naturalised regions, the cumulative risks of installing several HPPs are real.

Thus, the present SEA seeks, with the assessment strategy followed, to safeguard, in the recommendations emanating from this process, that the pursuit of energy objectives - justifiable and necessary - does not compromise the maintenance of irreplaceable environmental values, i.e. that it takes place in a sustainable manner.

10 DETERMINATION OF THE OVERALL SENSITIVITY

The results here presented must necessarily be understood and contextualized in a temporal moment - which is the present. In this sense, they are based on a set of values that portray the realities that currently exist - be it environmental values, human occupation of the territory or other infrastructures in presence - and that are, consequently, valid only as long as these same assumptions remain.

The intention is therefore to strengthen this framework, which defines the assessments made and, consequently, the recommendations produced, in the sense that no perennial and immutable guidelines, whose relevance could remain unchanged, should be drawn from this assessment.

This chapter intends to prioritize the hydropower schemes based on their feasibility from an environmental and sustainable point of view, and to identify opportunities and risks to the environment of the strategic options considered in the definition of the schemes.

In order to achieve the proposed objectives, a set of criteria associated with the Critical Decision Factors was applied and energy criteria were also considered. The application of these criteria to the schemes was, therefore, based on the environmental value of hydroelectric energy production, consequently seeking a solution that could correspond to an acceptable compromise between the exploitation of the hydroelectric potential and the conservation of the island's ecological values.

The assessment criteria, sequentially applied, were the following:

Ecological criteria	1. Avoid the construction of infrastructures within the boundaries of the natural park; 2. Avoid affecting areas of primary forest; 3. Avoid affecting areas contained in the polygons of occurrence of the 3 species critically endangered.
Energy criteria	4. Power; 5. Energy produced in average year; 6. Storage capacity (when applicable).

For each of the ecological criteria a score system was created based on a weighting of the different CDF. Thus:

– **Spatial Planning (Natural Park Zoning)**

- Interference with Type I Total Protection Zone: **5 points**;
- Interference with Type II Total Protection Zone: **4 points**;
- Interference with Type I Partial Protection Zone: **3 points**;
- Interference with Type II Partial Protection Zone: **2 points**;

- Interference with the Buffer Zone: **1 point**;
- No interface with the PNOST: **0 points**.

– **Land Uses**

- Interference with Primary Forest: **3 points**;
- Interference with Secondary Forest: **2 points**;
- Interference with Shadow Plantation: **1 point**;
- Does not interfere with any of the above categories: **0 points**.

– **Critically Endangered Species**

- Interference with the 3 polygons of occurrence of CR species: **3 points**;
- Interference with the 2 polygons of occurrence of CR species: **2 points**;
- Interference with 1 polygon of occurrence of CR species: **1 point**;
- Does not interfere with any polygon of occurrence of CR species: **0 points**.

It should be noted that in cases of Schemes with infrastructure interfering with different classes of the same criterion (e.g. Scheme with infrastructure in primary and secondary forest areas) it was decided to respect the precautionary principle and, thus, award the most severe score.

Also, the weighting of the scheme in relation to the selected criteria concerns the **proposed infrastructures**, not neglecting, however, a more careful analysis in the cases where the scheme generates reservoirs.

The application of the criteria was organized in an evaluation matrix and resulted in a weighting of the hydropower schemes, grouped in 4 increasing levels of conditioning:

5. **LIGHTLY CONDITIONED**: this category includes the schemes which add up to a total score ranging from **0 to 3 points**. The development of each of these projects does not exempt the completion of the respective formal Environmental Impact Assessment (EIA) procedure;
6. **CONDITIONED**: this category includes the schemes which add up to a total score ranging from **4 to 6 points**;
7. **VERY CONDITIONED**: this category includes the schemes which add up to a total score of **7 or 8 points**;
8. **ADVISED AGAINST**: this category includes the schemes for which, by adding up a score of **9 or greater**, it is not recommended to pursue.

In view of the above, the 33 potential hydropower schemes under consideration were analyzed. **Table 10.1** presents the results.

Table 10.1 – Evaluation Matrix.

Caption:

Light green	Poorly conditioned
Light yellow	Conditioning
Light orange	Very conditioned
Dark red	Unadvised

Basin	Scheme	Ecological Criteria				Energy Criteria			Weighting
		Spatial planning: Natural Park zoning	Land use	CR species	Total	Power (MW)	Energy produced in average year (GWh)	Storage capacity (days)	
Iô Grande	Iô Grande 1	1	2	1	**4**	6,9	26,5	13,2	Conditioning (yellow)
Iô Grande	Iô Grande 2	5	3	3	**11***	5,9	23,2	__	Unadvised (red)
Iô Grande	Iô Grande 3	5	3	3	**11**	2,8	10,6	__	Unadvised (red)
Iô Grande	Iô Grande 4	5	3	3	**11**	1,8	6,9	__	Unadvised (red)
Iô Grande	Iô Grande 5	5	3	3	**11**	2,7	10,3	__	Unadvised (red)
Iô Grande	Iô Grande 6	5	3	2	**10**	1,0	3,9	__	Unadvised (red)
Abade	Abade 1	0	1	0	**1**	2,4	9,1	__	Poorly conditioned (green)
Abade	Abade 2	1	2	0	**3**	2,4	9,4	__	Poorly conditioned (green)
Abade	Bombaim / Abade 3	1	2	0	**3**	1,8	7,7	__	Poorly conditioned (green)
Abade	Abade 4	1	2	0	**3**	1,2	4,6	__	Poorly conditioned (green)

* Check the weighting justification below.

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Basin	Scheme	Ecological Criteria				Energy Criteria			Weighting
		Spatial Planning Natural Park zoning	Land use	CR species	Total	Power (MW)	Energy produced in avergae year (GWh)	Storage capacity (days)	
Manuel Jorge	Gueguê	0	1	0	**1**	0,32	1,0	__	
	Manuel Jorge 1	0	1	0	**1**	0,4	1,8	__	
	Manuel Jorge 2	0	1	0	**1**	0,8	3,5	__	
	Manuel Jorge 3	1	1	0	**2**	0,5	2,2	__	
	Manuel Jorge 4	1	1	0	**2**	0,9	3,8	__	
Ouro	Ouro 1	0	1	0	**1**	0,2	0,9	__	
	Ouro 2	0	1	0	**1**	0,5	2,0	__	
	Ouro 3	0	1	0	**1**	0,8	3,2	__	
	Agostinho Neto	0	1	0	**1**	0,4	N/A	__	
	Ouro 4	0	2	0	**2**	0,9	3,4	__	
	Ouro 5	0	2	0	**2**	1,1	4,4	__	
	Ouro 6	1	3	0	**4**	1,3	5,0	__	

Basin	Scheme	Ecological Criteria				Energy Criteria			Weighting
		Spatial Planning / Natural Park zoning	Land use	CR species	Total	Power (MW)	Energy produced in average year (GWh)	Storage capacity (days)	
Cantador	Cantador 1	1	2	0	**3**	1,1	4,3	__	
	Cantador 2	3	3	1	**7**	2,0	7,6	__	
	Cantador 3	5	3	1	**9**	1,3	5,0	__	
Lembá	Lembá 1	0	2	0	**2****	5,5	21,2	49,1	
	Lembá 2	5	3	3	**11**	2,8	10,9	__	
	Lembá 3	5	3	3	**11**	0,8	3,2	__	
	Lembá 4	5	3	3	**11**	0,8	3,2	__	
Xufexufe	Xufexufe 1	3	3	3	**9**	3,0	11,6	95,0	
	Xufexufe 2	3	3	3	**9**	1,2	4,8	__	
Quija	Quija 1	3	2	3	**8**	4,4	17,1	__	
	Quija 2	3	3	3	**9**	0,6	2,3	__	

** Check the weighting justification below.

Below is a summary table with the Schemes grouped by level of conditioning.

Table 10.2 – Summary table of the Schemes by level of conditioning.

Level of conditioning		Hydropower Schemes	
		Quant.	Name
	Lightly conditioned	17	Ouro 1 a Ouro 5 (incluindo Agostinho Neto); Abade 1 a Abade 4; Manuel Jorge 1 a Manuel Jorge 4 (incluindo Guegué); Cantador 1; Lembá 1
	Conditioned	2	Iô Grande 1; Ouro 6
	Very conditioned	2	Quija 1; Cantador 2
	Advised against	12	Iô Grande 2 a Iô Grande 6; Lembá 2 a Lembá 4; Xufexufe 1 e 2; Cantador 3; Quija 2

The evaluation is complemented by a project overview, presented in **Drawing 01** of this report.

Regarding the Iô Grande 1 Scheme, evaluated as *conditioned*, although there is no infrastructure construction foreseen for the Obô Natural Park area (and, consequently, there is no need to ensure accessibility in the Park area), the Scheme generates a reservoir[9] (**Table 10.3**) that will have partial development within the Obô Natural Park boundaries.

The table also includes the reservoirs of the Lembá 1 and Xufexufe 1 Schemes, to be analyzed in more detail further ahead.

Table 10.3 – Area of the Obô Natural Park (PNOST) affected by the Iô Grande, Lembá and Xufexufe reservoirs.

Reservoir	Total area of the reservoir (ha)	Area of reservoir within the PNOST (ha)	% of reservoir withing the PNOST	% of the PNOST flooded
Iô Grande 1	143	40	28	0,16
Lembá 1	162	12	7	0,05
Xufexufe 1	182	182	100	0,7

As one can see, the area flooded by the Iô Grande 1 reservoir will be approximately 143 ha, of which 40 ha will be inside the Park boundaries (corresponding to 28% of the reservoir area and submerging about 0,16% of the Natural Park area).

[9] The areas of the reservoir were obtained by digitizing them from the HIDRORUMO study (1996).

As for the Ouro 6 Scheme, which was evaluated as *conditioned*, although none of the infrastructures affect the Natural Park or interfere with the polygons of occurrence of the critically endangered species, it is foreseen the implantation of one of the dams in a primary forest area which, according to the selected evaluation criteria, results in a more severe weighting.

As for Lembá 1 Scheme, and notwithstanding the evaluation as *lightly conditioned* given none of the infrastructures being foreseen inside the Natural Park area or interfering with the polygons of occurrence of critically endangered species, the respective reservoir will flood approximately 162 ha, of which 12 ha will be inside the Park boundaries (corresponding to 7% of the reservoir area and submerging about 0.05% of the Obô Park area).

However, the importance of the storage capacity of these two Schemes (13,2 days in Iô Grande 1 and 49,1 days in Lembá 1) is emphasized, since it makes possible to store water that can ensure not only the production of energy in periods of absence of rainfall, but also the regulation of the island's electrical network, functioning as "batteries" for energy storage. This is a very relevant and decisive aspect in the country's energy autonomy regarding burning imported diesel and, as such, despite the environmental conflicts generated by these uses, it is understood that the energy criteria recommend its pursuit.

For these cases, and in order to minimize the potential impacts and reduce the affects to acceptable levels, an analysis of the re-dimensioning of the dam heights may be proposed so that the respective reservoirs can minimize the Natural Park flooded areas. Mitigation and/or compensation measures regarding the Obô Park affectation should also be proposed.

Regarding Xufexufe 1 Scheme, although it has an estimated storage capacity of 95 days, it was evaluate as *advised against* because, besides generating a reservoir that will flood approximately 182 ha (100% inside the park boundaries, submerging about 0.7% of it), it also foresees the construction of infrastructures within the Obô Natural Park limits, in a primary forest area and with interference with the occurrence polygons of the critically endangered species.

The Quija 1 and Cantador 2 Schemes were evaluated as *very conditioned*. As for the Quija 1 Scheme it is due to the interference of the planned infrastructures with the various criteria under analysis and as for the Cantador 2 Scheme it is due to the location of the weir and the initial section of the diversion channel in areas with ecological conditioning. Thus, the future construction of these two schemes may be feasible if adequate and proportional mitigating measures are ensured.

In the case of hydropower schemes that were evaluated as *advised against* it is recommended not to build them in the current context, with the exception of the Iô Grande 2 Scheme under the condition that the recommendations below are met.

The Iô Grande 2 Scheme was evaluated as *advised against* once the current configuration foresees the construction of two weirs with water intakes in different water bodies (one in the Ana Chaves river and the other in the Iô Grande river) and a great interference of the scheme with the various selected ecological criteria. However, the Iô Grande river corresponds, in the area of interference of the scheme, to the boundary of the Natural Park. Therefore, and in order to try to make this solution feasible, it is proposed to dispense with the water intake on the Ana Chaves river and, regarding the necessary infrastructures on the Iô Grande river – excepting the weir which is a transversal structure to the river – that are currently designed within the Natural Park (right bank of the river), it is proposed to move them to the left bank, outside the boundaries of the Park.

This option would imply the development of a different configuration of the scheme from the one considered so far, but it is understood that its development can be recommended under these conditions.

The strategic options identified above provide relevant opportunities for the energy sector on the island of São Tomé that consequently influence the country's economic and social dynamics. This environmental assessment process also represents an energy planning that incorporates environmental and sustainability aspects, aligned with the priorities of the Government of São Tomé and Príncipe, and conceives measures that make hydroelectric production compatible with land use planning and biodiversity conservation.

It should be noted, however, that the potential of these opportunities is directly dependent on an alignment between the authorities and other entities in the future formulation and implementation of policies, plans and programs.

Regarding the risks, and excepting all those (particularly environmental and social) that naturally arise from the development of projects of this nature, it is identified the under exploitation of the hydroelectric potential due to the lack of investment or, on the contrary, an unbridled investment that results in the installation of a productive capacity that, in some periods, may be higher than its absorption capacity which will pose new and demanding challenges in the management of both production with different origins and the grid itself.

The present evaluation does not dispense, in case of further development of each one of the schemes, with other formal procedures for environmental assessment.

Finally, and in order to emphasize what was said at the beginning of this chapter, it is important to point out that the Strategic Environmental Assessment process was developed in light of current circumstances and currently available data, recognizing the limitation of existing knowledge on some of the factors considered and the unpredictable evolution of certain external conditions to the project. Thus, it is admitted that the results here expressed are susceptible to change if the circumstances that justify them also change.

11 ALTERNATIVES

11.1 OPTIONS TO CONSIDER

Based on the Sensitivity Assessment (see **Chapter 10**) carried out, it is important to highlight a number of projects which, in the design analysed, present a set of interferences with the environmental values studied that strongly condition their environmental viability.

Some of these hydropower schemes, however, have values (social, economic, strategic) that recommend the consideration of alternative configurations that make it possible to reduce the level of environmental conditioning to sustainable values, while maintaining the other values that initially led to the definition of these HPPs as interesting.

It should be noted, however, that there are other situations in which, in the scope of this SEA, it was understood that the potential negative effects of these solutions on the environmental values under analysis were so high that, together with the location of these possible hydropower schemes, there would be no way, through the development - in this phase of basic design of the HPPs - of alternative solutions, to enhance their environmental sustainability.

In relation to this set of projects, it will always be possible, at a later time, to develop studies of broad scope and high detail that may find ways to enhance the environmental viability of these solutions, if they are considered determinant for the development of São Tomé and Príncipe. However, the scope of this SEA is to prioritize solutions considering their compatibility with environmental values, so it is considered that these possible future studies go beyond the scope of the present analysis.

Thus, the HPPs that are covered by the present consideration of alternatives are:

- Iô Grande 1
- Iô Grande 2
- Lembá 1

In the cases of HPP **Iô Grande 1** and **Lembá 1** (both of which are based on the construction of dams that will generate considerable reservoirs), and in order to minimise potential effects and reduce their impact to acceptable levels, the alternatives to be considered include re-dimensioning the heights of the dams so that the respective reservoirs to be created can minimise the flooded areas inside the PNOST.

As for the **Iô Grande 2** HPP, which appears as *advised against*, since, according to the current configuration that foresees the construction of two dams with water intakes in distinct water lines (one in the Ana Chaves River and another in the Iô Grande River), a great interference of the HPP with the various selected ecological criteria is caused. However, the Iô Grande River corresponds, in the HPP's interference area, to the PNOST limit. Therefore, and in order to try to make this solution viable, it is proposed that the alternative to be considered abandons the water intake located on the Ana Chaves river and, regarding the necessary infrastructures on the Iô Grande river that are currently planned to be developed within the PNOST area (right riverbank), with the exception of the weir, which will naturally be a transversal structure to the river, it is proposed to move them to the left bank, outside the limits of the Park.

This option will imply, in practice, the development of a different configuration of the HPP to the one considered so far, but it is understood that, under these conditions, its development may be recommended.

11.2 RESULTS IN COMPARISON OF ALTERNATIVES

Table 11.1presents a summary of the sensitivity assessment carried out for each of the three assessed hydropower schemes.

Table 11.1- Sensitivity analysis carried out for the Iô Grande 1, Iô Grande2 and Lembá 1 HPP (original configuration).

Use	Ecological Criteria				Weighting
	Spatial Planning – Zoning of the Park	Land use	CR Species	Total	
Iô Grande 1	1	2	1	**4**	
Iô Grande 2	5	3	3	**11**	
Lembá 1	0	2	0	**2**	

It should be noted that in relation to the Iô Grande 1 HPP (see **Item 8.2.1**), the reservoir planned for this solution partially covers the Park's Type I Partial Protection area, and it should also be noted that the planned infrastructures also interfere with the polygon of occurrence of *Bostrychia bocagei,* and the reservoir cumulatively overlaps with the occurrence of *Crithagra concolor*. These circumstances led to this HPP being rated *conditioned* (see **Chapter 10**)

On the other hand, and as already mentioned in **Item 8.7.1**and in **Chapter 10**, the Lembá 1 HPP, despite not having structures planned the construction of which significantly interfere with the CDFs considered, will generate a reservoir that, at the planned height, will interfere with a Total Protection Area Type I of the Park, Native Forest areas (in the PNOST area) and will also flood areas included in the three polygons in question (*Bostrychia bocagei*, *Crithagra concolor* and *Lanius newtoni*). As such, this HPP was given an *lightly conditioned* weighting, although it is recommended that consideration be given to an alternative with a reservoir at a lower level in order to reduce the above-mentioned interference.

Thus, and because the sensitivity assessment focused on the interference of the infrastructures to be built in each HPP, and not on the areas to be affected (namely by submersion in the reservoirs), the alternatives in question for the HPPs of Iô Grande 1 and Lembá 1, do not see their weighting altered, since the infrastructures, although smaller, will be located in the areas already defined. Even so, if it is assumed that the alternatives to be compared allow avoiding entirely the submergence of areas inside PNOST, surely the real impacts of the dams on the CDFs under study will be, in practice, much less significant. Cumulatively, and regarding the Iô Grande 2 HPP, assuming that the indications in **Item 11.1** are fully complied with, then the sensitivity assessment of these alternative configurations would be the one presented in **Table 11**.2.

Table 11.2- Sensitivity analysis carried out for the Iô Grande 1, Iô Grande2 and Lembá 1 hydropower schemes (alternative configuration).

Use	Ecological Criteria				Weighting
	Spatial Planning	Land use	CR Species	Total	
	Zoning of the Park				
Iô Grande 1	1	2	1	**4**	
Iô Grande 2	1	2	3	**6**	
Lembá 1	0	2	0	**2**	

Naturally, this scenario recommends the adoption of the above-mentioned alternative configurations, considering the three to be environmentally viable, naturally subject to confirmation of the conditions for environmental licensing through the carrying out of Environmental and Social Impact Studies for each HPP to be implemented.

12 SUMMARY OF STAKEHOLDER INVOLVEMENT

12.1 LIST OF RELEVANT ENTITIES FOR CONSULTATION

The following relevant entities are identified for consultation under the SEA process of the Hydroelectric Potential in São Tomé:

- Ministry of Public Works, Infrastructure, Natural Resources and Environment (MOPIRNA);
- General Directorate of Natural Resources and Energy (DGRNE);
- General Directorate of Environment (DGA);
- General Regulatory Authority (AGER);
- Water and Electricity Company (EMAE);
- National Institute of Meteorology (INM);
- Ôbo Natural Park of São Tomé (PNOST);
- Industry Direction;
- Association for the Promotion of Renewable Energies;
- Association of Renewable Energy Companies;
- Fiduciary Agency for Project Administration (AFAP);
- Multilateral Organizations;
- Companies potentially interested in building and/or operating Schemes;
- Local Authorities;
- NGOs:
  - Birdlife International;
  - ALISEI;
  - Projeto Tesouro d’Obo;
  - Fundação Príncipe;
  - Others.
- Citizens with an interest in the SEA process.

12.2 STAKEHOLDER ENGAGEMENT AND DISSEMINATION OF INFORMATION

As an instrument that facilitates strategic decision-making processes, SEA can and should function as a platform for discussion and stakeholder engagement, and be a means to foster collective thinking and communication, promoting deliberative and inclusive policy formulation and planning processes.

Through dynamic and active involvement, not only the incorporation of diverse values and perceptions about the use of São Tomé's hydroelectric potential is guaranteed, but it also reinforces the sense of responsibility, transparency and communication during the process. At the same time, engaging with the relevant agents throughout the process allows for a more effective consultation at the legally required moments.

The initial phase of the SEA process included the engagement with various entities (**Table 12.1**), in several face-to-face and virtual meetings that aimed to present the project, gather perspectives on it and discuss potential future implications.

Table 12.1 – Entities that attended the various work meetings.

Entities
General Regulatory Authority (AGER)
General Directorate of Environment (DGA)
General Directorate of Natural Resources and Energy (DGRNE)
Water and Electricity Company (EMAE)
National Institute of Meteorology (INM)
Ministry of Public Works, Infrastructure, Natural Resources and Environment (MOPIRNA)
NGOs (BirdLife International, ALISEI, Projeto Tesouro d'Obo e Fundação Príncipe)
Obô Natura Park of São Tomé (PNOST)
National Spatial Planning Plan Team (PNOT)

Notwithstanding the initial moments of involvement, it is intended that other interaction moments occur in subsequent steps, desirably engaging with all the stakeholders identified as relevant.

13 CATEGORISATION OF HPPS ACCORDING TO THE AFRICAN DEVELOPMENT BANK'S SAFEGUARDS SYSTEM

The African Development Bank's Integrated Safeguards System (ISS) recognises the challenge to development efforts brought about by climate variability and change, as development interventions interact with the physical and ecological environment. Thus, the ISS requires that Bank-funded projects be verified and categorised according to their vulnerability to environmental risks.

As shown in **Item 5.2**, the AfDB safeguards system consists of five operational safeguards (SO), among which **SO 1 - Environmental and Social Assessment** stands out. This overarching safeguard governs the process of determining the environmental and social category of a project and the resulting environmental and social assessment requirements.

The assessment shall be conducted in accordance with the principles of proportionality and adaptive management. The level of assessment and management required shall be proportionate to the level of risk posed by the project - identified during the screening and scoping process - and the management measures adopted shall be capable of being adapted to changing circumstances throughout the project's life cycle.

The verification and categorisation required for programme-based operations - particularly budget support or other loans for regional or sector programmes - may trigger the preparation of a Strategic Environmental and Social Assessment if there is a significant environmental and social risk. In this case, the borrower designs and implements an Environmental and Social Management Plan (ESMP) to manage the environmental and social risks of projects, in accordance with Bank safeguards.

The environmental and social assessment covers all relevant direct and indirect, cumulative and associated impacts of the project, identified during the scoping phase, including those specifically covered in SO 2-5, for which there are specific requirements:

- **SO 2** - Involuntary resettlement: land acquisition, population displacement and compensation
- **SO 3** - Biodiversity, renewable resources and ecosystem services
- **SO 4** - Pollution prevention and control, hazardous materials and resource efficiency
- **SO 5** - Labour conditions, health and safety

The categorisation follows the principle of using an appropriate type and level of environmental and social assessment for the operating model. To this end, a category is proposed, providing supporting documentation and sufficient baseline data to allow the Bank to review and validate the proposed category. Possible categories include:

– **Category 1**: *projects likely to cause significant environmental and social impacts*

Category 1 projects are likely to have significant and/or irreversible adverse environmental and/or social impacts, or significantly affect environmental or social components which the Bank or the borrowing country considers sensitive.

In some cases, projects are included in Category 1 because of their potential cumulative impacts or the potential impacts of associated facilities. Any project requiring a Full Resettlement Plan (FRAP) under the provisions of the Bank's policy on involuntary resettlement is also considered to be Category 1.

Category 1 projects require an Environmental and Social Impact Assessment (ESIA), leading to the preparation of an ESMP.

– **Category 2**: *projects likely to cause less adverse environmental and social impacts than Category 1 projects*

Category 2 projects are likely to cause site-specific environmental and/or social impacts that are less adverse than those of Category 1 projects. Likely impacts are few in number, site-specific, largely reversible, and readily minimised by implementing appropriate management and mitigation measures or by incorporating internationally recognised design criteria and standards.

A project that involves resettlement activities for which an Abbreviated Resettlement Plan (ARAP) is required is classified as Category 2. Most funded projects are included in this category unless the nature, scale or sensitivity of the project involves a high level of environmental and social risk or no such risk.

Category 2 projects require an appropriate level of environmental and social assessment tailored to the expected environmental and social risk, so that risks can be managed in accordance with Bank safeguards.

– **Category 3**: *projects with negligible adverse environmental and social risks*

Category 3 projects do not directly or indirectly adversely affect the environment and are not likely to induce adverse social impacts. They do not require an environmental and social assessment. Beyond categorisation, no action is required.

However, to properly design a Category 3 project, it may be necessary to conduct gender analysis, institutional analysis, or other studies on specific and critical social considerations to anticipate and manage unintended impacts on affected communities.

– **Category 4**: *projects involving loans to financial intermediaries*

Category 4 projects involve bank loans to financial intermediaries that lend or invest in sub-projects that may produce adverse environmental and social impacts. Financial intermediaries include banks, insurance, reinsurance and leasing companies, microfinance providers, *private equity* funds and investment funds that use Bank funds to lend or provide equity finance to their clients.

Table 13.1presents the categorization of the various HPPs considered in this study. Since category 4 will not be applicable to the project in question, it will not be included in the analysis.

Table 13.1 - Categorisation of HPPs according to African Development Bank Operational Safeguards.

River	HPP	Category		
		1	2	3
Iô Grande	Iô Grande 1	✓		
	Iô Grande 2	✓		
	Iô Grande 3	✓		
	Iô Grande 4	✓		
	Iô Grande 5	✓		
	Iô Grande 6	✓		
Abade	Abade 1		✓	
	Abade 2		✓	
	Abade 3 / Bombaim		✓	
	Abade 4		✓	
Manuel Jorge	Gueguê			✓
	Manuel Jorge 1		✓	
	Manuel Jorge 2		✓	
	Manuel Jorge 3		✓	
	Manuel Jorge 4		✓	
Ouro	Ouro 1		✓	
	Ouro 2		✓	
	Ouro 3		✓	

River	HPP	Category		
		1	2	3
	Agostinho Neto			✓
	Ouro 4		✓	
	Ouro 5		✓	
	Ouro 6	✓		
Cantador	Cantador 1		✓	
	Cantador 2	✓		
	Cantador 3	✓		
Lembá	Lembá 1		✓	
	Lembá 2	✓		
	Lembá 3	✓		
	Lembá 4	✓		
Xufexufe	Xufexufe 1	✓		
	Xufexufe 2	✓		
Quija	Quija 1	✓		
	Quija 2	✓		

14 RANKING OF HPPS

Based on the sensitivity assessment portrayed in **Chapter 10**, and the categorisation in **Chapter 13**, already informed by the contributions of some of the *stakeholders* identified in **Chapter 12**, and the resulting conclusions, as well as the alternatives referred to in **Chapter 11**, it is possible to systematise the hierarchy of the various HPPs considered in the scope of this SEA according to the degree of conditioning attributed by the analysis of the CDFs (**Chapter 6.1**). Thus, **Table 14.1**presents a summary with the HPPs grouped by level of conditioning factors.

Table 14.1- Summary table of the HPPs by level of constraints.

Level of constraints		Hydropower Schemes	
		Sum	Name
	Lightly conditioned	17	Ouro 1 to Ouro 5 (including Agostinho Neto); Abade 1 to Abade 4; Manuel Jorge 1 to Manuel Jorge 4 (including Guegué); Cantador 1; Lembá 1
	Conditioned	2	Iô Grande 1; Iô Grande 2; Ouro 6
	Very conditioned	2	Quija 1; Cantador 2
	Advised against	12	Iô Grande 3 a Iô Grande 6; Lembá 2 a Lembá 4; Xufexufe 1 and 2; Cantador 3; Quija 2

The assessment is complemented by the project overview drawing, present in **Drawing 01** of this report.

15 FINAL REMARKS

Considering the ranking of the assessed schemes (see **Chapter 13**), it is possible to materialise these inferences in eminently practical and achievable recommendations in subsequent moments of Santomean strategy for the promotion of renewable energies in the country.

Thus, and for the **HPPs included in the *lightly conditioned* class** [Ouro 1 to Ouro 5 (including Agostinho Neto); Abade 1 to Abade 4; Manuel Jorge 1 to Manuel Jorge 4 (including Guegué); Cantador 1; Lembá 1], Terms of Reference (ToR) must be organised for the preparation of the respective Environmental Impact Studies, which do not need to include special environmental concerns, beyond those normally required in the setting of a (legally mandatory) ESIA.

The ToR to be assembled shall define the stages and methodologies to be used in the preparation of the studies. It is already identifed the need for the work to be carried out to simultaneously respond to the provisions of national legislation of São Tomé and Príncipe (namely Decree-Law No. 37/99 of 30 November) and the *Integrated Safeguards System (ISS) of* the African Development Bank (more specifically the *Environmental and Social Assessment Procedures (ESAPs)* component).

It should be noted that this future Environmental Impact Assessment will be completely independent and autonomous from the work to which this document refers. Thus, the Environmental and Social Impact Assessment (ESIA) procedure to which each project will be subjected may conclude that it is environmentally viable or, on the contrary, consider it unfeasible, regardless of the categorisation assigned in this work.

This results from the eminently different nature of the two processes - Strategic Environmental Assessment and ESIA - in which the analyses carried out in each one are based on different principles and objectives and, therefore, do not allow extrapolating assessments or predicting the respective conclusions.

Regarding the **Iô Grande 1 HPP,** having been assigned a level of ***conditioned***, it is suggested that this HEP may be subject to a more preventive procedure than those previously characterized.

Therefore, it is recommended that, in the necessary development of the Final Design, the possibility of changing the configuration of the dam be considered, namely by optimising its height so that the respective reservoir to be created can minimise the area to be flooded in the PNOST, thus reducing - or at the very most avoiding - the submergence of territories inside the Park, which would also minimise the need for measures to minimise impacts and/or compensate them.

In addition to this recommendation, the ToR to be prepared for the ESIA should also provide for:

- The need to carry out a robust characterization of the flora, fauna and habitats of the area to be submerged by the reservoir, based on field surveys specifically carried out for this purpose;
- The need to assess the loss of longitudinal connectivity in the river resulting from the construction of the dam and, should the impacts be considered relevant, the design of measures to effectively mitigate them;
- The obligation to design a monitoring programme for ecological values - starting during the construction phase and continuing through the operation phase of the project - in which the following aspects will have to be defined:
    - Values to be monitored
    - Objectives
    - Monitoring sites and periodicity
    - Parameters to be monitored and sampling methodologies
    - Data processing methods
    - Reporting (content and frequency) and programme review
- The obligation to design measures to compensate for the loss of habitats in the PNOST due to the submergence of the reservoir area, which may include planting native forest, acquiring land for nature conservation and combating invasive exotic species, among others.

Regarding the **Iô Grande 2** hydropower scheme (***conditioned*** level), its implementation depends on the development of a new circuit configuration that allows the infrastructures – diversion circuit, forebay, penstock and power station building - to be implanted on the left bank of the river, i.e. outside the PNOST area.

This configuration - if economically viable - will imply a different conception from the one initially thought (although located in approximately the same area), since it no longer includes the use of the inflow from the Ana Chaves river, which naturally influences the power and energy produced.

In the event that it is decided to proceed with this alternative configuration, then it must be ensured that the ESIA of this HEP provides for:

- The need to carry out a robust characterization of the flora, fauna and habitats of the area affected by the weir, based on field surveys specifically carried out for this purpose;

- The obligation to design a monitoring programme for ecological values - starting during the construction phase and continuing through the operation phase of the project - in which the following aspects will have to be defined:
  - Values to be monitored
  - Objectives
  - Monitoring sites and periodicity
  - Parameters to be monitored and sampling methodologies
  - Data processing methods
  - Reporting (content and frequency) and programme review
- The obligation to design measures to compensate for the affectation of habitats in the PNOST by the weir construction, which may include planting native forest, acquiring land for nature conservation, combating invasive exotic species, among others.

Regarding the **Ouro 6 hydroelectric power station** (***conditioned*** level), should it be decided to proceed with its implementation, it is considered essential that the EIA to be carried out (in accordance, at least, with Decree-Law no. 37/99, of 30 November) provides for

- The need to carry out a robust characterization of the flora, fauna and habitats of the area affected by the weir, based on field surveys specifically carried out for this purpose;
- The obligation to design a monitoring programme for ecological values - starting during the construction phase and continuing through the operation phase of the project - in which the following aspects will have to be defined:
  - Values to be monitored
  - Objectives
  - Monitoring sites and periodicity
  - Parameters to be monitored and sampling methodologies
  - Data processing methods
  - Reporting (content and frequency) and programme review
- The obligation to design measures to compensate for the affectation of habitats in Native Forest areas (within the PNOST Buffer Zone) by building a weir, which may include planting native forest, acquiring land for nature conservation, combating invasive exotic species, among others.

For the hydropower schemes considered to be ***highly conditioned*** (Cantador 2 and Quija 1), it is recommended that consideration only be given to the possible effective implementation of these schemes after robust environmental and social studies have been carried out to provide a rigorous characterisation of the reality in presence and the respective impacts.

Naturally, for those projects considered ***advised against*** (Iô Grande 3 to Iô Grande 6; Lembá 2 to Lembá 4; Xufexufe 1 and 2; Cantador 3; Quija 2) it is recommended that the implementation of these projects be ruled out for the time being. The possible future consideration of any of these configurations should, it is advised, always be preceded by an in-depth environmental and social analysis that allows the available data and the assessments carried out to be updated.

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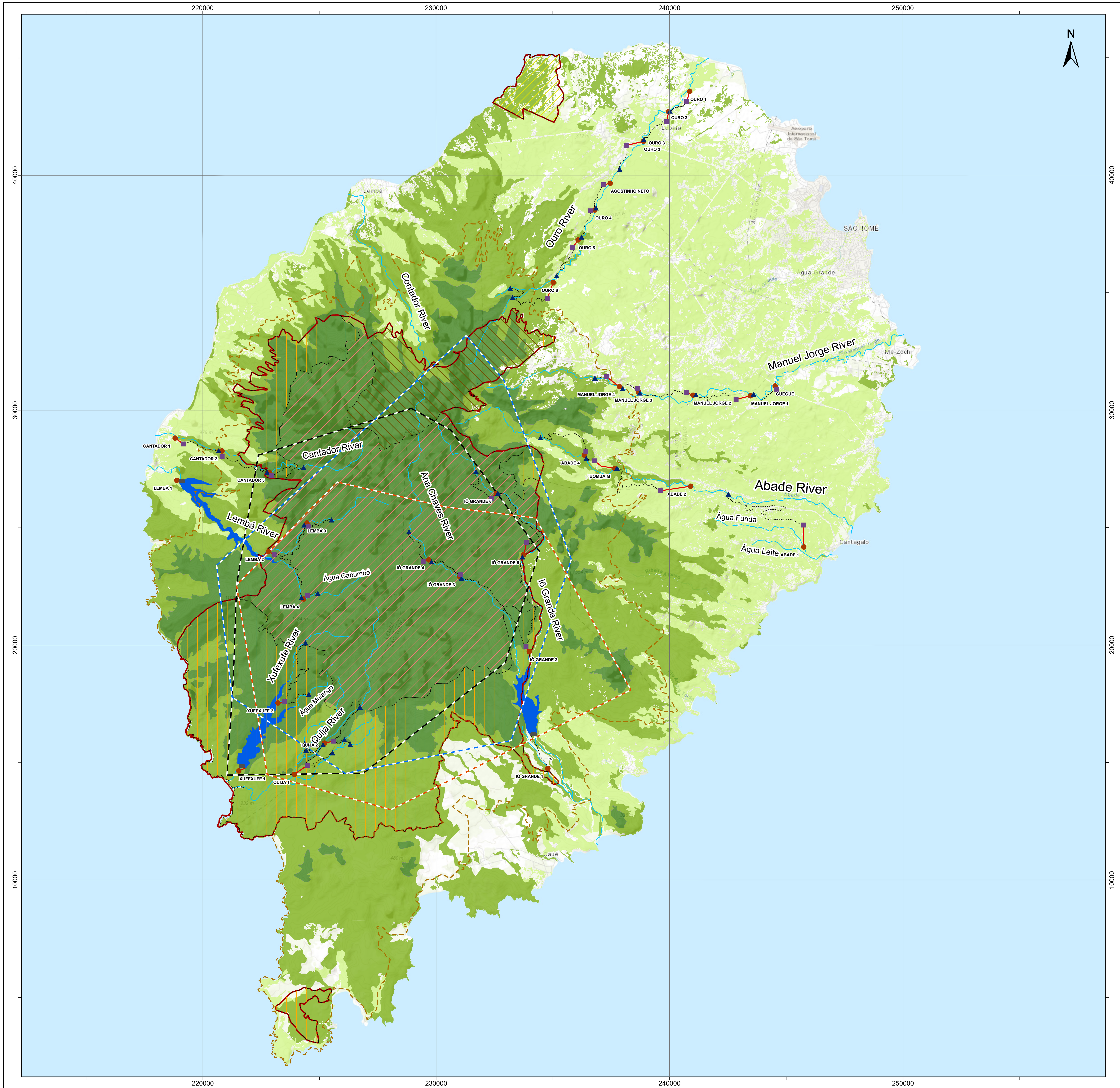
DRAWING 01 – PROJECT OVERVIEW



Legend

Obô Natural Park of São Tomé

- Park Boundary
- Buffer Zone

Zoning

- Partial Protection - Type I
- Partial Protection - Type II
- Total Protection - Type I
- Total Protection - Type II

Land Use

- Native Forest
- Secondary Forest
- Shade Plantation
- Waterbodies

Critically Endangered Bird Records

Species

- Bostrychia bocagei (São Tomé ibis)
- Crithagra concolor (São Tomé grosbeak)
- Lanius newtoni (Newton's fiscal)

Hydraulic Circuits

Components

- Powerhouse
- Weir
- Dam
- Forebay
- Diversion Channel
- Pipe
- Reservoirs

0 5 10 km

Data Origin:

Esri, © OpenStreetMap contributors, HERE, Garmin, USGS, METI/NASA, NGA

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