PHYSICAL CLIMATE CHANGE RISK ASSESSMENT

M’BANZA CONGO AIRPORT

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Revisión	Fecha	Elaborado por:	Aprobado por:
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Content

1. INTRODUCTION

Climate change is a multifaceted and complex issue that can lead to serious environmental and socioeconomic consequences and even threaten the security of countries. The impacts of climate change have become one of the most important challenges for the life of future generations.

Within this framework stands the recent revision and release of the **Equator Principles (EPs, version IV)**[1] which is a risk management framework adopted by financial institutions for determining, assessing, and managing environmental and social risks in projects and is primarily intended to provide a minimum common standard for due diligence and monitoring to support responsible risk decision-making. In March 2023, 138 Equator Principles Financial Institutions (EPFIs) in 38 countries have officially adopted the EPs, covering the majority of international project finance debt within developed and emerging markets. The EPs categorize projects that are financed by EPFIs based on the environmental and social impacts that they generate and the risks that they may pose to financing. Category A projects have the highest risks, while category C is used for low-risk projects.

According to EPIV, a Climate Change Risk Assessment (CCRA) is required to be undertaken:

- For Category A and, as appropriate, Category B projects. For these projects, the CCRA has to include consideration of relevant climate-related 'Physical Risks' as defined by the **Task Force on Climate-Related Financial Disclosure (TCFD)**[2]. As it is the case of this project.
- For all projects, in all locations, when combined Scope 1 and Scope 2 emissions are expected to be more than 100,000 tons of CO_2 equivalent annually. For these projects, the CCRA is to include considerations of climate-related 'transition risks' (as defined by the TCFD). The CCRA must also include a completed alternatives analysis which evaluates less greenhouse gas (GHG) intensive alternatives. This study has already been performed and does not apply to this project.

The TCFD Recommendations on Climate-related Financial Disclosures state that "*physical risks resulting from climate change can be event driven (acute) or longer-term shifts (chronic) in climate patterns*".

Acute physical climate risks can include increased severity and frequency of droughts, storms, floods, heat waves and wildfires. **Chronic physical climate risks** can include sea level rise and longer-term temperature increase. Climate-related physical risks may include a variety of effects:

- Direct damage to assets, as a result of extreme weather events (i.e., drought, storms) or rising sea levels.

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[1] The Equator Principles Association, 2020 (**The Equator Principles EP4 July2020 (equator-principles.com).**

[2] See Task Force on Climate-Related Disclosures, Recommendations of the Task Force on Climate-related Financial Disclosures, June 2017.

- Changes in water availability, sourcing, and quality, often with consequent social impacts: Disruption to operations, ability to transport goods and supplies and impacts on employee/community safety, and more.

The CCRA fulfils diverse objectives depending on the information needs, and on challenges caused by climate change. These can include the following.

- Raising awareness: CCRA helps increasing awareness of the consequences of climate change.
- Identification and prioritization of risks: many factors contribute to a system's sensitivity, exposure, and adaptive capacity. CCRA provides insight into these factors, and this helps the client to prioritize the risks to be addressed.
- Identification of entry points for climate change adaptation intervention: the final results and the process of CCRA can help identifying possible adaptation responses. CCRA can show where early action is required.
- Tracking changes in risk and monitoring and evaluating adaptation: repeating CCRA can help to track changes over time and generate knowledge on the effectiveness of adaptation.

This document presents an analysis of related to the physical risks of climate change of the New Airport of M'Banza Congo (the project) located in Zaire province in Angola. This includes acute risks (event-driven) risks as well as chronic risks (those due to longer-term shifts in climate patterns), project-related financial risks and possible risk mitigation measures are given.

2. METHODOLOGY

This section of the CCRA chapter presents an overview of the methodology for CCRA for physical risks that applies to the current Project. The assessment will result in the identification of physical risks that may affect the Project within a certain time frame, and in a number of adaptative measures that Quantum may consider and implement to mitigate these risks.

Quantum has developed a Physical Climate Change Risk Assessment based on Climate Change Risk Assessment Guidance Note of EPIV and existing methodologies for the assessment of climate change risks and vulnerability as part of adaptation strategies.

Guidelines and methodologies from the ISO 14091 as well as the Intergovernmental Panel on Climate Change (IPCC)[3] and the World Bank Group[4] were used as a guidance for defining factors that contribute to determine the risk.

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[3] The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science related to climate change.

[4] The World Bank Group (WBG) is a family of five international organizations that make leveraged loans to developing countries.

2.1. Approach

These methodologies consider a variety of risk components as follows:

- Climate-related Hazard: natural or human induced climate-related hazard, such as flood, wildfire, extreme heat, that can occur at the Project Site. The changes in intensity of hazard related events and of their probability over-time are influenced by climate change.
- Exposure: the possibility for a Project in a specific site to be adversely affected by a certain hazard because of the presence of certain Project services, resources, infrastructures, people and other Project's intrinsic elements that are prone to be affected. A Project, depending on its intrinsic nature and characteristics, may or may not be exposed to a certain hazard that occur at the Project Site. Exposure is therefore an indicator of if the Project "can or cannot be affected" by a certain hazard.
- Sensitivity: propensity or predisposition of elements of the Project to be affected by a certain hazard. Sensitivity is a measure of "how much" a Project exposed to a certain hazard can be affected.
- Adaptive capacity: the ability of the Project to adjust to climate hazard-related events, to mitigate potential damages, to take advantage of opportunities, or to respond to the consequences.
- Vulnerability: expresses the magnitude of potential effects and consequences of climate hazard-related events on elements of the Project. Vulnerability results from the combination of Sensitivity and Adaptive capacity.
- Risk Assessment: the result of the combination of Hazard probability or intensity at a certain time and the Vulnerability.

The definition of risk components as defined by IPCC are hazard, exposure, and vulnerability, as described in the following table:

Table 1 Definition of risk components as per IPCC AR6[5]

Risk component	Definition
Hazard	The potential occurrence of a natural or human-induced physical event or trend, that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision and environmental resources.
Exposure	The presence of people, livelihoods, species, or ecosystems, environmental functions, services and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.
Vulnerability	The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt. For example, a community exposed to a drought hazard would have increased vulnerability if it lacked the capacity to bring in water resources from elsewhere or to adapt to reduced water availability.

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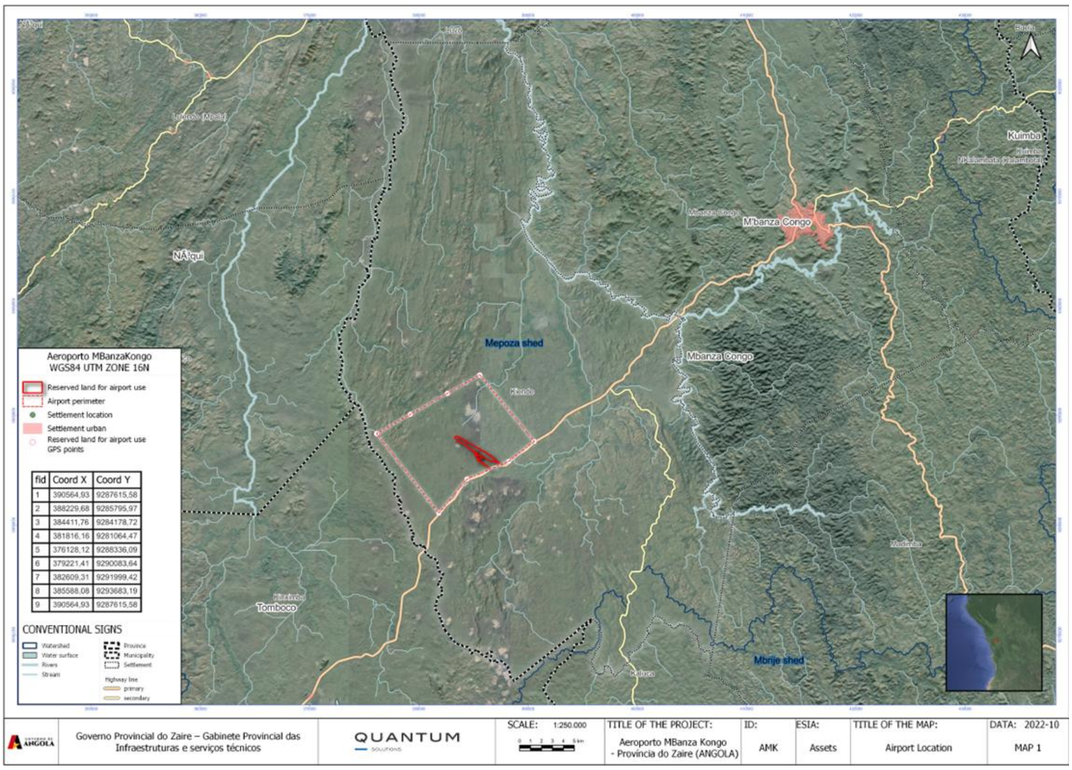
[5] IPCC: Intergovernmental Panel of Climate Change

3. CLIMATE OVERVIEW

The Project is located in an area of flat relief, mainly covered by scrubland and savanna degraded by anthropic pressure. The project is located to the south of the city of M'Banza Congo, some 30 km along the road linking this city with Luanda (capital of Angola). The Project area is referred as "Nkiende II", being the name of the nearest community (see Figure 1).



fid	Coord X	Coord Y
1	390564,93	9287615,58
2	388229,68	9285795,97
3	384411,76	9284178,72
4	381816,16	9281064,47
5	376128,12	9288336,09
6	379221,41	9290083,64
7	382609,31	9291999,42
8	385588,08	9293683,19
9	390564,93	9287615,58

Figure 1. Project location

Information collected from the World Bank Group – Climate Change Knowledge Portal[6] and reports released by USAID's Climatelinks[7] were used to obtain an overview of the current climate and the mean climate projections.

M'Banza Congo is located inland in the northwest region of Angola at Zaire province and has a tropical savanna climate characterized as hot and humid. The area experiences a wet season from October to May, with March and April being the wettest months. The dry season occurs in winter, from June to September, with June and July being the driest months. The region is influenced by the movement of the Inter-Tropical Convergence Zone (ITCZ), which brings rainfall as it migrates southward from the equator in October.

The temperature observations show that Zaire has experienced significant warming over recent decades, with an average annual temperature increase of about 1,5°C between 1901 and 2021.

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[6] The Climate Change Knowledge Portal (CCKP) provides global data on historical and future climate, vulnerabilities, and impacts.

[7] USAID. 2018. "Climate Risk Profile: Angola." U.S. Agency for International Development. **Climate Risk Profile: Angola | Global Climate Change (climatelinks.org)**.

The rates of increase were different in the different seasons of the year, being faster in winter, at about 0,47°C per decade, and slower in summer, at about 0,22°C per decade, as it is shown in Figure 2.

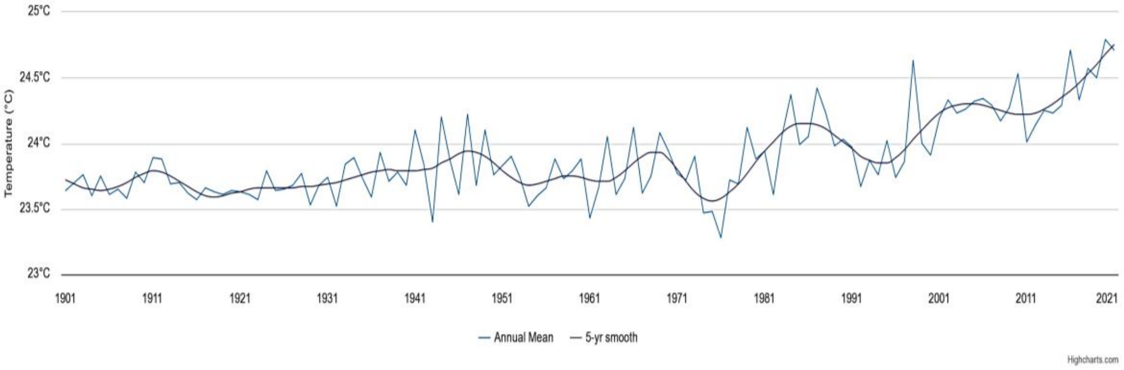

Figure 2 Observed average Annual Mean-Temperature of Zaire, Angola for 1901 – 2021 (Source: Climate Change Knowledge Portal)

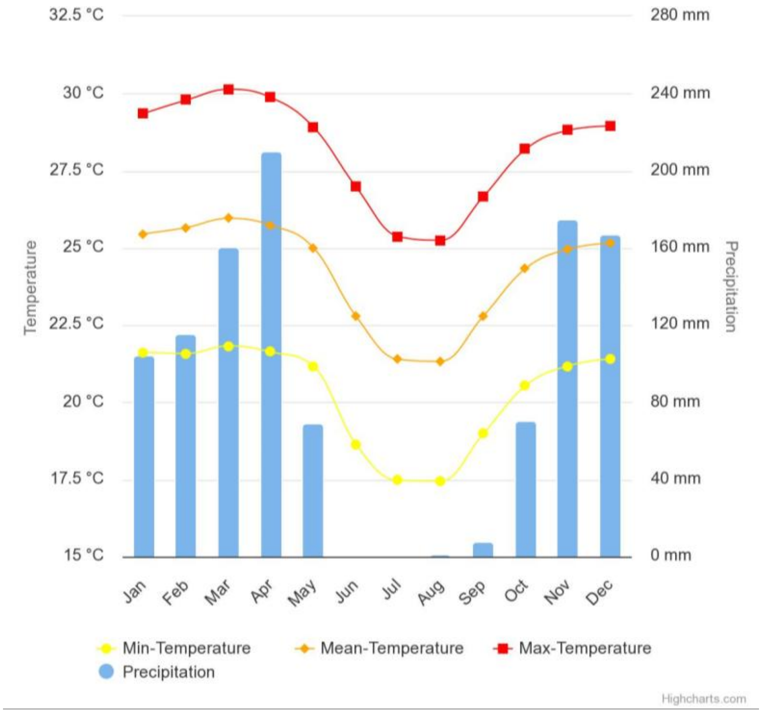

Figure 3 Monthly climatology of Min-Temperature, Mean-Temperature, Max-Temperature &Precipitation 1991-2020 of Zaire, Angola (Source: Climate Change Knowledge Portal)

Regarding precipitation, historical climate trends show that between 1901 and 2021 the average annual precipitation in Zaire has increased in 144 mm, being April the month whit the highest level of precipitation 200 mm.

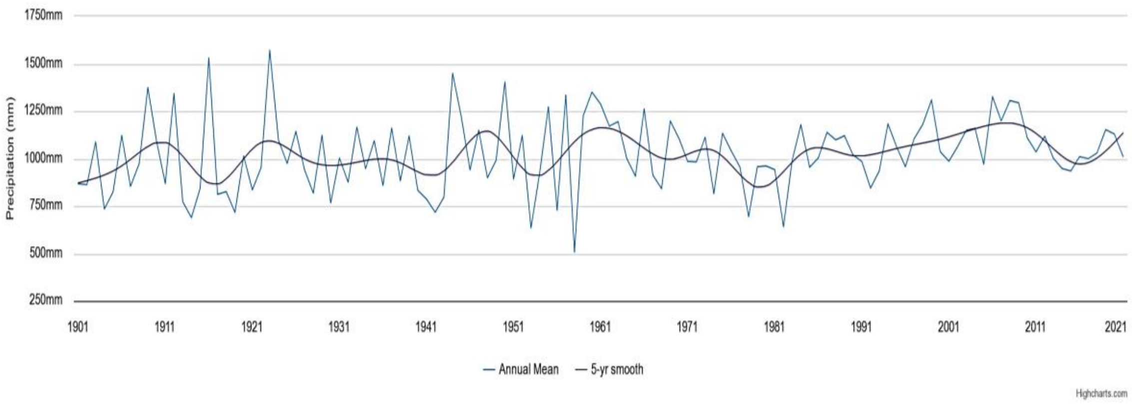

Figure 4 Observed average Annual Precipitation of Zaire, Angola for 1091 to 2021 (Source: Climate Change Knowledge Portal)

4. PHYSICAL RISK SCREENING

4.1. Climate hazards

The first step was to identify the climate-related hazards that may affect the Project site and, among them, those the Project may be exposed to. Information from World Bank Group – Climate Change Knowledge Portal, Vulnerability section, were consulted to identify the most relevant hazards at the Country Level. In addition to this, Think Hazard portal (implemented by Global Facility for Disaster Reduction and Recovery (GFDRR) in collaboration with World Bank and providing high level hazard assessment worldwide) was used to refine the investigation at the level of M'Banza Congo. The outcomes of this process resulted in the following list of selected hazards. They are listed together with the main justification for their inclusion in the risk assessment.

The climate hazard behaviour was projected using Climate Score Global 2.0, implemented by Jupiter Intelligence[8]. It was used as the data source for assigning a class of either probability or intensity to each scoped-in climate-related hazard. Climate Score Global quantifies climate-related hazards at any given location globally predicting how future climate conditions will influence the intensity or the frequency of extreme meteorological events or natural disasters such as future floods, extreme heat events and droughts. The tool employs dozens of respected climate models coupled with machine learning, land use and elevation data, as well as models for hydrology, and severe weather. Data present a very high spatial resolution (90-meter globally), quantifying a set of hazards-specific metrics in 5-year increments from 2020 through 2100 (plus the baseline 1995) and for three climate scenarios, made by a combination of Shared Socioeconomic Pathways (SSPs) and Representative Concentration Pathways (RCPs)[9], as it is shown in Table 2.

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[8] Climate Score Global https://jupiterintel.com/products/

[9] Shared Socioeconomic Pathways (SSPs) are scenarios of projected socioeconomic global changes up to 2100. They are used to derive greenhouse gas emissions scenarios with different climate policies. Representative

The shaded rows represent the optimistic, intermediate, and pessimistic scenario that will be considered for the hazard projections analysis.

Table 2 Share Socioeconomic Pathways and Representative Concentration Pathways

SSP-RCP	**Description of scenario**	**Estimated warming. *Very likely range (°C)***		
		Short term (2021-2040)	**Mid-term (2041-60)**	**Long-term (2061-2100)**
SSP1-1.9	Most optimistic: emissions reach net zero by 2050.	1.2 to 1.7	1.2 to 2.0	1.0 to 1.8
SSP1-2.6	*Optimistic* - Next best/low emissions: emissions reach net-zero after 2050.	1.2 to 1.8	1.3 to 2.2	1.3 to 2.4
SSP2-4.5	Intermediate - Middle of the road: emissions only reach net-zero by 2100.	1.2 to 1.8	1.6 to 2.5	2.1 to 3.5
SSP3-7.0	*Intermediate* - Medium/high emissions: emissions roughly double from current levels by 2100.	1.2 to 1.8	1.7 to 2.6	2.8 to 4.6
SSP5-8.5	*Pessimistic* - High emissions: Current CO2 emissions levels roughly double by 2050.	1.3 to 1.9	1.9 to 3.0	3.3 to 5.7

Considering that the Airport is an infrastructure which is built, the entire temporal scope available, 2020-2100, it has been considered to characterize the future climate-related hazards potentially affecting the Project. Among all possible metrics available, the most representative were selected for each hazard (see Table 3). Where metrics were not available, bibliographic support has been used to estimate climate hazard behaviour in the time.

Table 3 Most representative metrics selected to characterize each hazard

HAZARD	**METRIC**
EXTREME PRECIPITATIONS	Mean maximum daily total water equivalent precipitation (in mm) experienced at the 100-year return period.
FLOODS	Mean anomaly of precipitation (%) based on regional climate models (RCM) ensemble.
EXTREME HEAT	Mean days per year with high temperature exceeding the local historical (1980-2010) 99th percentile high temperature.
DROUGHT	Months per year where the rolling 6-month average Standardized Precipitation Evapotranspiration Index is below -2 based on the means of several parameters from GCMs.

Concentration Pathways (RCPs) are greenhouse gas concentration possible future trajectories adopted by the IPCC.

HAZARD	METRIC
WATER STRESS	Number of events and mean magnitude of droughts for different time periods, according to two RCPs, computed from SPI-6, and based on the RCMs ensemble

According to the Hazard input data and the metrics considered, the following are the main considerations to describe the scoped-in hazards and their evolution over time at the Project site. For each Hazard, the related figure shows the evolution across the temporal scope in a range of tree (3) different emission scenarios (green lines: optimistic; orange lines: intermediate; red lines: pessimistic) and distributed in short-, mid-, and long-term (see Table 2). Different styles refer to the 3 different statistics of each metric (solid line: mean; dashed line: 95th percentile(upper); dotted: 5th percentile (lower)). Mean values of each metric have been used to describe trends over time. The upper and lower percentiles have been used to provide considerations about the level of confidence of the prediction. Wider discrepancy compared to medium values show a low level of confidence while small discrepancy shows a higher level of confidence.

Horizontal grey dashed lines represent the hazard class limits. Please note that a higher level of hazard for a better scenario may happen sometimes, particularly in the near future. What matters and should be looked at is the overall trend within the long term that clearly indicates higher hazard levels for the worst scenario.

a) Extreme precipitations

Extremes event only occur in a conjunction of several preconditions. For example, extreme rainfall requires maximized moisture transport in the region, high temperatures (on large temperatures gradients) and significant instability of the atmosphere. An alignment of these aspects is relatively rare. Nevertheless, under climate change some of these conditions might see a systematic increase in occurrence. If high temperatures are more often fulfilled, then the chance for a combined occurrence can also increase, warmers temperatures are especially important for precipitation because for that 1ºC of increased air temperature, that air's potential to carry moisture increases by 7%, and therefore if rain were to form much more water could be tapped into.

A lack of station data over the region leads to large uncertainties in the estimation of observed rainfall trends and low confidence in changes in extreme rainfall particularly in Angola, where after 1974, the quantity and quality of meteorological record are considerably reduced. Nevertheless, available data shows that mean annual rainfall over Angola has decreased at an average of around 2 mm per month (2,4%) per decade between 1960 and 2006. This annual decrease is largely due to decreases in March-April-May rainfall, which has decreased by 5 mm per month (5.4%) per decade, which is aligned with the African trend where an increase in temperature and decrease in annual precipitation has been recorded from meteorological stations in the southeastern coast of Southern Africa during last decades. These changes are expected to have important impacts on key sectors such as agriculture and livestock systems[10]. It is important to highlight that other hazards occur as a consequence of extreme precipitations such as flooding and storms therefore, this hazard has been scoped in for the climate change risks assessment.

Extreme precipitation projections

The mean maximum daily total water equivalent precipitation (in mm) experienced at the 100-year return period is around 130 mm at present, which correspond to a “low” hazard level. However, values are expected to increase in the future, according to all emission scenarios.

In the *short-term* range, for the optimistic scenario (solid green line) the intensity of extreme precipitation slightly increases reaching a peak of 135 mm in 2040 as well as in the intermediate scenario (solid yellow line), and for the pessimistic scenario (solid red line) this value increases to 145 mm in the same year mentioned above, nevertheless in this range of time extreme precipitations correspond to a *low* hazard level.

In the *mid-term*, for the optimistic scenario the intensity of extreme precipitation is stable within 135 mm with a slight decrease in 2065 still corresponding to a *low* hazard level. On the other hand, in the intermediate scenario the intensity of precipitations increases significantly up to 150 mm between 2050 to 2070 as well as in the pessimistic scenario where precipitation rise 155 mm in 2070 corresponding to a *medium* hazard level in the intermediate and pessimistic scenarios.

In the *long-term*, the extreme precipitation intensity in the optimistic scenario is similar to the mid-term, corresponding to a *low*-level hazard. In the intermediate scenario precipitations remain stable in 150 mm however in the pessimistic scenario it is expected that precipitation rise 160 mm in 2080 and slightly reduce to 155 mm in 2090 before becoming stable to 2100, corresponding to a *medium* level hazard (see Figure 5).

Short-term **Mid-term** **Long-term**

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[10] Carvalho, S.C.P., Santos, F.D. and Pulquério, M., 2017. Climate change scenarios for Angola: an analysis of precipitation and temperature projections using four RCMs. International journal of climatology, 37(8), pp.3398-3412.

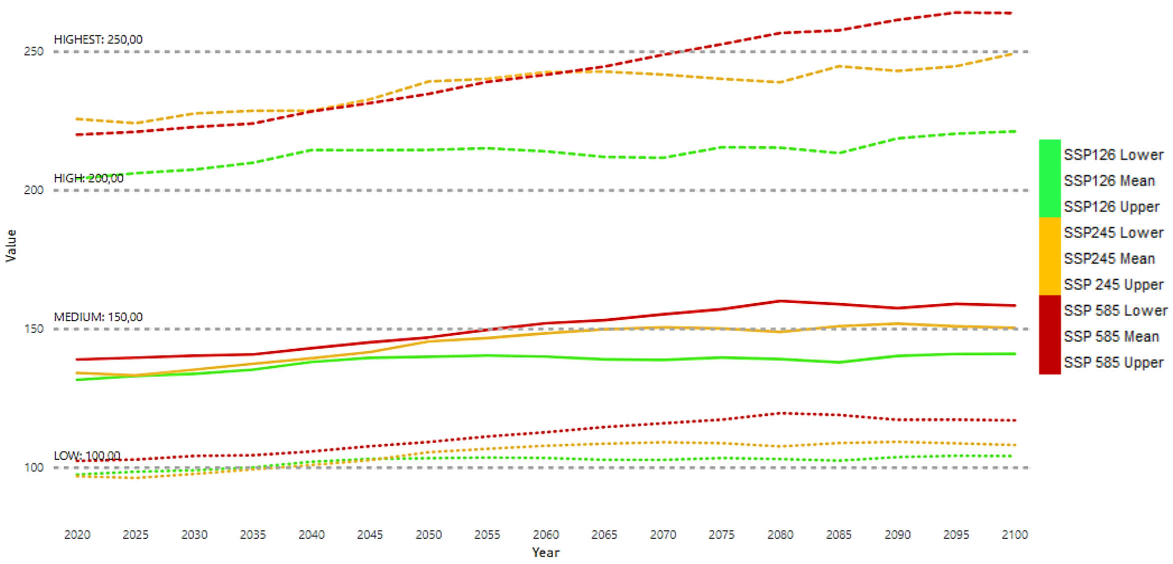

Figure 5 Extreme precipitations (Mean maximum daily total water equivalent precipitation (in mm) experienced at the 100-year return period)

b) Flooding including pluvial flood.

Flooding is a severe natural hazard that occurs throughout Angola is a recurrent issue that has caused significant damage to the city's infrastructure, houses, and commercial buildings. The situation is even worse in rural areas, where residents live on riverbanks, making them highly vulnerable to flooding.

Flooding is a common natural hazard in the region, with heavy rainfall often causing rivers to overflow and inundating nearby communities. In recent years, flooding has become increasingly frequent and severe, causing damage to homes, infrastructure, and agricultural lands.

The impact of flooding in M'Banza Congo has been exacerbated by rapid urbanization, which has led to the construction of buildings and infrastructure in flood-prone areas.

Climate change is expected to exacerbate flooding in M'Banza Congo and other parts of Angola, with projected increases in rainfall. The risk of flooding is compounded by the country's outdated infrastructure and inadequate drainage systems, which are ill-equipped to handle the increasing frequency and severity of flooding. Addressing the flooding hazard in M'Banza Congo will require a comprehensive approach, including improving infrastructure and drainage systems, implementing early warning systems. Additionally, community education and awareness campaigns are crucial for promoting disaster preparedness and reducing the impact of flooding on vulnerable communities. Although this hazard is considered *Low* by the Thinkhazard webside it has been scoped in for the climate change risks assessment.

Flooding projections

The annual mean precipitation in Zaire province belonging to the Cuango basin, is between 1200 to 1400 mm at present with a mean anomaly of precipitation (%) of -6 to -4 % at present, which corresponds to a low-risk hazard.

As is typical across the region, rainfall projections for Angola are mixed with little agreement between models. Depending on the model used and the climate scenario, trends range from -6.6 to +6.7 mm /decade. In general, models show a slight decrease in precipitation throughout the country or approximately -2% by 2100.

For the analysis of floodings in Angola the intermediate (RCP 4.5) and pessimistic (RCP 8.5) scenarios will be considered as they were available at a basin level, which is shown in the following Figure 6. Moreover, range of time between 2011 to 2024 is considered short-term, 2041 to 2027 mid-term and 2071 to 2100 long-term.

In the short term, for the intermediate scenario the precipitation anomaly is expected to be -6 to -4% and for the pessimistic scenario it is reduced to -4 to -2%, corresponding to a *low*-level risk for both scenarios, due to the slight margin between projections and the present situation.

In the mid-term, the anomaly of precipitation in intermediate scenario is -4 to -2% and for the pessimistic scenario it increases to -6 to -4%, which still corresponds to a *low*-level risk for both scenarios where rainfall projected will not vary significantly from the current conditions and the extremes events such as floodings could maintain the same pattern.

In the long-term, both scenarios intermediate and pessimistic will be expected to present an anomaly of precipitation of –8 to -6%, which reduce the average rainfall, corresponding to a low-level hazard[11].

In contrast to this, the intensity of extreme precipitation is expected to increase at a country level. The occurrence of 1-in-100-year wet event in the wet season is likely to become more frequent. By the 2060, Angola will experience a 1–100-year flood event four times more frequently under a pessimistic scenario[12]. However, it should be noted that projections of flood events that result from rainfall are subject to substantial modelling uncertainty, largely due to the uncertainty associated with spatial distribution of future precipitation.

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[11] Carvalho, S.C.P., Santos, F.D. and Pulquério, M., 2017. Climate change scenarios for Angola: an analysis of precipitation and temperature projections using four RCMs. International journal of climatology, 37(8), pp.3398-3412.

[12] Schlosser, A., Sokolov, A., Strzepek, K. et al. The changing nature of hydroclimatic risks across South Africa. Climatic Change 168, 28 (2021). https://doi.org/10.1007/s10584-021-03235-5

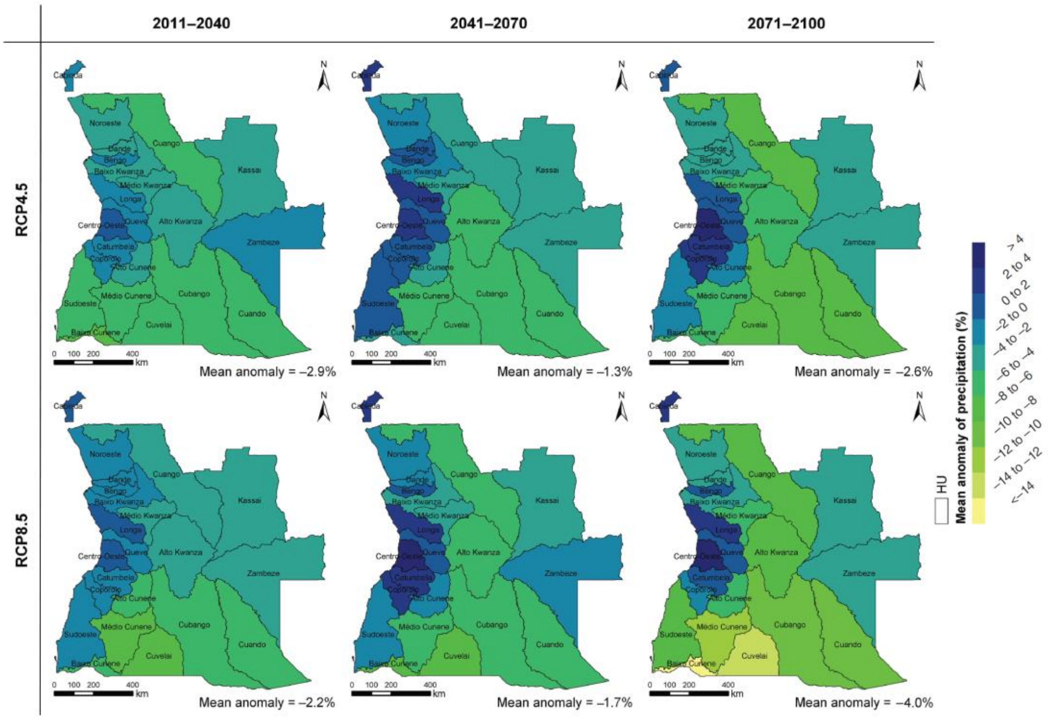

Figure 6 Mean anomalies of precipitations in Angola between 2011 to 2100. (Source: Carvalho et al 2017)

c) Extreme Heat including Wildfires Hazard

In M'Banza Congo there is more than a 25% chance that at least one period of prolonged exposure to extreme heat, resulting in heat stress, will occur in the next five years. Project planning decisions, project design, and construction methods should take into account the level of extreme hazard**.**

According to the most recent assessment report of the Intergovernmental panel on Climate Change, continued emissions of greenhouse gases will cause further warming, and it is virtually certain that there will be more frequent hot temperature extremes over most land areas during the next fifty years. Warming will not be regionally uniform. In Angola, the temperature increase in the next fifty years will be slightly higher than the worldwide average. This climate hazard is related to item c) Wildfires hazard, as this is a consequence of the other, which will be analysed together. Therefore, this hazard has been scoped in for the climate change risks assessment.

On the other hand, wildfires are a significant hazard in Angola, particularly in the southern regions, where dry and hot weather conditions create a favourable environment for wildfires to occur. The wildfires can lead to significant property damage, including damage to crops and loss of life, and can also result in adverse health effects from smoke inhalation. The fires can also contribute to deforestation, which can impact local ecosystems, reduce biodiversity, and lead to soil erosion. In 2020, Angola experienced one of the most severe wildfire seasons in recent years, with thousands of hectares of land destroyed.

Wildfires pose a recurring hazard in Zaire, wreaking havoc on the region with devastating consequences. The dry season brings about high temperatures and arid conditions, thereby creating an environment conducive to fire outbreaks. Human activities, including uncontrolled fires and agricultural burning, as well as natural factors like lightning strikes, can trigger the fires. Moreover, the increasing frequency and severity of wildfires in the region can be attributed to climate change, which has led to droughts and elevated temperatures, causing vegetation to dry out and become more susceptible to burning. Additionally, deforestation and land-use change, often driven by human activities, are also exacerbating the risk of wildfires. The smoke and air pollution emanating from these fires can have severe health impacts on the local population.

According to Think Hazard portal, in Zaire Province the wildfire hazard is classified as high according to the information which means that there is greater than a 50% chance of encountering weather that could support a significant wildfire that is likely to result in both life and property loss in any given year. Therefore, this hazard has been scoped in for the climate change risks assessment.

Extreme Heat projections

Extreme heat hazard is expected to increase in the future, according to all scenarios. However, as shown in **¡Error! No se encuentra el origen de la referencia.**, the trend is very much depending on the emission scenario. The number of hot days per year with temperatures above the local mean high temperatures is around 7-8 now, corresponding to a *low* hazard level.

In the short term, for both the optimistic and intermediate scenario, the number of days with high temperatures increases to 10 days per year around 2030, reaching the *medium* level, whereas in the pessimistic scenario this value increases to 18 days per year in 2040 still corresponding to a *medium* level hazard.

In the mid-term, for the optimistic scenario values stabilize in 15 days per year remain in the *medium* level and in the intermediate scenario increases to 20 days of high temperatures per year with a peak in 2065 corresponding to a *high*-level risk. However, the pessimistic scenario shows a significant increase over pass the 30 days per year since 2055 achieving the *highest* level of the risk.

In the long-term, the optimistic scenario is stabilized in 15 days of high temperatures per year up to 2100 still corresponding to a medium level risk. Nevertheless, for both the intermediate and the pessimistic scenario largely over pass the high-level risk with more than 20 to 30 days of high temperatures achieving the highest-level risk.

It is important to mention that comparing the selected mean metric with the upper and lower, it can be noticed that values sensibly diverge in all scenarios, for the entire temporal scope. This can result in the worst case in 1 or 2 hazard classes difference for a given time period. Therefore, the level of confidence can be considered "Medium”.

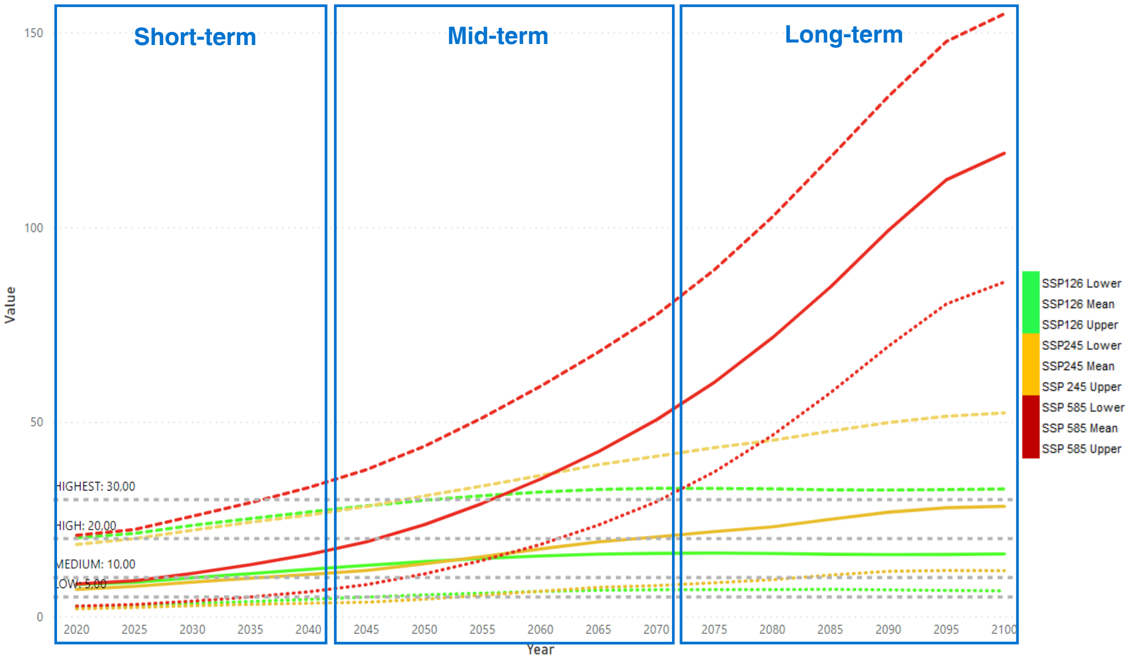

Figure 7 Extreme heat hazard (Value = Mean days per year with high temperature exceeding the local historical (1980-2010) 99th percentile high temperature).

d) Drought Hazard

In Angola, drought had an average annual occurrence of 11% between 190 to 2020. Droughts can result in severe economic, social, and environmental consequences that can have a devastating impact on agricultural production, populations, and livelihoods. This was evident during the severe drought that occurred in Angola from 2012 to 2016, one of the worst in the region's history, affecting over 1,5 million people, including many in M'Banza Congo[13]. In this region, the drought resulted in a significant reduction in agricultural output, with farmers losing crops and livestock due to lack of water, leading to food shortages and malnutrition. Moreover, the drought caused a decline in water quality and quantity, resulting in health issues and the spread of waterborne diseases.

These issues are closely related to climate change, as rising temperatures and changing weather patterns increase the frequency and severity of droughts. Deforestation and overgrazing, which contribute to drought in Angola, are also linked to climate change due to their impact on carbon emissions and forest cover loss. Climate-related disasters (floods, storms, droughts) cost Angola nearly US$1.2 billion between 2005 and 2017, and on average droughts alone affect about a million Angolans every year. Therefore, this hazard has been scoped in for the climate change risks assessment.

Drought Hazard projections

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[13] Climate Change Knowledge Portal. Angola.

Drought hazard is a significant threat at the Project site. According to the selected metric to describe drought conditions (Months per year where the rolling 6-month average Standardized Precipitation Evapotranspiration Index is below -2), there is an increasing trend over the years according to all scenarios. Values are around 0.20 at present, representing almost a *medium* hazard level.

In the short term, for the optimistic scenario, values are above 0.25 since 2035 corresponding to a medium level hazard as well as for the intermediate scenario. Nevertheless, for the pessimistic scenario it over passes the 0.4 in 2040 still in a medium level hazard.

In the mid-term range, the optimistic scenario stabilizes in 0.35 remaining in a medium level hazard, whereas the evapotranspiration index increases in 2060 for the intermediate scenario and in 2045 for the pessimistic scenario achieving a high level of hazard with values up to 0.50.

In the long-term range, the optimistic scenario achieves the high level in 2080 increasing to 0.5 and the intermediate scenario remains stable in the high level up to 2100. Nevertheless, in the pessimistic scenario, the evapotranspiration index over pass 1.0 in 2071, achieving the highest level of the hazard.

The variability between the upper and lower metrics is very high and the values significantly diverge in all scenarios. Therefore, the level of confidence of the hazard assessment should be considered "Low".

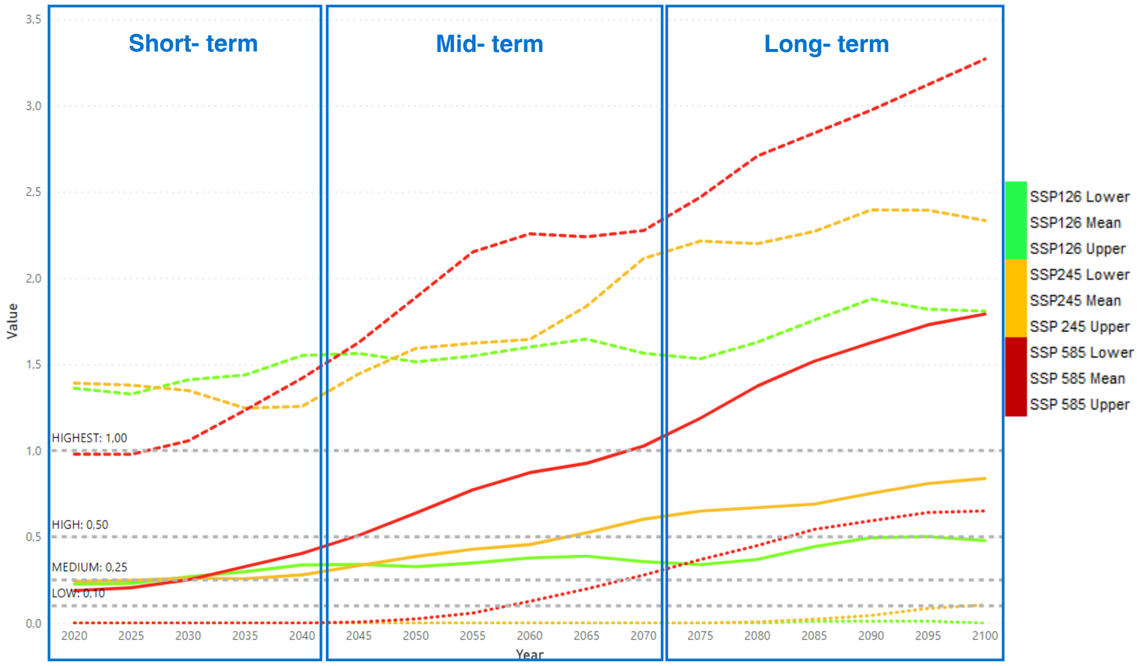

Figure 8 Drought hazard (Value = Months per year where the rolling 6-month average Standardized Precipitation Evapotranspiration Index is below -2 based on the means of several parameters from GCMs).

e) Water stress

Water stress is a broad term which encompass the availability, quality, and quantity of water, that could be determined by anthropogenic or environmental factors. Angola has a diverse hydrological network with considerable water availability, the country has 47 major river basins and rivers which are distributed across five principal drainage areas, the Atlantic Ocean, the Zaire basin, the Zambezi basin, the Cuvelai basin and the Cubango river basin. Although Angola is rich in water resources, they are unequally distributed in the country, as the south and coastal regions water flows are usually low whereas in the north and central regions the water flows are significantly higher. In the shorth-term water availability should not be a problem, however as the country develops, water shortages may occur. Additionally, Angola faces a severe shortage in sanitation services with only 50% to 60% of the population served, however significant progress has been made, given that in 1990 these percentages were around 30% to 40%[14].

On the other hand, water scarcity referred only to the availability (or lack thereof) of water across countries, usually representing the ratio of a region's water demand to water supply, contributing to the water stress. This is why, a country with abundant water resources, can still face water shortage. Increasing consumption combined with more frequent droughts and heat events will increase water demand and put additional pressure on already scarce water resources.

In Angola exist water policies and strategies in progress at a national and regional levels such as the creation of a *National Institute for Water Resources* which manage the country's water resources however, water quality control is not yet highly regulated taking place on an occasional basis for specific research despite of the low percentage of population that count with at least basic services in rural scenarios (22%). Generally, Angola has low levels of water stress comparing with other countries of the region[15], nevertheless, although this hazard has a low level, it has been scoped in for the climate change risks assessment, as requested.

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[14] Deloitte. (2014). Water country profile.

[15] https://data.worldbank.org/indicator/ER.H2O.FWST.ZS?end=2020&start=2020&view=map

Figure 9. Level of water stress: freshwater withdrawal as a proportion of available freshwater resources in Angola, change over time, compared to other countries in the region (Source: https://www.sdg6data.org/en/country-or-area/Angola).

Water stress projections

Model projections are inconsistent in their estimates of change in drought hazard, which influences water scarcity as well as the quality and availability of water which compound the water stress. The present hazard level may increase in the future due to the effects of climate change[16].

Given that drought hazard is slightly related to the availability and quality of water, a projection based of bibliographic support is presented as follows:

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[16] ThinkHazard. M'Banza Congo.

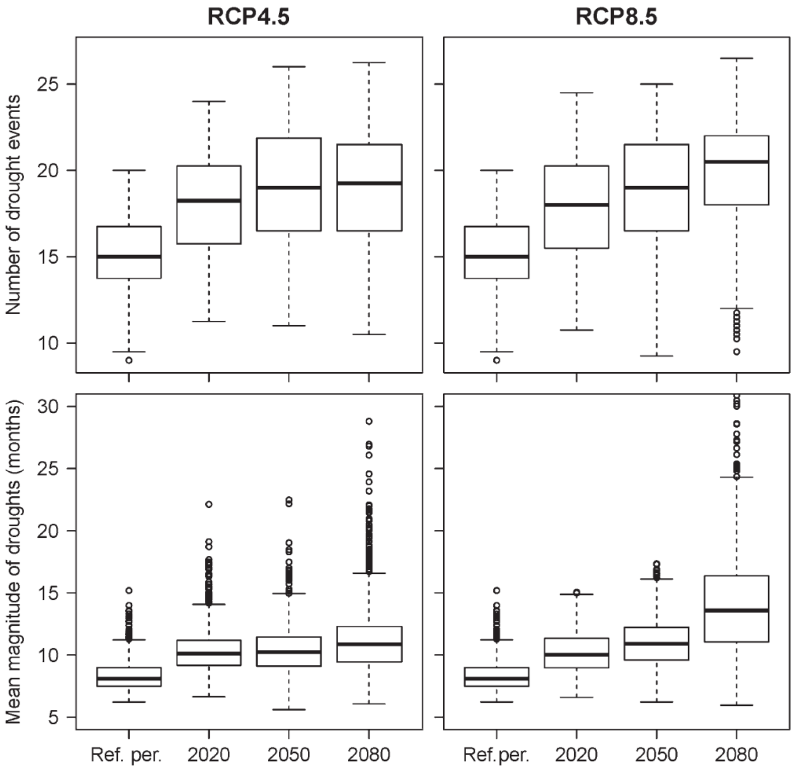

Figure 10. Number of events of droughts for three ranges of times in two scenarios (Source: Carvalho et al., 2017)

In the short-term range, both the intermediate and the pessimistic scenario present between 15 to 20 droughts events, achieving a medium level hazard which remains for the mid-, and long-term up to 2080. Although the frequency of droughts generally remains constant over the century, climate change is likely to have a larger effect on their magnitude. An increase in the severity of droughts is expected over the different periods under pessimistic scenario, which can double in magnitude by the end of the century. When comparing the reference period and the short-term projections, an increase in magnitude is also expected under intermediate scenario, although that increase remains constant throughout the century[17].

4.2. Exposure assessment

Once hazards potentially affecting the Project site were identified, the exposure of the Project to each hazard was addressed. The key question in the exposure assessment is the following:

- *In case of any of the selected climate-related hazard hitting the Project site, would the Project be impacted?*

The evaluation considered the intrinsic characteristics and features of the Project:

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[17] Carvalho, S.C.P., Santos, F.D. and Pulquério, M., 2017. Climate change scenarios for Angola: an analysis of precipitation and temperature projections using four RCMs. International journal of climatology, 37(8), pp.3398-3412.

Table 4 Exposure assessment

HAZARD	ELEMENT EXPOSED	EXPOSURE	JUSTIFICATION
Extreme precipitation	Infrastructures/People	YES	Buildings (and other facilities) as well as workers could be affected by extreme precipitations considering rainfalls and storms. These events could affect the airport operations and the normal movements of workers /passengers in and out of the project. The impact of extreme precipitations must be considered in all phases of the project. Project planning decisions, project design, construction and emergency response planning methods should take into account the magnitude of this hazard. Extreme precipitations hazard is therefore scoped in.
Flooding/ Pluvial flood	Infrastructures/People	YES	Buildings (and other facilities) as well as workers could be affected by flooding. M'banza Congo is vulnerable to flooding resulting from heavy rainfall and inadequate drainage systems. This can cause damage to infrastructure, loss of life, and can also lead to disruption of project timelines and budgets. Thus, the airport can be considered exposed to flooding due to watercourses overflowing and this hazard will be scoped in from the analysis.
Extreme Heat and Wildfires	Infrastructures/People	YES	Buildings and other facilities could be affected by extremely hot temperatures. Similarly, people /passengers would be impacted by temperatures which are already high, and they are expected to increase even further. The impact of wildfire must be considered in all phases of the project. Project planning decisions, project design, construction and emergency response planning methods should take into account the high level of wildfire hazard. Wildfire hazard is therefore scoped in.
Drought	Infrastructures/People	YES	The airport depends highly on water for its vital functions (water supply for the project activities and workers health). The lack of water supply causes a decline in water quality and quantity, resulting in health issues and the spread of waterborne diseases between workers. Thus, the airport can be considered exposed to drought and this hazard will be scoped in from the analysis.
Water stress	Infrastructures/People	YES	All water supply will be provided from authorized wells around the project footprint and water for worker consumption will be provided from authorized companies which allow this resource available for the airport activities and workers. Thus, the airport can be considered exposed to water stress and this hazard will be scoped in from the analysis.

4.3. Vulnerability

Measuring vulnerability encompasses determining sensitivity and adaptative capacity of the project area. The following items describe the elements considered to assess vulnerability:

4.3.1. *Sector Vulnerability*

A sector vulnerability screening has been developed considering EU Taxonomy. The following table shows the climate-related hazard sensitivity for Airport Infrastructure (sector):

Table 5 Vulnerability screening

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

4.3.2. *Sensitivity*

The Project Sensitivity towards each hazard is presented below with the main considerations that justify the assessment.

Sensitivity to Extreme precipitation: overall Sensitivity has been assigned “MEDIUM”.

- Extreme precipitations could bring disruptions to both infrastructures and operations. However, in a short-term this hazard represents a low-level hazard and in a mid-, and long-term this hazard represents a medium hazard-level.
- Run-off waters generated by precipitations may affect Project components such as runways and internal and access roads. However, drainage project design considers a return period of 1-in-100 years, which ensure that the project could face extremes precipitations that occurs in a short-, mid-, and long-term.
- Buildings in the Project site and aboveground infrastructure could be sensitive to structural damages.

Extreme precipitations may bring local flooding, potentially affecting the following more sensitive Project components: runways, roads, and airport buildings.

Sensitivity to flooding: overall Sensitivity has been assigned “MEDIUM”. The airport would be impacted with moderate consequences dur to:

- Floodings could bring disruptions to both infrastructures and the airport operations. However, across the century this hazard maintains a low level although these events could be four times more frequents under a pessimistic scenario.
- A seasonal watercourse and a lagoon were identified around the project, however preventive actions were carried out to deviate that watercourse and all the construction activities are being avoided around the lagoon mentioned, aimed to prevent that possible flooding events affect the project.

New M'Banza Kongo Airport location and layout developed was defined as shows in the following figure. A detailed planialtimetric and topographic survey were carried out up to a 1:1,000 scale, for a better understanding of the existing relief and the natural water resources. In a first analysis it was possible to identify that a small watercourse/streams and a lagoon were located within the project area, known as Tombe stream, which flows from north to the EN-210 Highway. This temporary stream being a tributary of the left bank of the Congo River. The Runway and Take-off (runway) crossed the temporary Tombe stream.

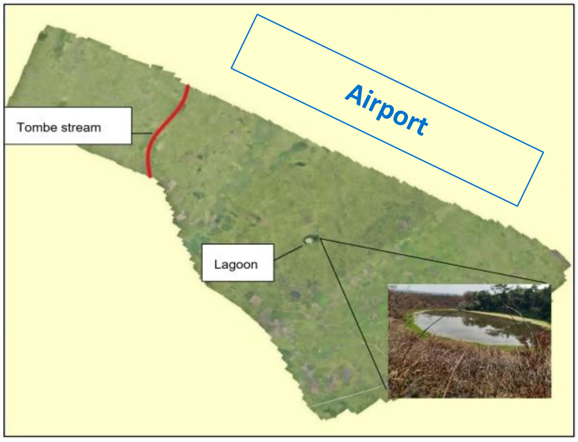

Figure 11 Location of Tombe stream and lagoon in the project area

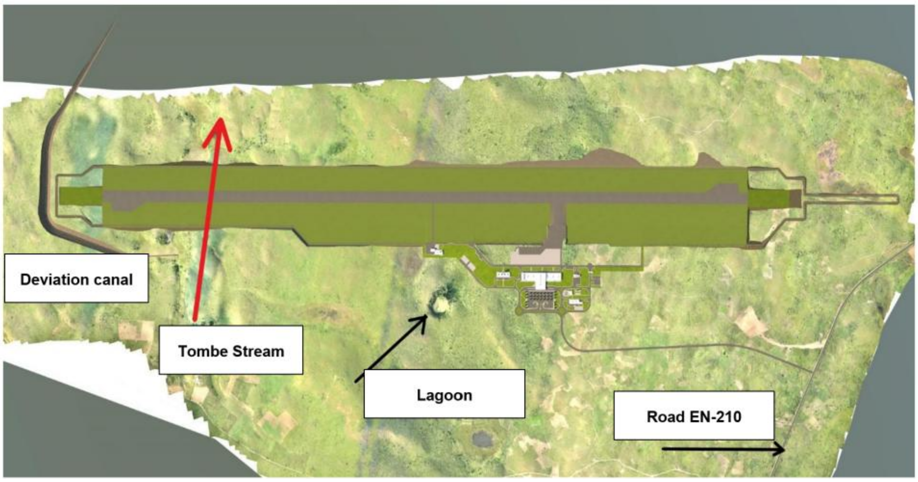

Figure 12 Deviation channel location

Sensitivity to Extreme heat: overall Sensitivity has been assigned "MEDIUM". The airport would be impacted with moderate consequences due to:

- Scrub vegetation cover around the project area could absorb heat and minimize the negatives effects of the heatwaves. However, vegetation cover could be exposed to wildfires that could affect project assets.
- Buildings and infrastructure are made of materials that could be susceptible to high temperatures, such as plastic (polymers breakdown), metal (corrosion speed up if humidity is also present), brick weathering (which can weaken the steel structure within a building's concrete exterior).
- Workers could suffer heat shocks while they are out of buildings in days where temperatures are above 35ºC. However, the number of days does not overpass 10 days per year until 2040.
- Roads are the only gateway to the airport and from where supplies will be transported. Extreme heat can particularly damage roads, creating traffic disruptions.

Sensitivity to Drought: overall Sensitivity has been assigned "MEDIUM". This is mostly due to the levels of water consumption of the airport:

- Due to the absence of public networks around the project footprint, all the Airport water supply will come from authorized wells, which will be treated to be distributed in the airport during operation activities.
- During operation phase, airport activities normally demand a daily estimated consumption of 100 m^3, which encompass mobile (passengers and companions) and fix (workers) population[18].

Sensitivity to Water stress: overall Sensitivity has been assigned “MEDIUM”. This is mostly due to the levels of water consumption of the airport:

- Due to the absence of public networks around the project footprint, all the Airport water supply will come from authorized wells, which will be treated to be distributed in the airport during operation activities.
- During operation phase, airport activities normally demand a daily estimated consumption of 100 m^3, which encompass mobile (passengers and companions) and fix (workers) population[19].

Table 6 Resume of Sensitivity levels

Climate hazard	Sensitivity level
Extreme precipitations	Medium
Floods	Medium
Extreme heat	Medium
Drought	Medium
Water stress	Medium

4.3.3. Adaptative capacity

The final step was to assign a class of Adaptive Capacity (“High”, “Medium” or “Low”), entailing all information collected through the assessment process, also considering their relative importance, reliability, and completeness. A conservative approach has been adopted assigning a lower Adaptive Capacity class whenever the assessment was uncertain due to inconsistent indicators.

The following are considerations that pertain to all hazards and evaluating them assisted in identifying the overall Adaptive Capacity concerning climate change-related events in the Project region:

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[18] Refer local ESIA.

[19] Refer local ESIA.

- In 2022 Angola adopted a Country Climate and Development Report[20]. The report identifies pathways to achieving climate-resilient growth. A robust analysis of the impact of climate science was undertaken, followed by an in-depth analysis of the macroeconomic and sectoral implications of climate impacts on Angola's future development prospects. The report was developed by the World Bank, the IFC and Multilateral Investment Guarantee Agency, in partnership with the Government of Angola.
- The Ministry of Environment of Angola, developed in 2020 an updated version of the First Intended Nationally Determined Contribution (iNDC) of Angola for 2020 - 2025[21], setting targets to contribute to the achievement of the PA goals and meeting the country compromises in climate change policy.
- The Government of Angola launched in 2017 the National Strategy for Climate Change 2018-2030[22], prepared by the Ministry of the Environment with support from the United Nations Development Program (UNDP), which identifies and defines a set of strategic options of mitigation and adaptation for different economic sectors.
- The Project has an active Emergency Preparedness & Response Plan, which was prepared by Quantum to be used by Sinohydro (the contractor) during construction activities.

Adaptive Capacity to Extreme Precipitations and floods: overall Adaptive Capacity has been assigned “medium”, due to project design considers drainage works inside the project footprint to face high levels of precipitations.

Adaptive Capacity to Extreme Heat: overall Adaptive Capacity has been assigned “medium”. Adaptive Capacity measures seem quite basic for this type of infrastructure. Ventilation and air conditioning systems (HVAC) will be installed in the buildings.

Adaptive Capacity to Drought: applying a conservative approach, overall Adaptive Capacity has been assigned “medium”. Project design considers technologies or processes that will be implemented for the reduction of water consumption, awareness campaigns to the workers and users of the airport will be also carried out during operation phase.

Adaptive Capacity to Water stress: applying a conservative approach, overall Adaptive Capacity has been assigned “medium”. Project design considers technologies or processes that will be implemented for the reduction of water consumption, awareness campaigns to the workers and users of the airport will be also carried out during operation phase and water quality monitoring will be implemented as necessaire during airport activities.

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[20] Source of the document: World Bank website, https://www.worldbank.org/en/publication/country-climate-development-reports

[21] National Determined Contribution of Angola. Republic of Angola (May 2021) and UNDP.

[22] Source of the document: ENAC 2018-2030_14082017.pdf (undp.org).

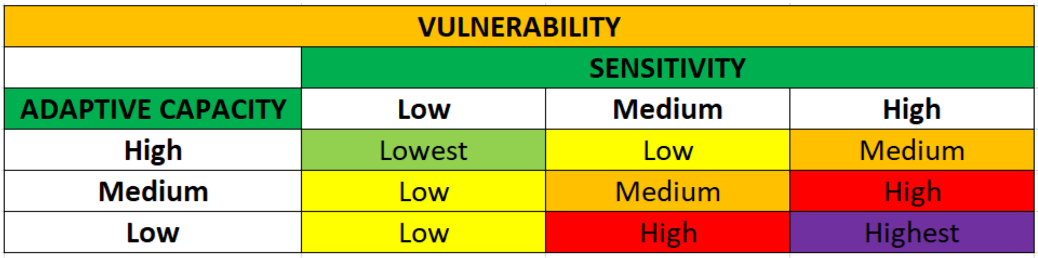
Table 7 Resume of Adaptative Capacity levels.

Climate hazard	Adaptative Capacity
Extreme precipitations	Medium
Floods	Medium
Extreme heat	Medium
Drought	Medium
Water stress	Medium

4.3.4. Vulnerability assessment

The magnitude of potential effects and consequences were assessed for each hazard, combining the Sensitivity and the Adaptive Capacity. A qualitative approach has been used, applying the matrix shown in the following table:

Table 8 Vulnerability matrix



VULNERABILITY			
	SENSITIVITY		
ADAPTIVE CAPACITY	Low	Medium	High
High	Lowest	Low	Medium
Medium	Low	Medium	High
Low	Low	High	Highest

The level of Vulnerability for all hazards assessed is "medium", meaning that the Project would be affected in case of such events, but consequences would be less severe. Table 9 shows the details of Vulnerability assessment for all hazards considered.

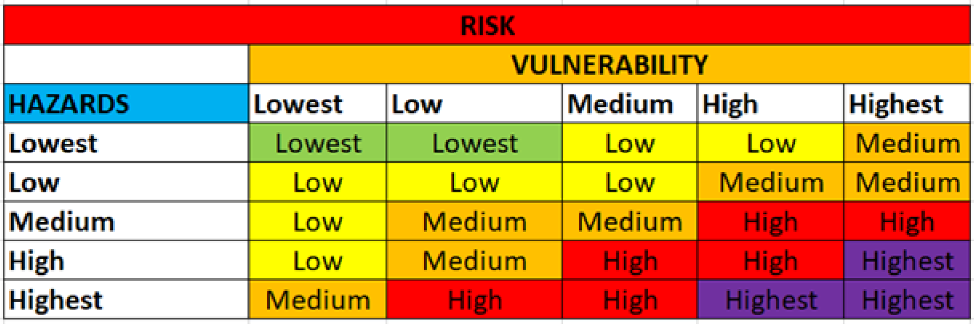
Table 9 Vulnerability assessment

Hazard	Sensitivity	Adaptive Capacity	Vulnerability
EXTREME PRECIPITATIONS	MEDIUM	MEDIUM	MEDIUM
FLOODS	MEDIUM	MEDIUM	MEDIUM
EXTREME HEAT	MEDIUM	MEDIUM	MEDIUM
DROUGHT	MEDIUM	MEDIUM	MEDIUM
WATER STRESS	MEDIUM	MEDIUM	MEDIUM

5. PHYSICAL RISK ASSESSMENT

The Climate Change Risk has been assessed combining Vulnerability and Hazard levels, according to qualitative considerations based on the following matrix:

Table 10 Risk matrix



RISK					
	VULNERABILITY				
HAZARDS	Lowest	Low	Medium	High	Highest
Lowest	Lowest	Lowest	Low	Low	Medium
Low	Low	Low	Low	Medium	Medium
Medium	Low	Medium	Medium	High	High
High	Low	Medium	High	High	Highest
Highest	Medium	High	High	Highest	Highest

Three range of times (short-, mid-, and long-term) were considered from 2020 to 2100 where optimistic, intermediate and pessimistic scenarios were analysed consistently with the Project lifespan and the selected temporal scope of the hazard's characterization. All risks resulted relevant, at present and in the future, according to all emission scenarios. The minimum level assessed is the "medium" risk class, which already requires a special attention. A summary of the outcomes is in the following:

Extreme precipitations Risk:

The risk of extreme precipitations should be taken under great consideration because the risk is "**medium**" already at present and it is expected to either remain like that for the entire temporal scope, for the optimistic scenario, or to further increase to the "high" level, for both the intermediate scenario (since 2070) and the pessimistic scenario (since 2060).

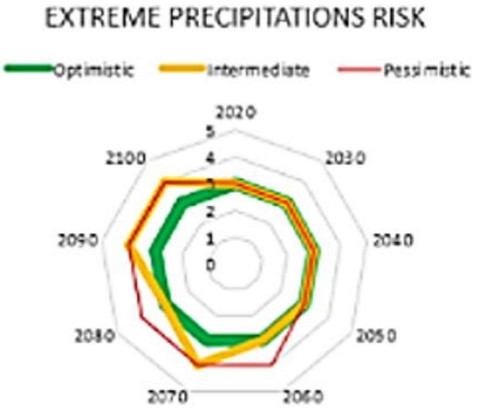


Figure 13 Detailed trends for Extreme precipitations risk over time and according to the three-carbon emission scenarios.

Floods

The risk projected for floods is "**low**" however should be considered due to it is already at present and it is expected to either remain like that for the entire temporal scope, as the intensity of extreme precipitations is expected to increase at a country level.

Climate hazard	Short-term			Mid-term			Long-term		
	SSP1-2.6	SSP3-4.5	SSP5-8.5	SSP1-2.6	SSP3-4.5	SSP5-8.5	SSP1-2.6	SSP3-4.5	SSP5-8.5
Floods	N/A	low	Low	N/A	Low	Low	N/A	Low	Low

Extreme Heat Risk:

Extreme Heat risk should be taken under consideration as it is expected to increase in the future according to all scenarios. The risk is expected to be a "**medium**" level in all scenarios by 2040. For the intermediate scenarios it further increases, reaching the "high" level in 2070. For the pessimistic scenario the increase is even faster, with the "high" level reached already in 2050.

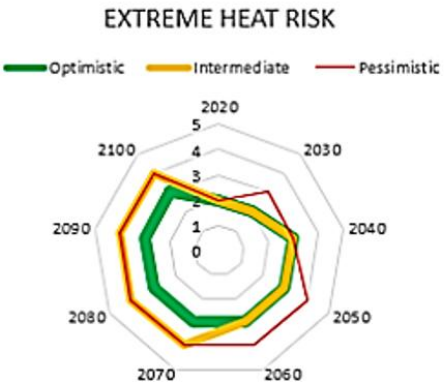


Figure 14 Detailed trends for Extreme heat risk over time and according to the three-carbon emission scenarios

Drought Risk:

This is one of the most critical risks because it is already "medium" at present and it is expected to rapidly increase in all emission scenarios, reaching the "**high**" level in 2030. For the intermediate and pessimistic scenarios, it increases even further, reaching the "highest" level respectively since 2070 and 2060.

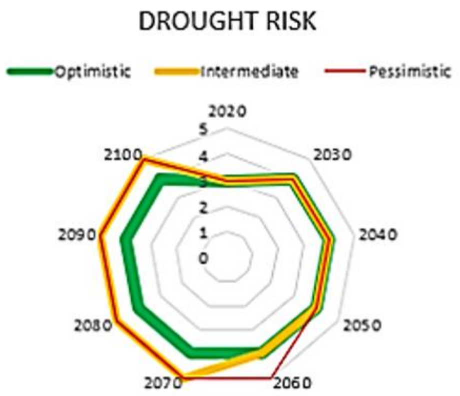


Figure 15 Detailed trends for Drought risk over time and according to the three-carbon emission scenarios.

<u>Water stress:</u>

This risk is already “**medium**” at present and however it could remain at the same level for over the century in every scenario, considering the historical data and projections presented.

Climate hazard	Short-term			Mid-term			Long-term		
	SSP1-2.6	SSP3-4.5	SSP5-8.5	SSP1-2.6	SSP3-4.5	SSP5-8.5	SSP1-2.6	SSP3-4.5	SSP5-8.5
Water stress	N/A	Medium	Medium	N/A	Medium	Medium	N/A	Medium	Medium

Table 11 Climate change risk assessment

Hazard	Level Level	Vulnerability	Risk level
Extreme precipitations	Medium	Medium	Medium
Floods	Low	Medium	Low
Extreme heat	Medium	Medium	Medium
Drought	High	Medium	High
Water stress	Medium	Medium	Medium

6. MATERIALITY ASSESSMENT

A double materiality approach is taken by identifying the risks that climate change may have on financial materiality and impact on materiality. This CCRA takes a double materiality approach. Double materiality is defined as any significant impact that the project has on the economy, environment, or society in the context of physical climate change, AND the impact that climate has on the Project.

Table 12 Materiality assessment

Risk	Materiality
Extreme heat	- Reduced staff productivity leading to increased costs from efficiency reduction - Costs associated with delay to construction during down time on extremely hot days. - Litigation costs associated with long-term worker health impacts - Reduced productivity leading to increased costs from efficiency reduction
Flooding / Wildfires	- Costs associated with delay to construction during down time - Reduced productivity leading to increased costs from efficiency reduction - Litigation costs associated with long-term worker health impacts - Risk to human welfare where income is affected by lack of work during event - Cost associated with transport difficulties, supply chain interruptions - Workers unable to access site leading to increased downtime
Wildfire events caused by the project	- As above where fire damages asset - Reputational risk following loss of life/injury/damage to assets could lead to reduced client and employee loyalty and investor divestment - Litigation costs associated with damage to public and private assets, and potential for litigation related to personal injury/ loss of life

7. RISK MITIGATION ACTIONS AND CONCLUSIONS

The Climate Change Physical Risk Assessment helped identifying the most critical climate-related risks, at present or in the future, according to different emission scenarios and during the lifetime of the Project as a consequence of Climate Change. The temporal scope has been precautionary chosen to extend up to 2100. Climate risks increase over time and have a peak at the end of the period, which implies that a shorter temporal scope would reduce the overall risk level.

The following measures are proposed to "reduce" the climate risks for the hazards considered in the assessment. The list of measures should be taken in consideration to reduce the Vulnerability of the Airport towards climate-related hazards.

All Risks

- The existing Project Emergency Preparedness & Response Plan should be expanded to include procedures and measures to deal with climate hazards during operation phase. The Plan should be regularly updated.

- Implement an early warning system and make provision for a direct connection with any existing early warning systems at local or regional level, if exists, to guarantee information on potential extreme event are monitored and shared on a daily basis.
- Maintain an efficient network connectivity within the Project site, making sure mobile communication and alternative communication systems would be available in case of an emergency due to climate-related extreme events.

Risk of Extreme Heat and Wildfires

- Consider using construction materials for buildings and other infrastructures with a lower capacity to absorb heat and higher capacity to maintain their main properties in case of extremely high temperatures.
- Provide proper and regular maintenance to buildings, infrastructures, and equipment to avoid increasing their sensitivity hot temperatures.
- Rescheduling working hours during extremely hot periods to ensure the safety and efficiency of staff working in outdoor areas.
- Consider the choice of building material used for the framing and façade of the buildings and aiming for non-combustible material for both. Conventional construction techniques using either or a combination of steel and concrete are proven to be reliable in wildfire provided these structures are well sealed to prevent firebrand entry (construction gaps should be less than 2mm).
- Provide trainings to the communities to increase awareness of the consequences of burning bush/herbaceous (as it is a common practice in Angola).
- Review health and safety plans, including development of heat-health action plans, and health and safety regulations such as:
    - ✓ Provision of cool potable water
    - ✓ Provision of shaded areas during rest periods
    - ✓ First Aid equipment to include treatment for dehydration e.g., electrolytes
    - ✓ Compulsory labour rest times on hot days
    - ✓ Appropriate dress codes

Risk of Droughts

- Introduce water efficiency systems and technologies to reduce water consumption.
- Introduce water efficiency systems and technologies to reuse water in the project.
- Implement strategies to diversify the water supply system such as water storages.

- Implement awareness campaigns addressing workers and airport users, to reduce water consumption.
- Reducing losses of water implementing a verification system to avoid water leaks.
- Locating new standby resources (for emergency)
- Providing permits to exploit additional resources.
- Small scale water collection/harvesting.

Risk of Extreme Precipitations

- Implement measures to protect the Airport and its main more sensitive infrastructures from infiltration due to intense precipitations, or disruption caused by strong wind and lightings which often characterize severe storms events.
- Keep manholes and drainage channels clean to avoid potential flooding in cases of heavy rain associated with intense precipitations.
- Tombe stream, studies were carried out to redefining the layout of the implementation of the AMK Project to eliminate, or if not possible, minimize such interferences / impacts, manly considering extreme precipitations, over 100 years. The temporary stream had to be diverted through an open channel of comfortable dimensions. The deviation was calculated for rainfall with a recurrence period of up to 100 years, which would allow maintaining the watercourse with a slope that guarantees a water velocity that avoids erosion.