AARDVARK CERTIFICATION LTD

Mascarenhas Hydroelectric Power Plant

Climate Risk & Vulnerability Assessment

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Prepared for: Victory Hill Capital Partners LLP

Project Quality Control Sheet

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1 Introduction

This Climate Risk & Vulnerability Assessment (CRVA) report has been commissioned by Victory Hill Capital Partners LLP (Victory Hill) to assess the possible climate risks to which the Mascarenhas hydroelectric power plant might be exposed and its vulnerability to these risks. The report also identifies possible adaptation solutions to such risks where identified.

The CRVA has been conducted in accordance with the criteria of the EU Commission Delegated Regulation (EU) 2021/2139 which form the Technical Screening Criteria of the EU Taxonomy. In particular this report has been prepared to accord with the requirements of Appendix A of the above regulation, the Generic Criteria for Do No Significant Harm (DNSH) to Climate Change Adaptation.

2 Methodology

This CVRA has followed the process outlined in Appendix one of the Technical Screening Criteria of the EU Taxonomy. This sets out a three-step process as follows:

1. screening of the activity to identify which physical climate risks from the list may affect the performance of the economic activity during its expected lifetime;
2. where the activity is assessed to be at risk from one or more of the physical climate risks identified in step 1, a climate risk and vulnerability assessment to assess the materiality of the physical climate risks on the economic activity;
3. an assessment of adaptation solutions that can reduce the identified physical climate risk.

2.1 Climate risk screening

The asset considered under this assessment has an expected lifespan greater than 10 years and as such this assessment has been performed using highest available resolution projections across the different Representative Concentrations Pathways (RPC's) as used by the Intergovernmental Panel on Climate Change (IPCC) RCP2.6, RCP4.5, RCP6.0 and RCP8.5. The RCPs are a set of four trajectories which are used to model climate related impacts should the result of increased greenhouse gases in our atmosphere result in increased energy input at surface level measured in watts per square meter, ranging from 2.6 W m^{-2} (RCP2.6) to 8.5 W m^{-2} (RCP8.5) by the end of the 21st century, with RCP4.5 and RCP6.0 as intermediate scenarios. The RCP's were used as input projections to climate modelling which informed the IPCC's Fifth Assessment Report. The RCP's themselves are based upon potential changes in the major greenhouse gas concentrations as shown in the image below:

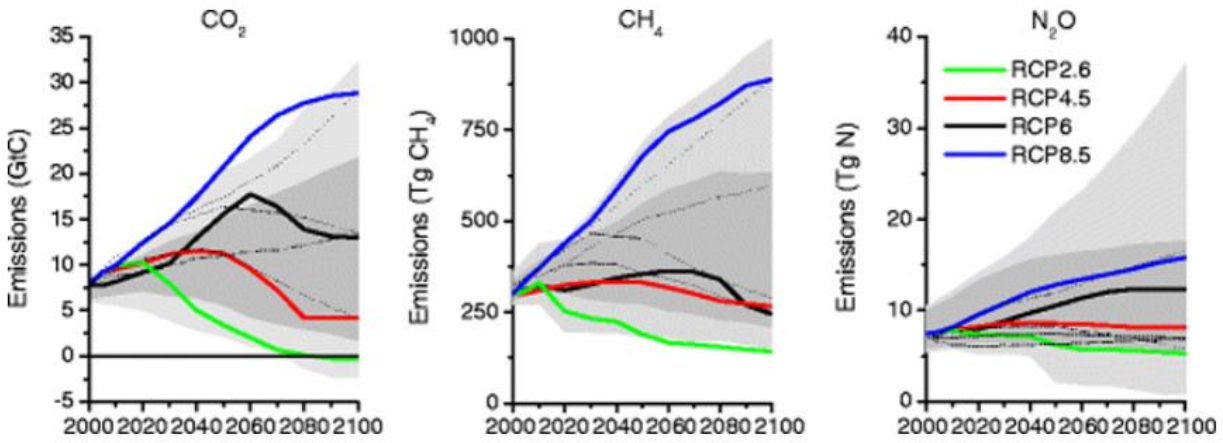

Figure 1: Representative concentration pathways (RCPs) for carbon dioxide (CO_2), methane (CH_4), and nitrous dioxide (N_2O).

RCP 8.5 is referred to as the "business as usual" scenario and was commonly used to interpret future climatic scenarios in the event of no mitigation policies and/or technologies being developed with increasing use of fossil fuels. This has latterly been described within the climate science community as being too pessimistic as we have seen countries develop a greater proportion of renewable energy in their energy mix and policy introduced to mitigate climate change. RCP 4.5 and RCP 6 are seen as the medium stabilisation scenarios where policy and technology is developed to stabilise greenhouse gas emissions and limit the worst effects of climate change. RCP2.6 is seen as a mitigation scenario where immediate action is taken to reduce levels of greenhouse gases from current levels.

Climate related impacts were modelled based on the RCPs at global and regional level with sections of the IPCC AR5 report dedicated to discussion of the predicted impacts to physical infrastructure. This analysis has been used to inform the expected changes to regional climate which the GSEO assets may be exposed to over their lifetime.

Within the EU Taxonomy Technical Screening Criteria, a set of climate-related hazards have been identified which each asset must be screened against. These hazards are shown below in table 1.It is worth noting that since IPCC AR5 RCPs have been replaced by shared socioeconomic pathways (SSPs) in the most recent IPCC report, AR6. SSPs include amalgamate RCPs with the addition of social, political, and economic factors that reduce or increase global ability to mitigate climate change. For this assessment the RCPs are sufficient because of the need to assess risk and vulnerability of assets under different warming scenarios which the RCPs still adequately represent.

Table 1: Climate-related hazards identified within the Technical Screening Criteria against which each asset is screened.

II. **Classification of climate-related hazards** (6)

	Temperature-related	Wind-related	Water-related	Solid mass-related
Chronic	Changing temperature (air, freshwater, marine water)	Changing wind patterns	Changing precipitation patterns and types (rain, hail, snow/ice)	Coastal erosion
	Heat stress		Precipitation or hydrological variability	Soil degradation
	Temperature variability		Ocean acidification	Soil erosion
	Permafrost thawing		Saline intrusion	Solifluction
			Sea level rise	
			Water stress	
Acute	Heat wave	Cyclone, hurricane, typhoon	Drought	Avalanche
	Cold wave/frost	Storm (including blizzards, dust and sandstorms)	Heavy precipitation (rain, hail, snow/ice)	Landslide
	Wildfire	Tornado	Flood (coastal, fluvial, pluvial, ground water)	Subsidence
			Glacial lake outburst	

2.2 Climate risk and vulnerability assessment

Where the asset has been found to be at risk from climate-related hazards, a vulnerability assessment has been carried out using inputs from the IPCC AR5 climate modelling of regional impacts on the locations where asset is situated. The vulnerability assessment considers the projected climate changes which will be experienced in this region which is based upon latest high resolution climate modelling. The impacts of these changes have been interpreted in order to understand the physical hazards the assets might experience over their lifetime.

Vulnerability of the asset to these projected climate related hazards is considered based on design standards the asset has been constructed to, site location and risk to climate related impacts as well as historic climate-related issues which may have been experienced in the region. All site-based data used in this assessment is derived from desk-based research and or reliance on 3rd party studies which may have been carried out during the planning/permitting process and due diligence process.

2.3 Adaptation Solutions

Adaptation solutions have been identified based on the outputs from the preceding two stages of the CRVA. Vulnerabilities identified which can be addressed through adaptation measures are outlined in order that the resilience of the asset is improved to withstand such vulnerabilities.

3 Mascarenhas hydroelectric power plant

3.1 Site description

The Mascarenhas hydroelectric power plant has an installed capacity of 198 MW and a physical guarantee of 134.8 MW. Commissioned in 1974 it has a lifespan of 100 years taking the operational phase of the project to 2073. The plant is owned by Energest S.A. which is headquartered in Sao Paulo. The site itself is surrounded by a mixture of habitat types and is semi-urban with surrounding brush and agricultural land. The area does support well vegetated areas.

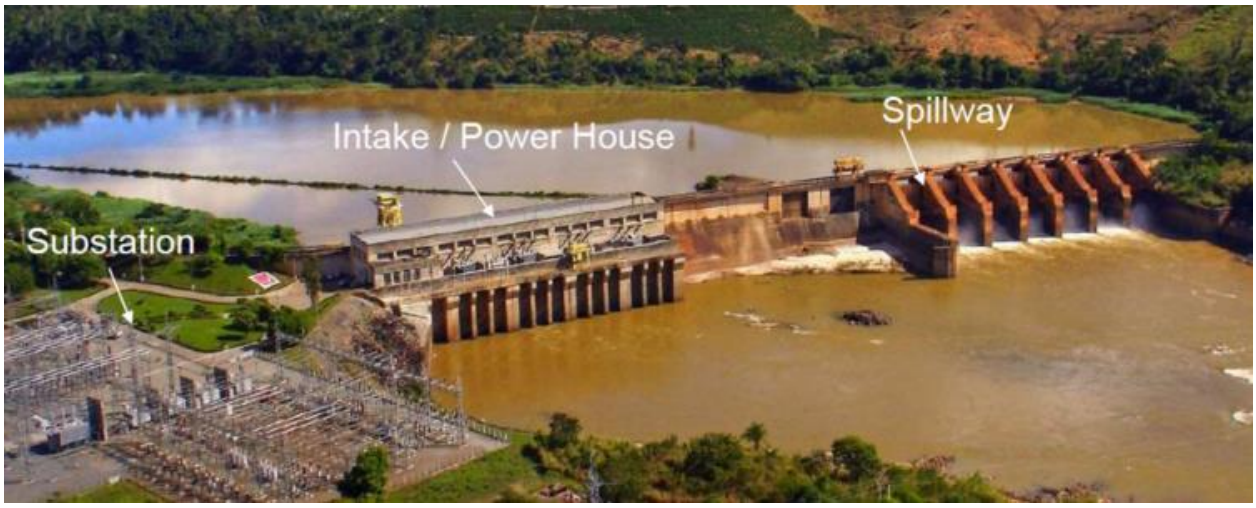

Figure 2: Mascarenhas hydroelectric power plant.

Figure 3: Arial view of Mascarenhas HPP

3.2 Site location

Mascarenhas HPP is located in Doce River, Baixo Guandu city, in the State of Espírito Santo and Aimorés city, in the State of Minas Gerais, Brazil.

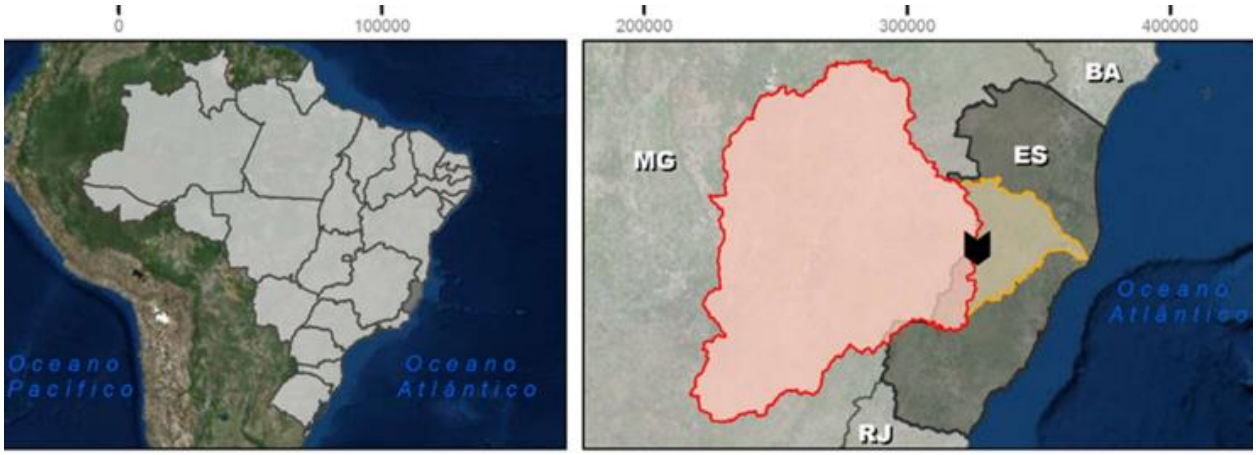

Figure 4: Location of the Mascarenhas HPP in the State of Espírito Santo.

Figure 5: Mascarenhas HPP proximity to Baixo Guandu.

3.3 Relevant IPCC AR5 climate change impacts

The AR5 report used the Coupled Model Intercomparison Project Phase 5 (CIMP5) model to project temperature and precipitation changes in South America between the RCP 2.6 and RCP 8.5 scenarios. Under RCP 2.6 the average temperature is projected to rise between 0.6ºC and 2.0ºC, and between 2.2ºC and 7ºC under RCP 8.5, in the region the Mascarenhas HPP is located. Precipitation is expected to increase under both RCP scenarios but the range of change is more uncertain under RCP 8.5. Models suggest that precipitation will increase through heavier rainfall events while the frequency of dry spells increases. This is likely to cause flooding following dry periods.

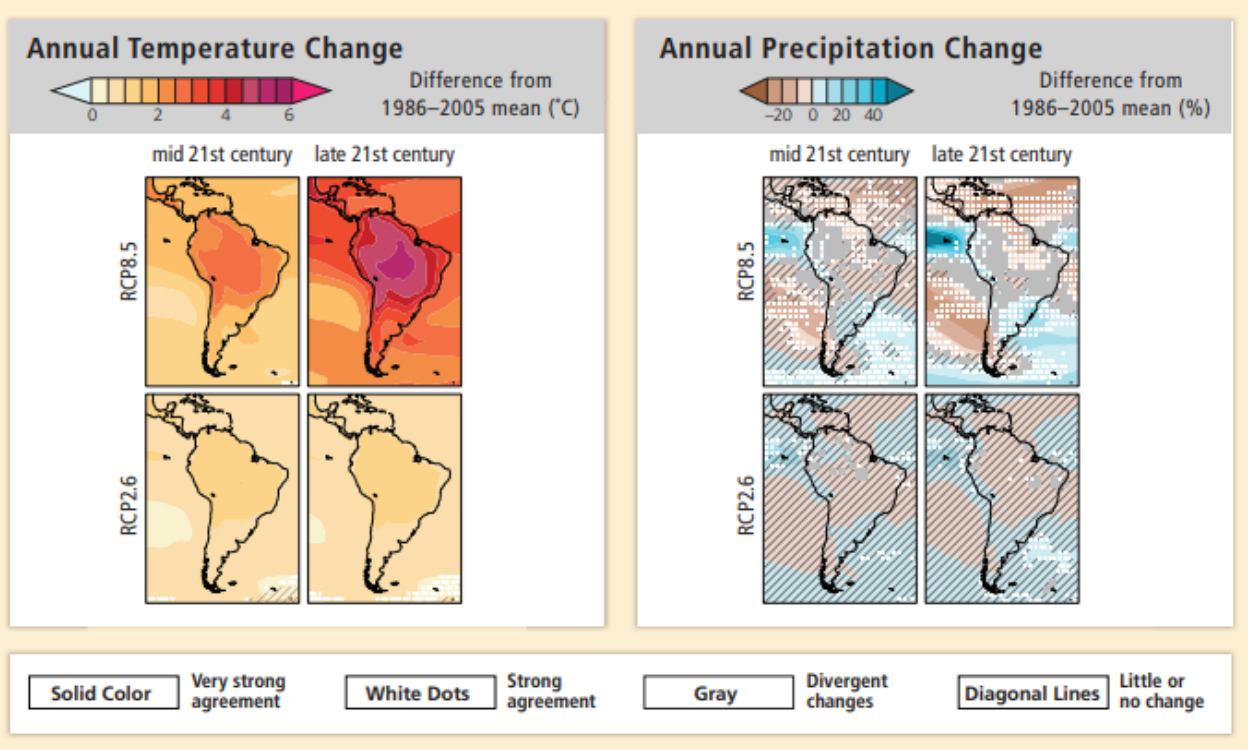

Figure 6 – RCP 2.6 and RCP 8.5 projections of changes in annual temperature change and annual precipitation – Source IPCC AR5.

3.4 Climate related hazards

The major climate related hazards affecting Mascarenhas HPP are river flooding and wildfire. With the change in rainfall patterns and intensity the risk of these hazards occurring will increase through the RCP scenarios.

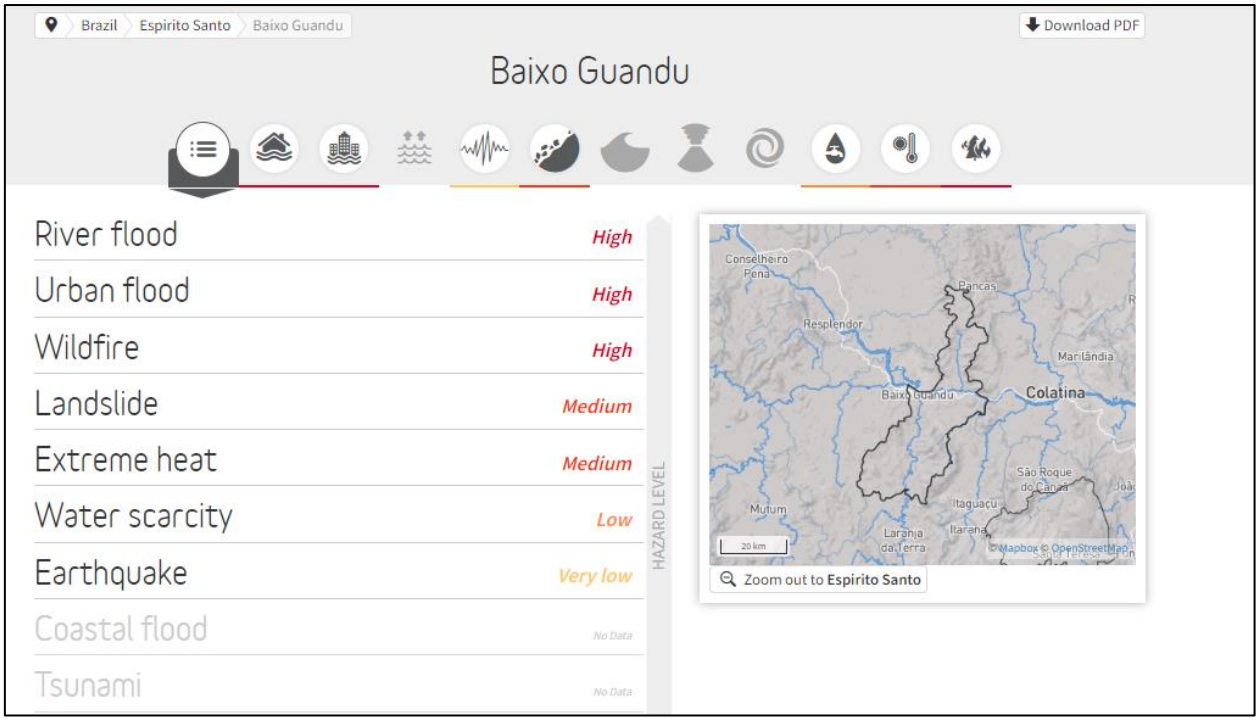

Figure 7: Climate related hazards as identified by thinkhazard.org.

The vulnerability assessment of the risk from river flooding and wildfire has been conducted as these are hazards identified as requiring an assessment under the Taxonomy, as shown in table 1. A vulnerability assessment will not be conducted for urban flooding as this is not relevant to this asset. The risk of landslide is considered medium for the region but this hazard has not been assessed because the topography surrounding Mascarenhas HPP does not indicate that this hazard might be experienced at the specific project location due to its relatively flat nature.

3.4.1 River Flooding.

A search for flood maps that reliably model flooding of the Doce river was conducted but nothing reliable was found using RCP scenarios at such a specific resolution. The technical report supplied by Victory Hill (ACL document GER1845-RE-0002-RO Technical report) and produced by Grupa Energia Consult in September 2022, indicates the maximum flow rate of the spillway is 14.500 m³/s. The report also indicates the most recent dam safety assessment documents anticipate a new flood value approximately 30% higher than the design value, however these documents are not available to ACL. The outputs of this report suggested that further assessment be carried out as the original design assumptions for the project will have been based on hydrological assessments carried out in the 1960's.

Victory Hill commissioned a further risk assessment to be carried out based on current hydrology of the site and the potential exposure to flood risk. The study found that the project was considered to be at low risk of river flooding but that the consequences of flodding would be significant. The study has put forward a suggested monitoring plan and further study plan which should be followed to ensure any necessary risk and potential adaptation measures are recognised prior to being required.

In light of this, at present, adhering to the latest assessment and monitoring plan is considered to be an adequate adaptation management strategy.

3.4.2 Wildfire.

ACL has assessed the risk to Mascarenhas HPP from wildfire to determine the extent and structure of the surrounding land and vegetation. This has included a review of Global Forest Watch to determine the occurrence of wildfire in the region. The land surrounding Mascarenhas HPP is mostly brush and agricultural land with some lightly developed areas nearby. The majority of vegetation and appears to have been cleared from imagery reviewed of the site however there is level of vegetation present which could support the spread of wildfire.

The technical due diligence report has put forward some direct and indirect actions to mitigate the risk of wildfires. The primary direct action is to have available on-site sufficient firefighting equipment to protect a particular 'preservation area' or permitter surrounding the site. This will be largely focussed around the land-based areas of the project and in particular the substation connecting the generator to the electricity grid. An indirect action suggested has been to promote wildfire awareness information to ensure that workers and local people are aware of the risks of wildfires, how to prevent them and how to manage the site in the event of a wildfire being detected.

Other measures could be adopted which will be to reduce the levels of vegetation around land-based aspects of the project and to introduce fire breaks in the surrounding areas of vegetation to restrict movement of wildfires and prevent them reaching the site.

The density of fire occurrences in the region does not appear to be high, especially in comparison to areas of Brazil and neighbouring countries where primary forest still exists and back burning is a method as a method to clear ground vegetation following logging for timber.

Figure 8: Fire density in the areas surrounding Mascarenhas HPP.

Based on the comparative lack of vegetation surrounding the facility and the low density of fires in the area, ACL does not believe Mascarenhas HPP to be at significant risk from wildfires and the adaptation measures outlined above should be followed to further reduce exposure of the project to the risk of wildfire.

3.5 Adaptation measures

Based on the information available, ACL has found that Mascarenhas HPP will need to follow recommended assessment and monitoring of hydrology impacts to the river to ensure the spillway design on the project is adequate to cope with increased rainfall as a result of climate change. This may lead to additional adaptation measures being considered in future however at present the risk of flooding to the asset is considered to be low.

ACL has not found information to suggest the facility needs to adapt to the risk of wildfire beyond the recommended direct and indirect actions identified within the technical due diligence report which are understood to already be in place.

4 Conclusion

The Mascarenhas hydroelectric power plant has been assessed for the sites vulnerability to climate related hazards identified in the EU Taxonomy's technical screening criteria. This assessment has considered the impact different RCP climate warming scenarios might have on individual hazards.

It was found Mascarenhas HPP is not at-risk physical risk from wildfire, despite the region being susceptible, because of surrounding vegetation types and measures in place to protect the site from wildfire.

The site was also assessed for its vulnerability to river flooding within a recently commissioned study and found to be at low risk. The recommend assessment and monitoring outlined in study should be followed to ensure the project remains suitably resilient to future climate related changes to rainfall given the long life span of the project.