REPORT

Mirny (Kazakhstan) 1GW Wind Farm Project

ESIA Report Chapter 09 - Climate Change Risk Assessment

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24685792-004-R-Rev 03

December 2025

Distribution List

Total Energies/Atkas Energy LLP

WSP Italy

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9.0 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 , 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. The EP4 categorize projects that are financed by Equator Principles Financing Institutions ("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 EP4, 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].
- For all projects, in all locations, when combined Scope 1 and Scope 2 emissions are expected to be more than 100,000 tonnes of CO2 equivalent annually. For these projects the CCRA is to include consideration of climate-related 'Transition Risks'. The CCRA must also include a completed alternatives analysis which evaluates lower greenhouse gas (GHG) intensive alternatives.

According to the Equator Principle Guidance Note on Climate Change Risk Assessment[3] a two-phased approach to the CCRA is proposed comprising the following components:

1) A preliminary review of the Project's compatibility with host country NCCs, including as appropriate NDCs, LTS and Paris Agreement objectives, with compatibility framed in the context of 'Aligned', 'Conditional' or 'Unaligned'.

2) 2. Development of Project Resilience to Physical and/or Transition Climate Risks (under categories in line with TCFD recommendations), as relevant, through a staged CCRA process of screening/scoping; risk assessment; and risk management.

Considering that this Project has been classified as a Category A Project, a Physical Climate Change Risk Assessment is required. A GHG inventory will be implemented at a second stage, when all needed information to properly quantify combined Scope 1 and Scope 2 emissions will be available.

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, 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:

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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.

[3] Equator Principle IV Guidance Note On Climate Change Risk Assessment (May 2023) is document to support the understanding and implementation of climate change risk assessment requirements

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

9.1 COMPATIBILITY WITH NATIONAL CLIMATE COMMITMENTS (NDCs)

9.1.1 The context

Since 2015, countries that adheres to the Paris Agreement[4] are required to submit a national climate action plan known as Nationally Determined Contribution ("NDC").

NDCs submitted under the Paris Agreement, are the main channel for countries to publicly state their self-defined ambitions in setting long-term decarbonisation targets to keep global temperature rise below 1.5 degrees and to set goals on enhancing climate resilience. Each country that has ratified the Agreement, is required to submit their NDCs to the United Nations Framework Convention on Climate Change ("UNFCCC") secretariat every five years. These represent a progression compared to the previous NDC and reflect its highest possible ambition. NDCs include targets, measures and policies and are the basis for national climate action plans, programmes and policies.

In line with EP4 Annex A, the CCRA should take "into consideration" the Project's "compatibility" with the NDC of the host Country.

9.1.2 Kazakhstan NDCs

Kazakhstan ratified the Paris Agreement in November 2016 and committed itself to the fulfilment of a target of economy-wide reduction of GHG emissions of 15% from 1990 emissions levels by 2030 in its NDC. The Republic of Kazakhstan aims to achieve carbon neutrality by 2060, which contributes to the accelerated achievement of the global peak of greenhouse gas emissions in the first half of the 21st century and also takes into account the constraints imposed by the principles of equity, sustainable development and poverty eradication.

Kazakhstan submitted its revised NDC in June 2023. Here following are the main highlights from the NDC:

- Kazakhstan commits to a 25% reduction in emissions by 2030, compared to 1990 levels, conditional on international support.
- The country also set an unconditional emissions reduction target of 15% by 2030, compared to 1990 levels.
- The revised NDC includes adaptation components for the first time, with a focus on agriculture, water, forestry, and disaster risk management.
- The country plans to expand adaptation measures to other sectors affected by climate change impacts such as health and infrastructure.

The Republic of Kazakhstan will need to introduce new and significantly strengthen existing carbon pricing mechanisms in order to achieve its NDC, which has a double dependence on fossil fuels (coal and oil) in the country. It will also be necessary to increase the share of renewable energy sources (solar and wind) in the balance of electricity production, and to use previously unused capacities to increase the manoeuvrability of the system.

9.1.3 Project compliance with Kazakhstan NDCs

Developed in partnership with the National Wealth Fund Samruk-Kazyna and the National Company KazMunayGas, the wind farm will be capable of supplying one million people with electricity from renewable sources, thereby helping decarbonize the country's energy mix.

[4] The Paris Agreement is a legally binding international treaty on climate change. It was adopted by 196 Parties at the UN Climate Change Conference (COP21) in Paris, France, on 12 December 2015. It entered into force on 4 November 2016.

The Mirny onshore wind Project will harness the winds that sweep across the region’s semi-arid expanses (averaging 8.9 meters per second per year) and transform them into low-carbon electricity. Featuring a total capacity of one gigawatt (GW), this onshore wind farm’s 150 wind turbines will be combined with a 600 megawatt-hours (MWh) battery-based ESS for a reliable and sustainable power supply.

According to a 25-year power purchase agreement (“PPA”) signed in June 2023, all the electricity produced by the Mirny Project will be sold to the Financial Settlement Center of Renewable Energy, a public entity owned by the Government of Kazakhstan, for the supply of the national grid. The Mirny facilities will deliver 4 TWh a year of renewable electricity, covering the needs of one million inhabitants, i.e. 4% of the country’s production, avoiding an estimated 3.5 million tons of CO2 emissions per year.

The Mirny wind farm is currently the largest wind farm Project ever undertaken in Kazakhstan. It represents a real technical challenge, not least because of its sheer size (it is almost 10 times bigger than the country’s largest solar power plant), the region’s extreme weather conditions (a summer-winter temperature difference of 70°C), and its distance from the electricity grid, requiring the construction of more than 200 km of power lines. Construction is due to start in the fall of 2025, with the first electricity injected into the grid in 2028.

Both goals and expected achievement listed above are definitely in line with Kazakhstan NDCs. The realization of this Project will contribute the reduce Kazakhstan GHG emissions and the impacts on Climate Change, helping the country to become more developed and more resilient.

9.2 OVERVIEW OF THE CLIMATE CHANGE PHYSICAL RISK ASSESSMENT METHODOLOGY

According to the ISO 14091 Standard “Adaptation to climate change – Guidelines on vulnerability, impacts and risk assessment[5]”, CCRA fulfils diverse objectives depending on a client’s information needs, and on challenges caused by climate change. These can include the following:

- Raising awareness: CCRA helps in increasing the 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 CCRA process 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 section of the CCRA chapter presents an overview of the methodology for CCRA for physical risks and applies it 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 the Client may consider and implement to mitigate these risks.

WSP developed a CCRA based on existing methodologies for the assessment of climate change risks and vulnerability as part of adaptation strategies. Guidelines and methodologies from the Equator Principle Guidance Note on Climate Change Risk Assessment, the ISO 14091 as well as the Intergovernmental

[5] ISO 14091 gives guidelines for assessing the risks related to the potential impacts of climate change. It describes how to understand vulnerability and how to develop and implement a sound risk assessment in the context of climate change.

Panel on Climate Change (IPCC)[6] and the World Bank Group[7] were used as a guidance for defining factors that contribute to determine the risk. These methodologies consider a variety of risk components whose definitions are 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: the result of the combination of Hazard probability or intensity at a certain time and the Vulnerability.

This methodology assesses all different climate-related hazards independently, at present and in the future, using projected data that cover the entire century, with a focus on specific time periods (named near future, medium future and distant future) consistent with the Project lifecycle, and according to multiple future carbon emission scenarios. For each specific hazard, the risk components are assigned a qualitative class ("i.e., "high", "medium", "low") and then combined using qualitative matrices, as explained in Figure 1. The result is a class of Risk ("low", "medium", "high" or "extreme") for each climate-related hazard considered in the analysis. The following figure shows the risk assessment process for a specific hazard "h" the Project is exposed to.

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

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

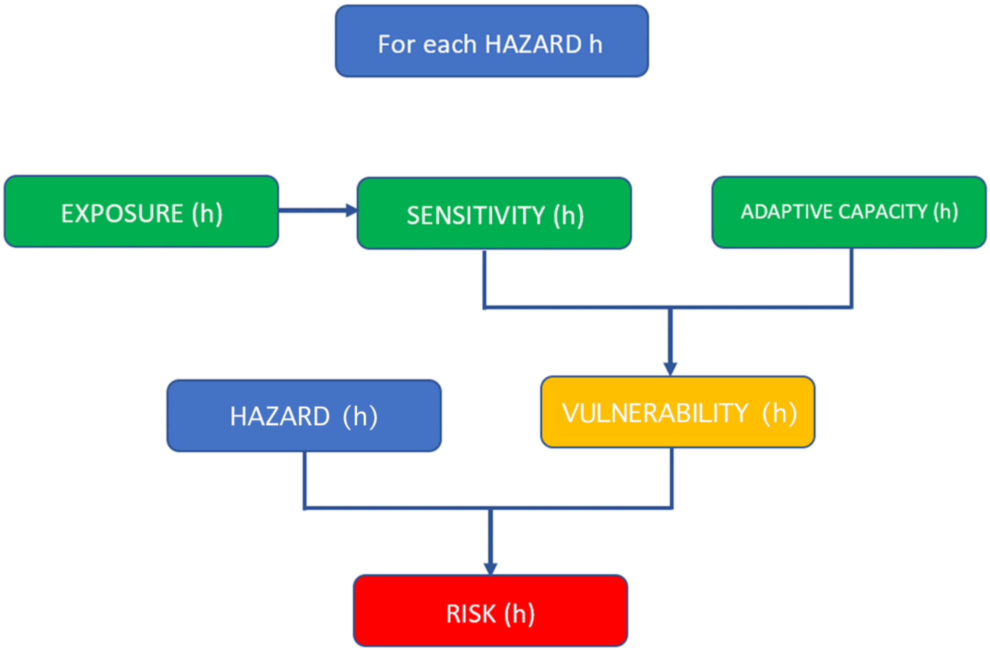

Figure 1: Workflow of the risk assessment for a specific hazard "h" the Project is exposed to, showing how different risk factors are combined across the analysis.

9.3 PHYSICAL RISKS ASSESSMENT

This CCRA aims at identifying the most relevant and critical risks due to climate-related events, at present and in the future, that may affect the Project. The CCRA will focus on the following main Project components:

- 150 WTGs for a total of 1 GW installed capacity and related foundations.
- BESS of 300/600 Megawatt-hour ("MWh") that will be operated by Kazakhstan Electricity Grid Operating Company ("KEGOC").
- Step-up substations, one to the North Mirny SS and one to the South Mirny SS of 500 kV/35 kV.
- Overhead Transmission Lines.
- Access roads.
- Underground Cables.

This study focuses on the potential impacts and related risks due to extreme events related to climate change that may happen at the Project site. The Project site with a focus on the components considered in the CCRA is represented in Figure 2 (underground cables are not shown).

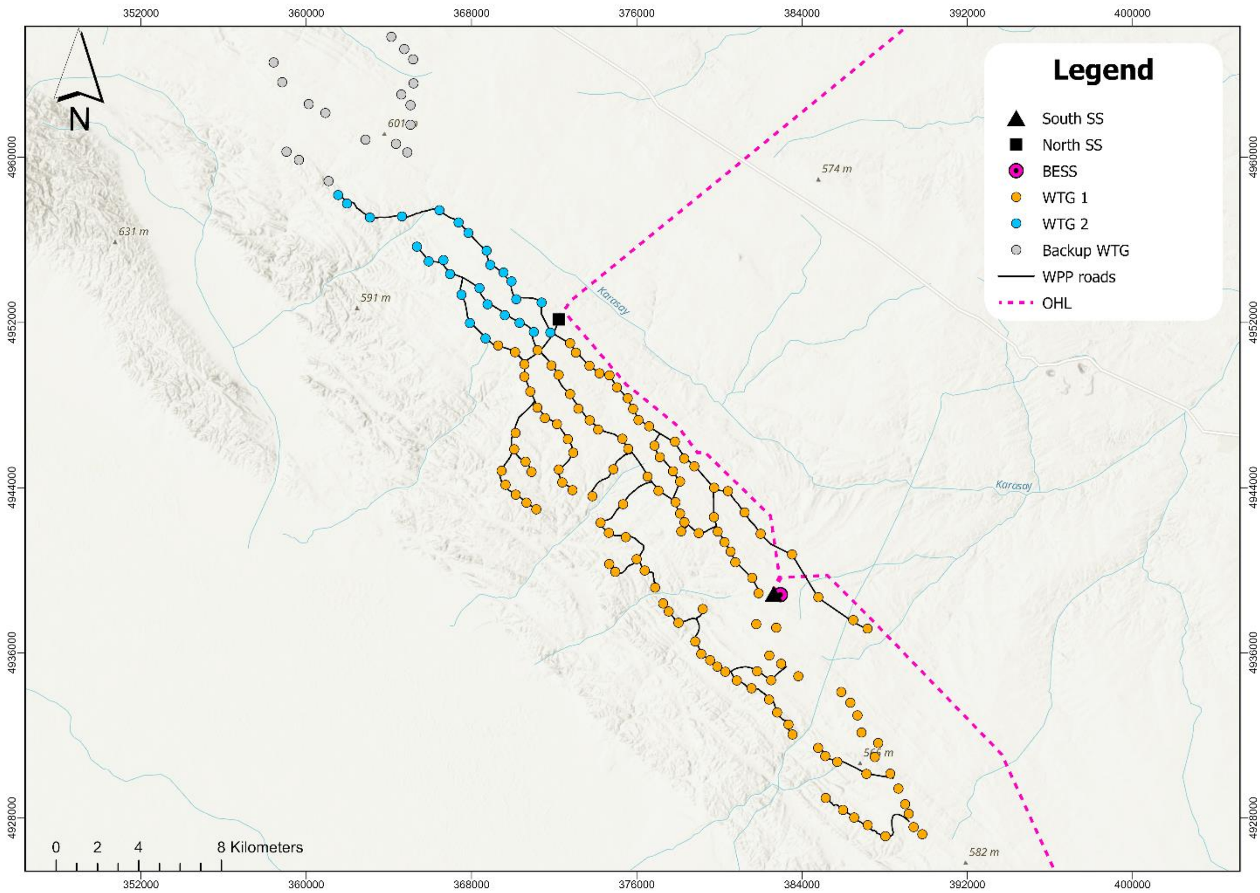

Figure 2 CCRA Area of Study and Project layout with a focus on Project components included in the CCRA.

9.3.1 Assessment of Hazards

9.3.1.1 Climate Overview of the Jambyl Region

9.3.1.1.1 Historical trends

For the historical climatic trends, data from the ERA5 (European ReAnalysis version5) reanalysis system were used, which provides hourly estimates of numerous atmospheric, terrestrial and oceanic climatic variables. The data covers the Earth on a 30 km grid and resolves the atmosphere using 137 levels from the surface to an altitude of 80 km. Information on uncertainties is also provided for variables with low spatial and temporal resolutions. Quality assured monthly updates of ERA5 (1950 to 2020) are released within 3 months in real time. Preliminary daily dataset updates are available to users within 5 days in real time.

Temperatures show an overall constant increase across the historical reference period while annual precipitations show significant fluctuations but no major trends.

Average Mean Surface Air Temperature

Average annual mean surface air temperature for Jambyl region shows an increase across the entire historical reference period, with a 5-year rolling mean moving from around 8.5°C in 1950 to around 11°C in 2020.

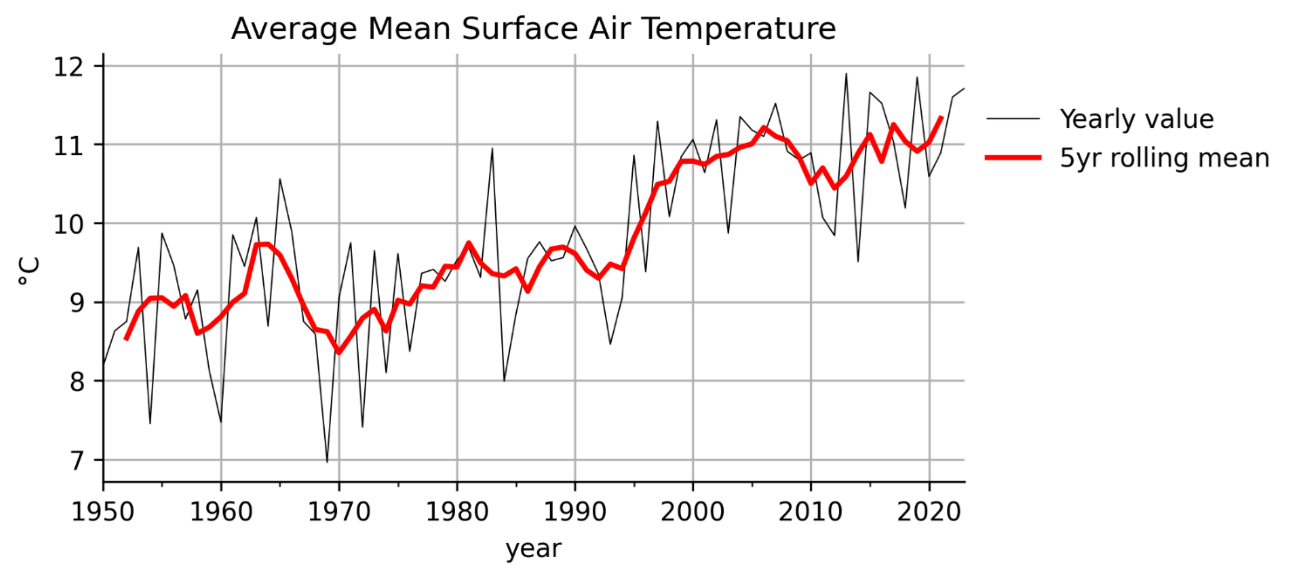

Figure 3: Average mean temperature over the aggregation period (1950 to 2020).

Average Maximum Surface Air Temperature

Average annual maximum surface air temperature for Jambyl region shows an increase across the entire historical reference period, with a 5-year rolling mean moving from around 13.5°C in 1950 to around 16.5°C in 2020.

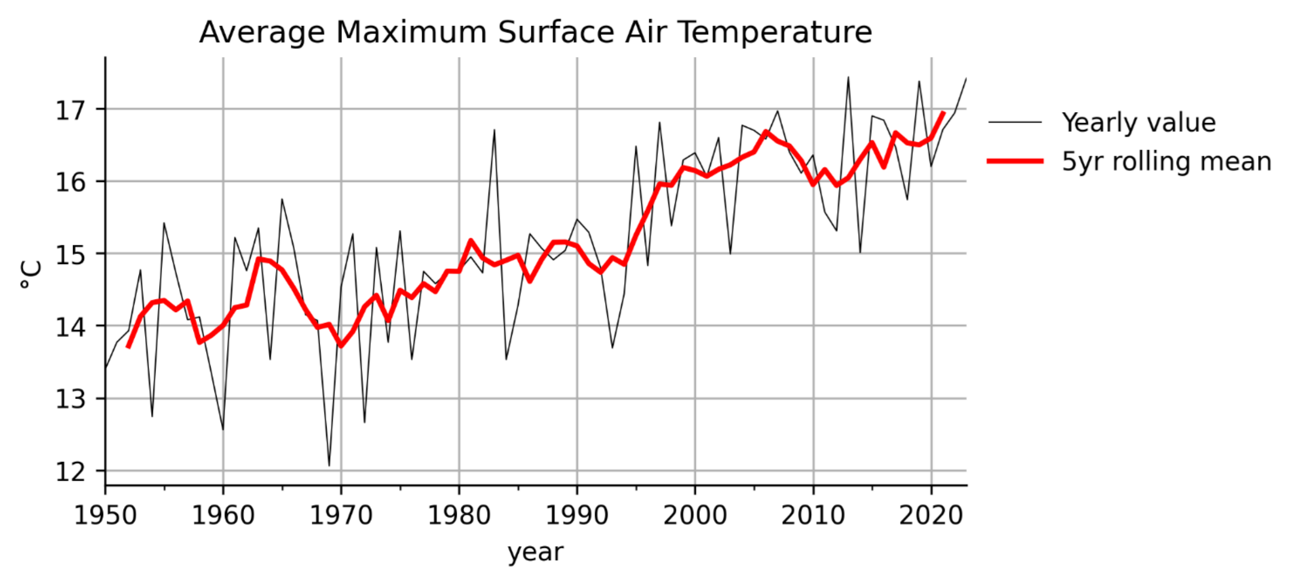

Figure 4: Average maximum temperature over the aggregation period (1950 to 2020).

Average Minimum Surface Air Temperature

Average annual minimum surface air temperature for Jambyl region shows an increase across the entire historical reference period, with a 5-year rolling mean moving from around 2.5°C in 1950 to nearly 5°C in 2020.

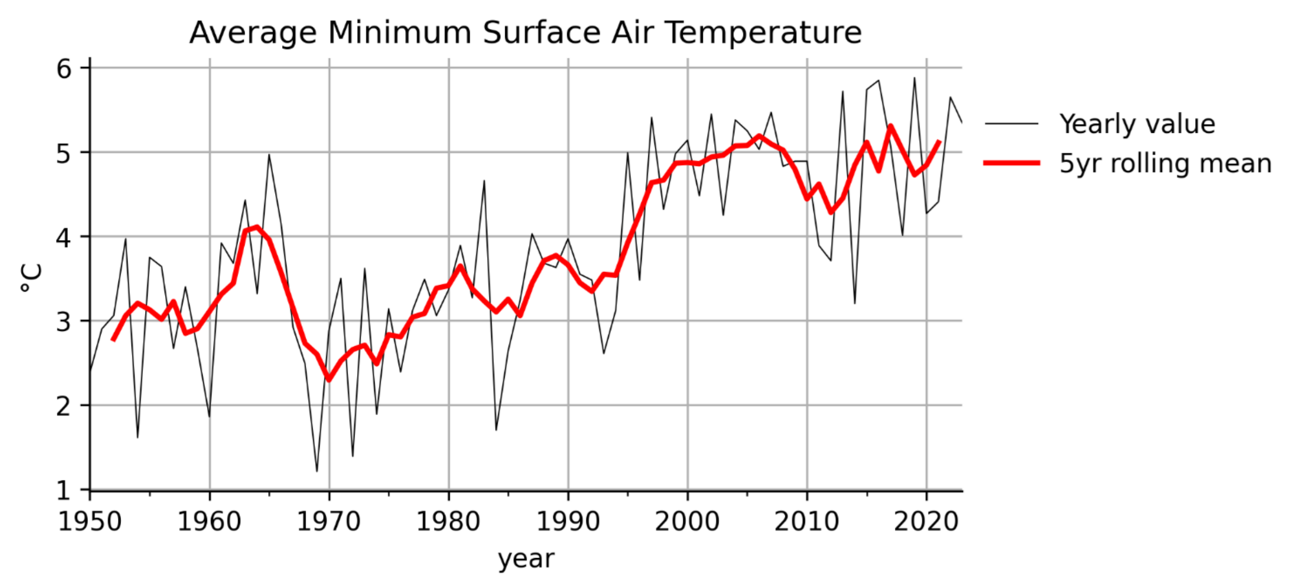

Figure 5: Average minimum temperature over the aggregation period (1950 to 2020).

Minimum of Daily Min-Temperature

Annual minimum of daily minimum surface air temperature for Jambyl region shows an increase across the entire historical reference period, with a 5-year rolling mean moving from around -28°C in 1950 to around -22°C in 2020.

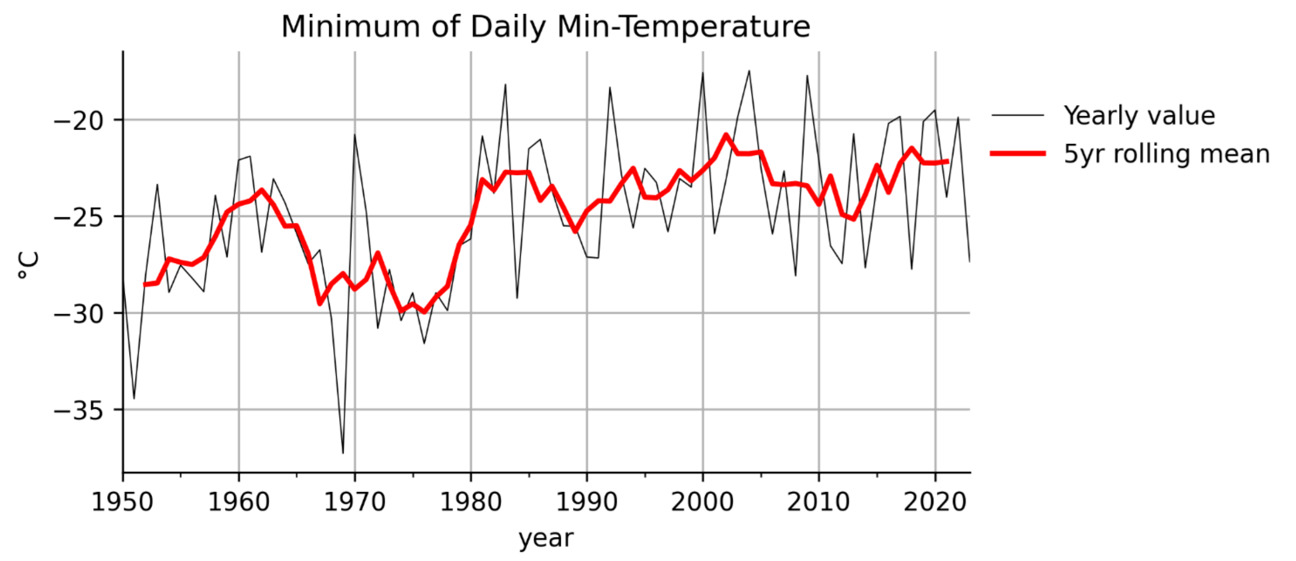

Figure 6: The single-day minimum value of the daily minimum temperatures over the aggregated data period (1950 to 2020).

Maximum of Daily Max-Temperature

Annual maximum of daily maximum surface air temperature for Jambyl region shows an increase across the entire historical reference period, with a 5-year rolling mean moving from around 38°C in 1950 to around 40°C in 2020.

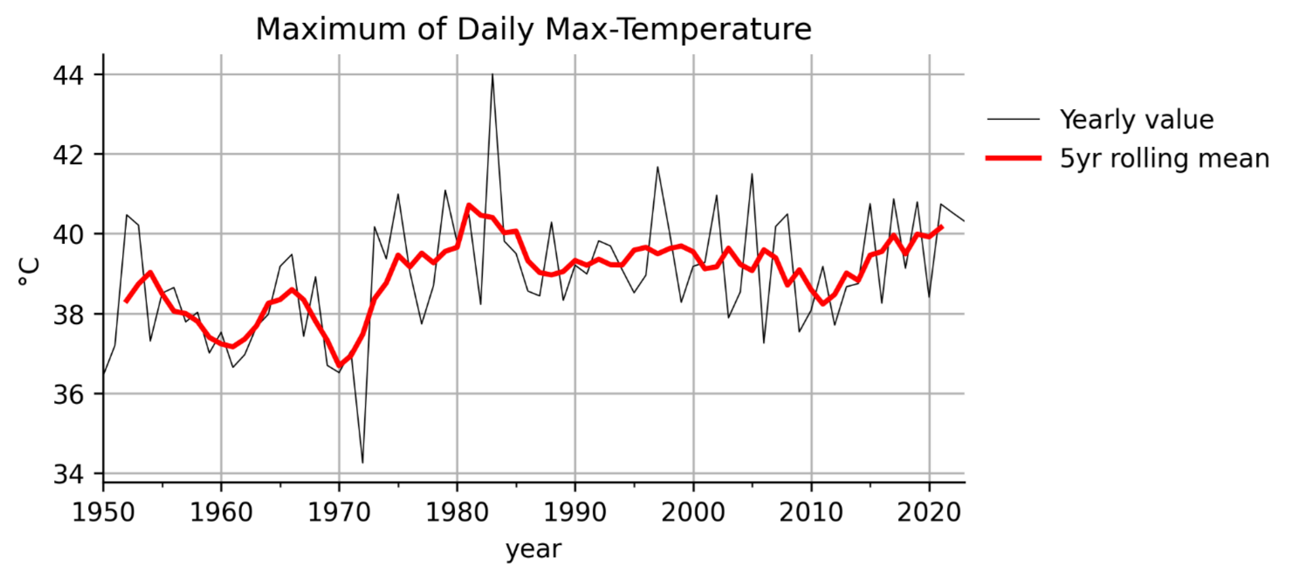

Figure 7: The single-day maximum value of the daily maximum temperatures over the aggregated data period (1950 to 2020).

Annual Precipitation

Annual aggregated accumulated precipitation for Jambyl region shows significant fluctuations across the entire historical reference period. However, comparing the with a 5-year rolling mean in 1950 (around 300 mm) and in 2020 (330 mm) with all other 5-year rolling mean values across the entire historical reference period, no major trends can be identified.

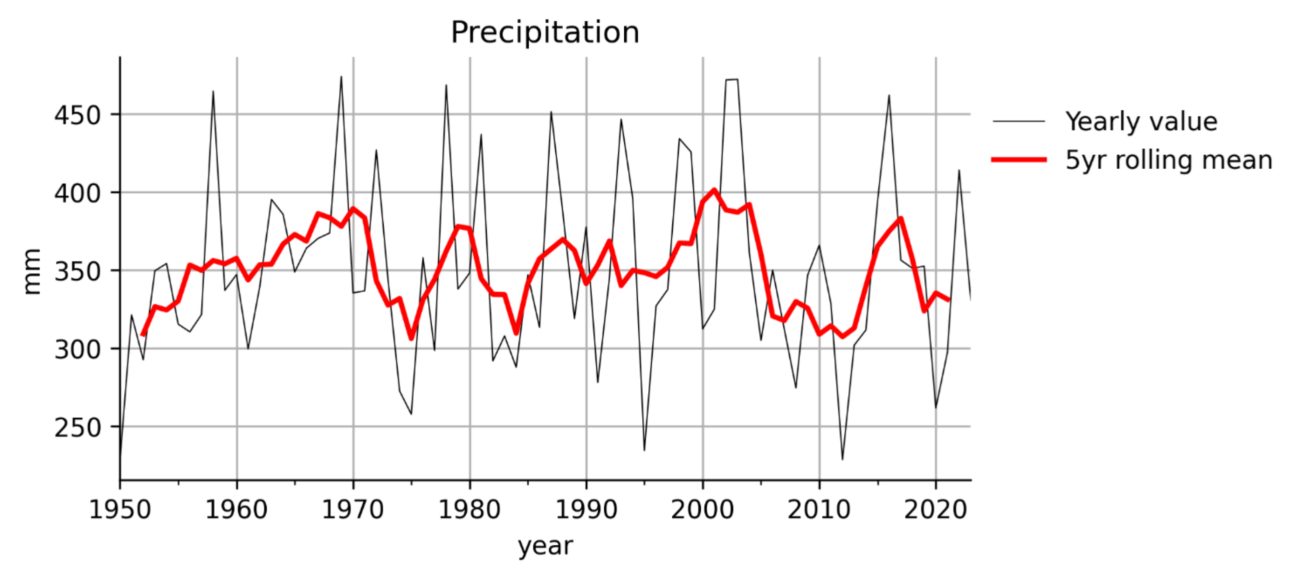

Figure 8: Aggregated accumulated precipitation over the aggregated data period (1950 to 2020).

Average Largest 1-Day Precipitation

Average largest 1-day precipitation for Jambyl region shows significant fluctuations across the entire historical reference period. However, comparing the with a 5-year rolling mean in 1950 (little less than 15 mm) and in 2020 (little more than 15 mm) with all other 5-year rolling mean values across the entire historical reference period, no major trends can be identified.

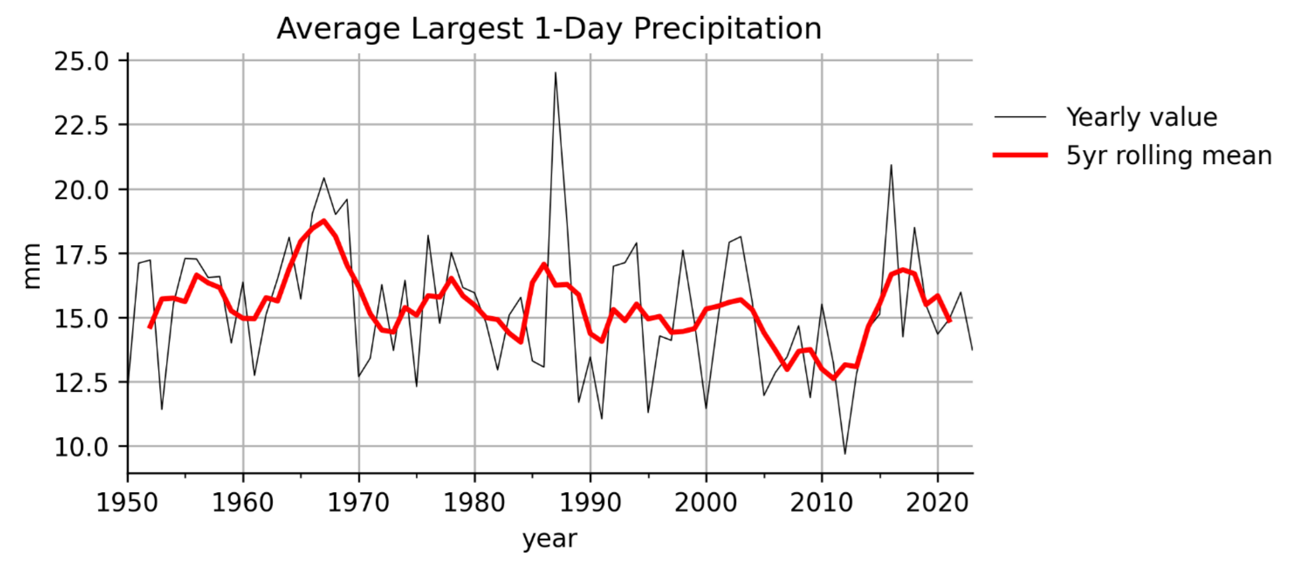

Figure 9: The average highest precipitation amount in a 1-day period during each month in the data period (1959 to 2020).

9.3.1.1.2 Present conditions

Present climate conditions have been evaluated based on information already described in *ESBS Report Chapter 04 - Baseline Conditions, Physical Environment* report (ref. doc. **24685792-002-R-Rev 1_ESBS**). The characteristic features of the climate in the Jambyl Region are significant aridity and continentality. This is due to the location of the Region within the Eurasian continent, its distance from the oceans, the nature of atmospheric circulation that contributes to frequent formation of clear or partly cloudy weather, as well as the southern position, which ensures a large influx of solar heat. In addition, a significant part of the Region is occupied by deserts (Betpaqdala and Moiynkum), and only the southwestern, southern, and southeastern edges are occupied by mountains (Karatau Ranges, Kyrgyz Alatau Ranges, and Shu-Ile Low Hill Terrain). These differences in the relief bring great diversity to the region's climate. The continentality of the climate is manifested in sharp temperature contrasts between day and night, winter and summer, and in the rapid transition from winter to summer. In the southern mountainous part of the region, the characteristics of continentality are softened: winter here is milder, and the precipitation is better.

The desert plains of the northern and central districts of the Region are particularly arid. Summers are very hot, with average July temperatures ranging from 21 to 25°C, and on some days, the air temperature reaches 45-48°C (absolute maximum). However, the winter severity does not correspond to the geographical latitude. The coldest month is January, with an average temperature of -8 to -12°C in the northern part of the Region and -4 to -7°C in the southern part. Cold Arctic air penetrating the south of the Region during winter causes severe frosts, reaching -45 to -50°C (absolute minimum).

The period with an average daily air temperature above 0°C is quite prolonged. In the northern part of the region, it lasts 240-250 days, and in the central districts, 260-270 days.

Overall, the Region receives little precipitation, especially in its plains (140-220 mm per year). A minimal amount of precipitation (135 mm per year) is noted in the northeast of the Region near the shores of Lake Balkhash. In the foothill areas, the amount of precipitation increases to 210-330 mm. In the mountains of the Kyrgyz Alatau, precipitation reaches 400-500 mm. Precipitation is distributed extremely unevenly throughout the seasons, with the majority occurring in the winter-spring period.

Throughout most of the region, the prevailing wind directions are east and northeast, with only the extreme south experiencing more frequent south and southeast winds. Their average speed is 2.5-3.5 m/s. In the mountainous areas, winds are influenced by local conditions (foehns, mountain-valley winds, etc.).

9.3.1.1.3 Future trends

Future climate projections for the period 2014-2100 were obtained from the Coupled Model Intercomparison Project Phase 6 (CMIP6) a Project of the Working Group on Coupled Modeling (WGCM) of the World Climate Reserach Program (WGCM), which coordinates since 1995 the global climate modeling experiments carried out by various working groups (for Italy by the Euro-Mediterranean Center for Climate Change (CMCC)), through the definition of common protocols and drivers for all models. The data is made available on a 100x100km grid and for a series of socio-economic scenarios (Shared Socioeconomic Pathways - SSP) which reflect different possible evolution scenarios of greenhouse gas emissions.

The data used are those referring to the Multi model ensemble for the following scenarios:

- SSP1-2.6: optimistic scenario in which global CO2 emissions are drastically reduced reaching net zero after 2050 thanks to an evolution of societies towards environmental and social sustainability and temperatures stabilize around 1.8°C more by the end of the century.
- SSP2-4.5: Intermediate scenario in which CO2 emissions hover around current levels before starting to decline mid-century but fail to reach net zero by 2100. Socio-economic factors follow their historical trends

without significant changes. Progress towards sustainability is slow, with development and income growing unevenly. In this scenario, temperatures rise by 2.7°C by the end of the century.

- SSP5-8.5: Pessimistic scenario where current CO2 emission levels roughly double by 2050. The global economy is growing rapidly, but this growth is fuelled by fossil fuel and energy high-intensive lifestyles. By 2100, the global average temperature will be as much as 4.4°C higher.

Temperatures show an overall increase, quite similar for all different emission scenarios until mid-century, while for the second part of the century for the pessimistic scenario the increase is more pronounced, less pronounced for the intermediate scenario and stability according to the optimistic scenario.

Precipitations show a slight increase for the intermediate and pessimistic scenario, while for the optimistic projections seem to fluctuate around present data.

Average Mean Surface Air Temperature

Future projections of average mean surface air temperature show an increasing trend in all different emission scenarios, until around the middle of the century, with around 1-1.6 °C increase compared to 2020, more significant for the pessimistic scenarios, little less for the intermediate and even lower for the optimistic scenario.

In the second half of the century differences among different scenarios are more evident. For the pessimistic and intermediate scenarios, average mean surface temperatures are predicted to keep increasing, with much higher increase for the pessimistic than for the intermediate scenario (around +5.6 in 2100 for the pessimistic scenario, around +2.5 for the intermediate) while for the optimistic scenario values show stability.

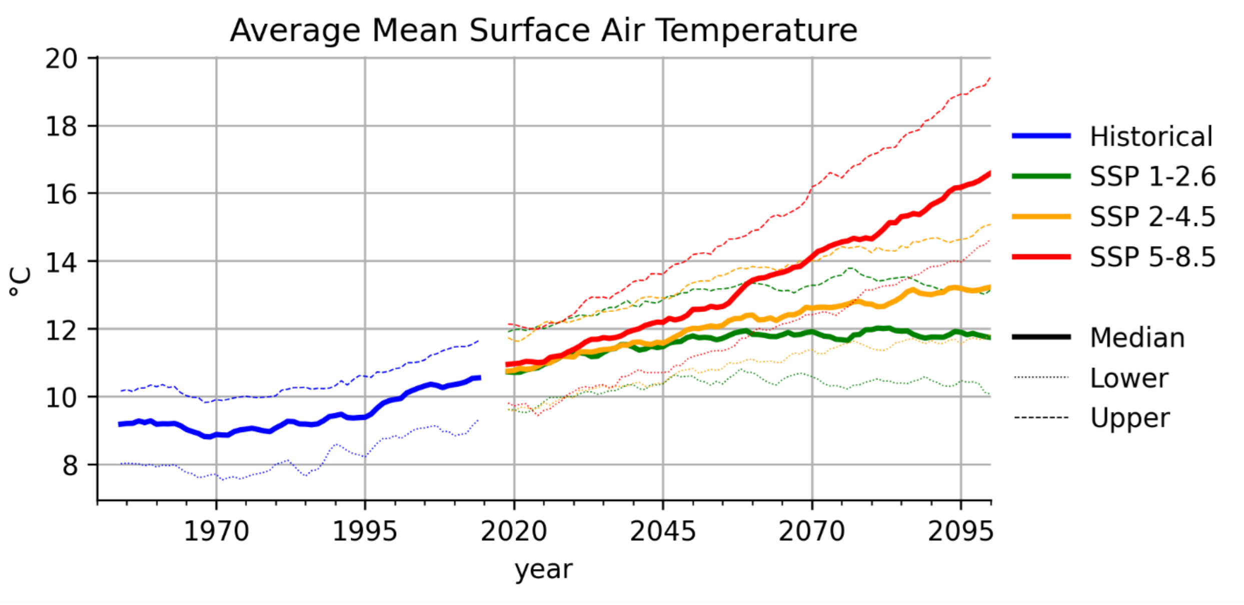

Figure 10: Average mean temperature over the aggregation period (2014 to 2100).

Average Maximum Surface Air Temperature

Future projections of average maximum surface air temperature show an increasing trend in all different emission scenarios, until around the middle of the century, with around 1.1-1.6 °C increase compared to 2020, more significant for the pessimistic scenarios, little less for the intermediate and even lower for the optimistic scenario.

In the second half of the century differences among different scenarios are more evident. For the pessimistic and intermediate scenarios, average maximum surface temperatures are predicted to keep increasing, with much higher increase for the pessimistic than for the intermediate scenario (around +5.7 in 2100 for the pessimistic scenario, around +2.5 for the intermediate) while for the optimistic scenario values show stability.

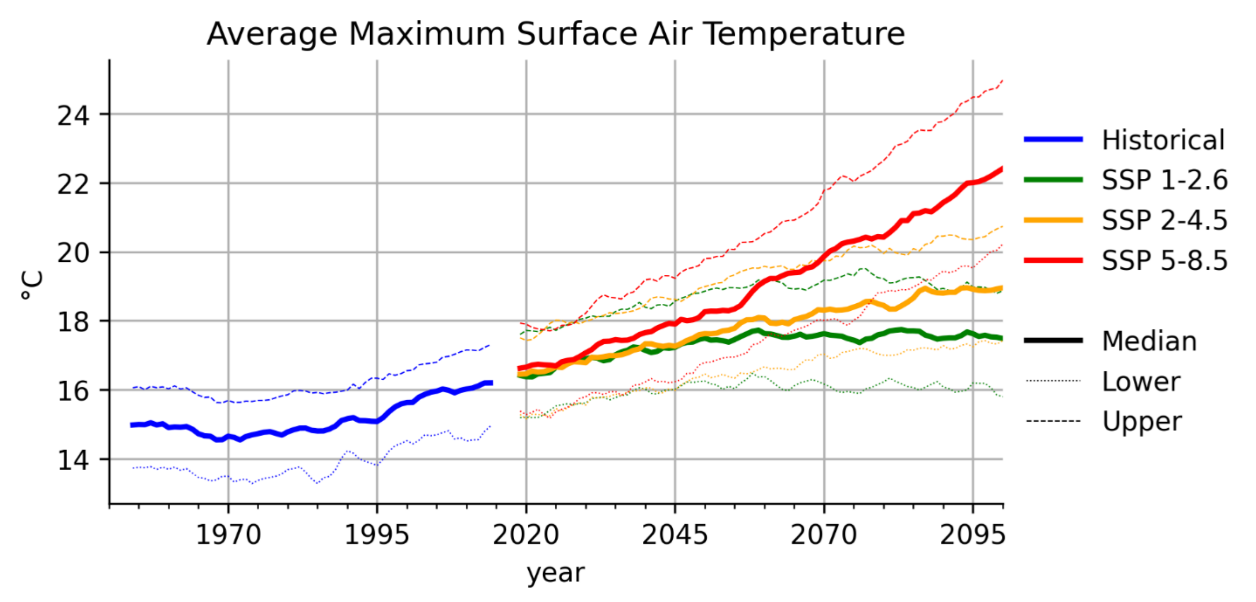

Figure 11: Average maximum temperature over the aggregation period (2014 to 2100).

Average Minimum Surface Air Temperature

Future projections of average minimum surface air temperature show an increasing trend in all different emission scenarios, until around the middle of the century, with around 1-1.6 °C increase compared to 2020, more significant for the pessimistic scenarios, little less for the intermediate and even lower for the optimistic scenario.

In the second half of the century differences among different scenarios are more evident. For the pessimistic and intermediate scenarios, average minimum surface temperatures are predicted to keep increasing, with much higher increase for the pessimistic than for the intermediate scenario (around +5.4 in 2100 for the pessimistic scenario, around +2.5 for the intermediate) while for the optimistic scenario values show stability.

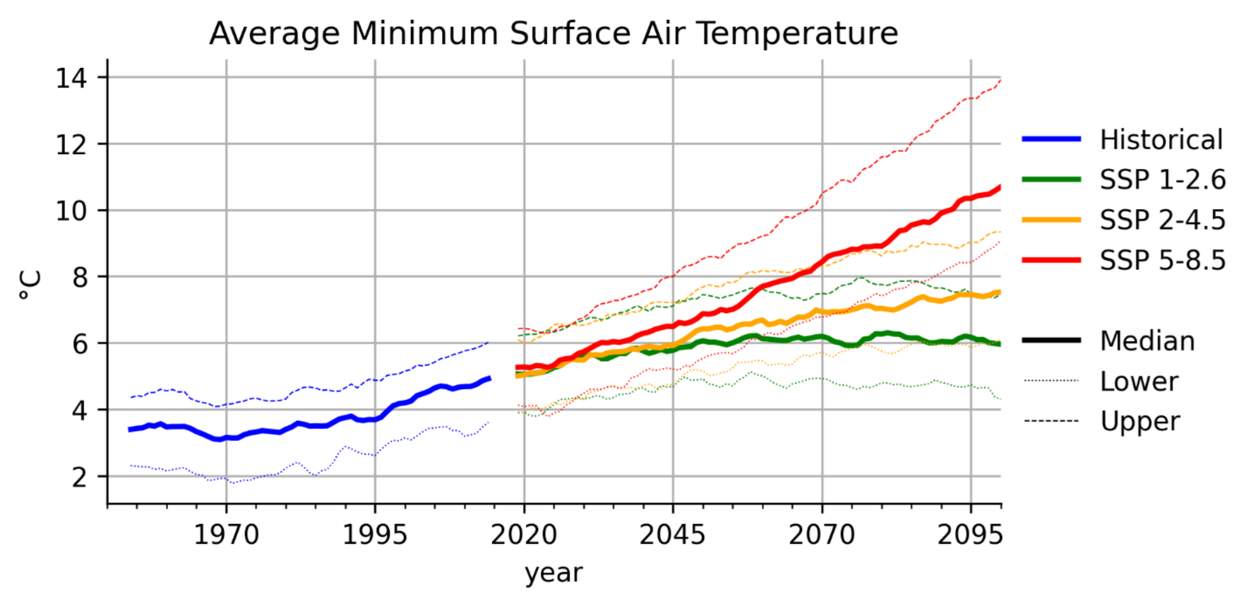

Figure 12: Average minimum temperature over the aggregation period (2014 to 2100).

Minimum of Daily Min-Temperature

Future projections of minimum of daily minimum surface air temperature show an increasing trend in all different emission scenarios, until around the middle of the century, with around 1.7-2.3 °C increase compared to 2020, more significant for the pessimistic scenarios, little less for the intermediate and even lower for the optimistic scenario.

In the second half of the century differences among different scenarios are more evident. For the pessimistic and intermediate scenarios, minimum of daily minimum temperatures are predicted to keep increasing, with much higher increase for the pessimistic than for the intermediate scenario (around +7.8 in 2100 for the pessimistic scenario, around +4.7 for the intermediate) while for the optimistic scenario values show stability.

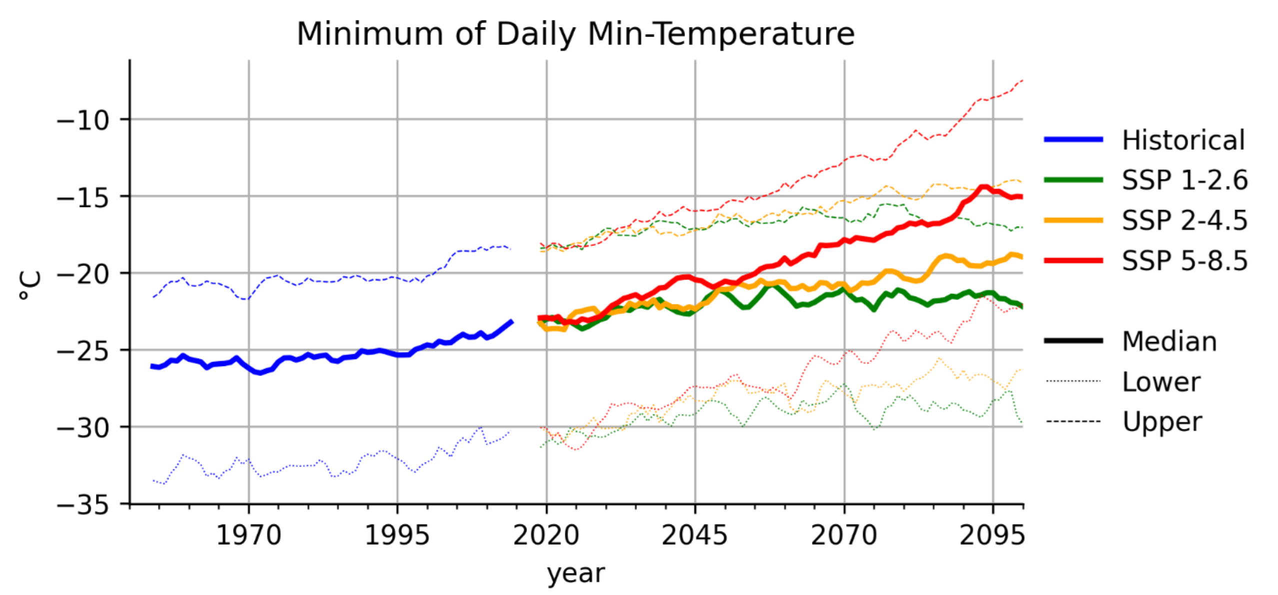

Figure 13: The single-day minimum value of the daily minimum temperatures over the aggregated data period (2014 - 2100).

Maximum of Daily Max-Temperature

Future projections of maximum of daily maximum surface air temperature show an increasing trend in all different emission scenarios, until around the middle of the century, with around 1.1-1.9 °C increase compared to 2020, more significant for the pessimistic scenarios, little less for the intermediate and even lower for the optimistic scenario.

In the second half of the century differences among different scenarios are more evident. For the pessimistic and intermediate scenarios, maximum of daily maximum temperatures are predicted to keep increasing, with much higher increase for the pessimistic than for the intermediate scenario (around +6.1 in 2100 for the pessimistic scenario, around +2.6 for the intermediate) while for the optimistic scenario values show stability.

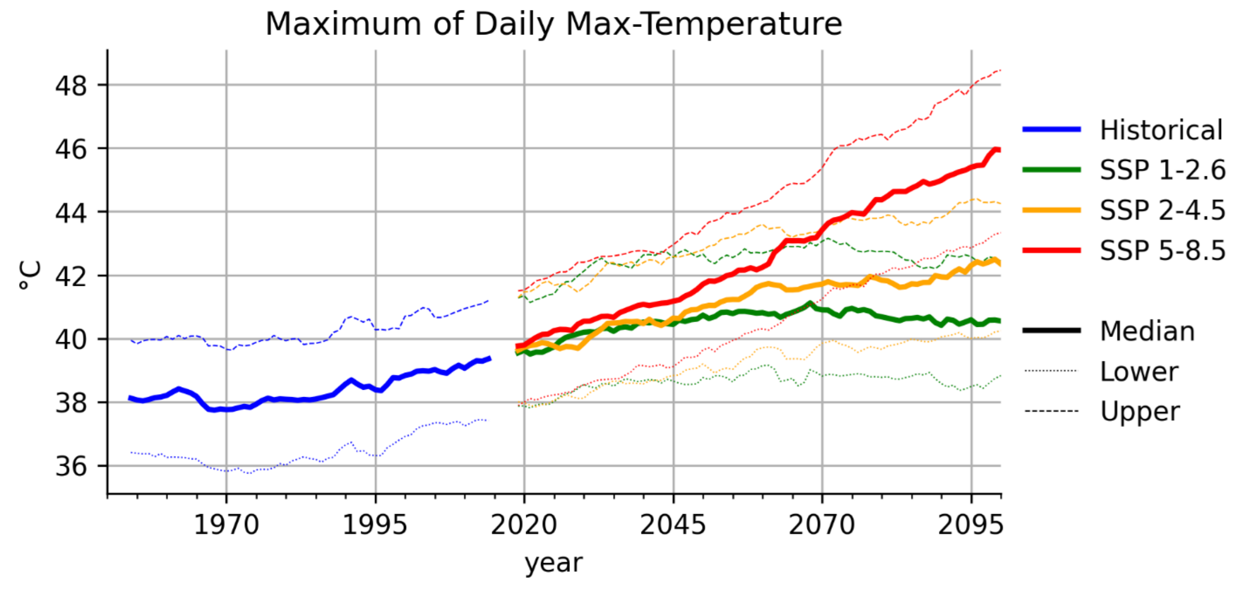

Figure 14: The single-day maximum value of the daily maximum temperatures over the aggregated data period (2014 - 2100).

Annual Precipitation

Annual precipitations predictions show a slight increasing trends, more pronounced for the intermediate and pessimistic scenarios, little bit less for evident for the optimistic scenario. Increments range from +15 to +27 mm in 2050 and from +8 to +39 mm in 2100.

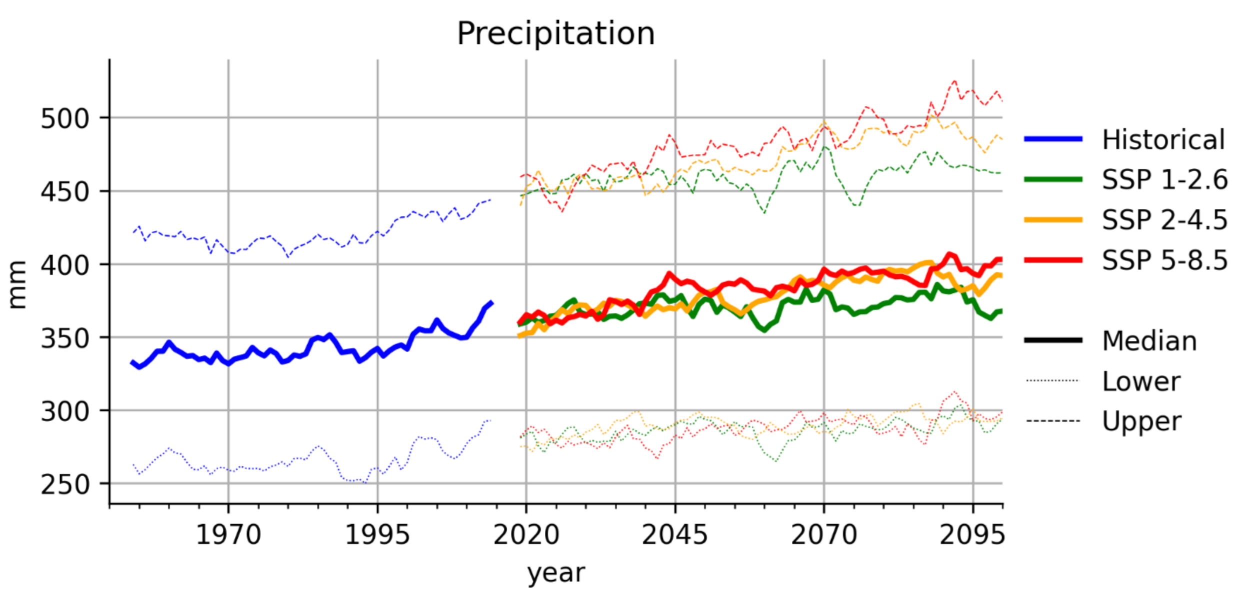

Figure 15: Aggregated accumulated precipitation over the aggregated data period (2014 to 2100).

Average Largest 1-Day Precipitation

Average largest 1-day predictions show a slight increasing trends, similar for all different scenarios and time periods. Increments range from +0.1 to +1.1 mm in 2050 and from +0.8 to +2.8 mm in 2100.

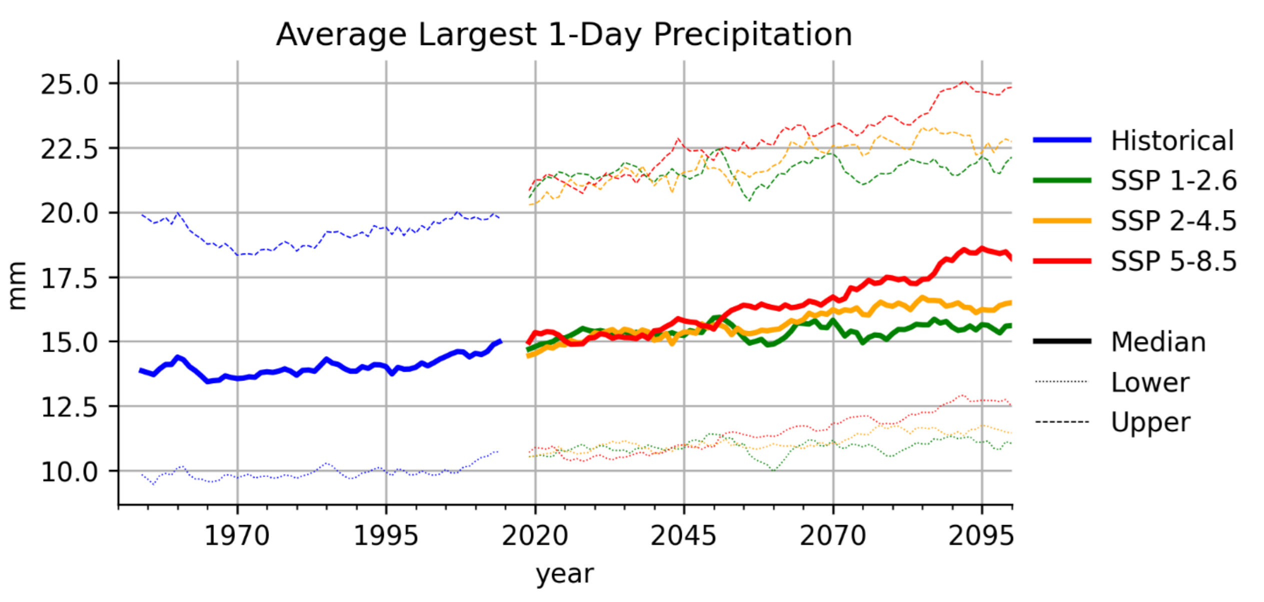

Figure 16: The average highest precipitation amount in a 1-day period during each month in the data period (2014 to 2100).

9.3.1.2 Climate Overview of the Project area

As already described in *ESBS Report Chapter 04 - Baseline Conditions, Physical Environment* report, (ref. doc. **24685792-002-R-Rev 1_ESBS**)., The climate at the Project area is primarily influenced by its location within the Shu-Ili Low Hill Terrain. Based on climatic data, this Region exhibits a temperate continental climate, or, following the Köppen classification, is identified as a semi-arid steppe zone. The extremes in air temperature range from a maximum of +47°C to a minimum of -46°C. During July, average summer temperatures remain moderate, between +24°C and +27°C, while in January, winter averages fluctuate between -7°C and -11°C.

The Region experiences a significant annual temperature variation, between 33°C and 38°C, although the uneven terrain helps moderate these fluctuations to some extent during certain times of the year. The frost-free period lasts for roughly half the year, spanning 180 to 190 days.

Annual precipitation levels range from 150 to 300 mm, decreasing as one moves northward. Nearly half of this precipitation occurs during the warmer months, from April to October, with a less pronounced peak in spring and summer, characteristic of a Central Asian-Kazakhstani moisture regime. A consistent snow cover typically forms from late November to early December, melting by the third week of February, with a depth of 10 to 20 cm.

The Region is prone to strong winds, with velocities reaching up to 40 m/s and occurring for 10 to 100 hours annually. The hydrothermal coefficient across the Project area is 0.2 or lower towards Lake Balkhash, indicating a highly arid climate. Over the decades, the Balkhash-Alakol river basin, encompassing much of the Project area, has experienced an average increase in air temperature of 0.35°C per decade, particularly during transitional seasons like spring and autumn. There has also been a minor decrease in annual precipitation by approximately 0.1 mm per decade, with the most significant reductions in spring. As a result of these shifts in temperature and precipitation, the Region has seen an extension of the frost-free period, prolonged droughts during the warmer months, diminished snow cover, and other indicators of increasing regional aridification.

9.3.1.3 Identification of Relevant Climate-related Hazards

According to **ISO 14091** and the **Equator Principle Guidance Note on Climate Change Risk Assessment**, the first step in the CCRA consists in the identification of the climate-related hazards that may affect the Project site and, among them, those the Project may be exposed to. The same indication is derived by the Additional available literature (i.e., **IPCC Report on Impacts, Adaptation and Vulnerability**, **UNEP Finance Initiative**[8], **World Bank National & Policy Climate and Disaster Risk Screening tool**[9], **Coast Adapt Risk Assessment tool**[10]) was considered to define a framework and guide the hazard identification process.

Key questions to consider in the hazard identification process are the following:

- Which are the past events and the main issues that affected the site as a consequence of climate change?
- Which are the climate-related hazards that may become relevant in the future?

Information from **World Bank Group – Climate Change Knowledge Portal, Vulnerability** were consulted to identify the most relevant hazards at the Country level. The Country level overview was integrated with the contents of the Country Climate and Development Report ("CCDR"), released in November 2022 and developed by the World Bank in partnership with the Kazakhstan government. Additionally, the **Kazakhstan's 8th National Communication on Climate Change**[11] provides further insights into the country's climate vulnerabilities and hazards, which were incorporated to supplement the national-level climate risk context. In addition to this, **THINK HAZARD portal**[12] (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 the Jambyl Region. Moreover, the information presented in the Baseline Report

[8] United Nations Environment Programme Finance Initiative (UNEP FI) is a partnership between UNEP and the global financial sector to mobilize private sector finance for sustainable development.

[9] Climate and Disaster Risk Screening represents a proactive approach to considering short- and long-term climate and disaster risks in Project and national/sector planning processes.

[10] Coast Adapt is an information delivery and decision support framework, helping to assess the risks from climate change and sea-level rise.

[11] United Nations Development Programme. (2023). Eighth National Communication and Fifth Biennial Report of the Republic of Kazakhstan to the UN Framework Convention on Climate Change.

[12] https://thinkhazard.org/en/

regarding the climatic conditions of the Jambyl Region and the Project site location was also consulted in order to identify the hazards more precisely.

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.

9.3.1.3.1 Flooding Hazard

At the regional level, flooding is identified as a potential climate-related hazard in the Moiynkum District of the Jambyl Region, where the Project site is located. According to the THINK HAZARD portal, the river flood hazard for this area is classified as ***high***, indicating that potentially damaging and life-threatening river floods are expected to occur at least once in the next 10 years. However, the Baseline Report notes that the Jambyl Region has a moderate flood risk, primarily affecting areas near rivers or in foothill regions prone to snowmelt and heavy rainfall.

Significant flooding events have been recorded in the region historically. For instance, in April 2017, snowmelt caused widespread flooding in the Jambyl Region, affecting over 7,000 people and damaging approximately 1,500 homes (FloodList, 2017: https://floodlist.com/asia/kazakhstan-snowmelt-floods-april-2017). These events typically occur during the spring snowmelt season, exacerbated by heavy rainfall and rising water levels in rivers such as the Shu and Talas. Such regional-level hazards highlight the broader vulnerability of the area to flooding.

The impact of climate change is expected to exacerbate flood risks in the future at the regional level. While model projections are inconsistent in their estimates of changes in rainfall, an increase in the frequency and intensity of extreme precipitation events is anticipated. This could lead to more severe and frequent river flooding, while also amplifying risks associated with surface water runoff.

At the Project site level, flooding is considered unlikely due to the area's geographic and climatic characteristics. As highlighted in the Baseline Report, the Project area is situated within the Shu-Ili Low Hill Terrain, which has a dry climate, low elevation, and poorly developed surface water network. Seasonal creeks and streams flow only during the spring snowmelt and usually dry up by summer. Localized water accumulation may occur temporarily during snowmelt, but no significant flood events have been recorded at the site. Furthermore, the hydrographic network of the area is limited, and the topographic study indicates that the general slope of the terrain makes the risk of flooding at the Project site low.

While flooding is unlikely at the Project site, given the flooding risk at the regional level and the future anticipations, flooding has been scoped in for the climate change risk assessment. This is further justified in consideration of the predicted future increasing trends in both annual accumulated precipitations and highest precipitation amount in a 1-day period.

9.3.1.3.2 Extreme Heat and temperature variability Hazard

Extreme heat is a notable climate-related hazard in the Moiynkum District of the Jambyl Region, where the Project site is located. According to the THINK HAZARD portal, the extreme heat hazard in this area is classified as ***medium***, indicating that there is more than a 25% chance that at least one period of prolonged exposure to extreme heat, resulting in heat stress, will occur within the next five years.

According to the Baseline Report, the Jambyl Region's climate is characterized by significant aridity and continentality, with extreme temperatures being a recurring feature. Summers in the northern and central districts, including the Moiynkum District, are particularly hot. Average July temperatures range from 21°C to 25°C, but the air temperature can reach an absolute maximum of 45-48°C.

Global warming trends suggest that temperatures in Kazakhstan are rising faster than the global average. This warming is expected to intensify extreme heat events, leading to a higher frequency and duration of heatwaves. According to the World Bank Climate Change Knowledge Portal and the Asian Development Bank (ADB) 2021 Climate Risk Country Profile, model projections indicate that temperatures in Kazakhstan could rise by as much as 5.3°C by the 2090s.

At the Project site level, the climate is influenced by its location within the Shu-Ili Low Hill Terrain, where summers are characterized by high temperatures and arid conditions, as detailed in the Baseline Report. July temperatures average between +24°C and +27°C, with extremes reaching +47°C. The region has also experienced a steady warming trend, with temperatures increasing by approximately 0.35°C per decade.

Given the arid climate of the region and Project site, along with projected increases in temperatures, both mean and maximum temperatures due to climate change, the extreme heat hazard and temperature variability have been scoped in for the climate change risk assessment.

9.3.1.3.3 Extreme Cold Hazard

According to the Baseline Report, extreme cold is a significant climate-related hazard in the Jambyl Region, where the Project site is located. The Region experiences a continental climate with harsh winters. The coldest month, January, sees average temperatures ranging from -8°C to -12°C in the northern districts and -4°C to -7°C in the southern districts. Severe frosts driven by Arctic air masses can cause temperatures to plummet to absolute minimums of -45°C to -50°C. These extreme cold events are most prevalent in the northern and central desert plains, where Arctic air intrusions create challenging winter conditions.

Global warming trends indicate a gradual rise in minimum temperatures, which may reduce the frequency and intensity of extreme cold events in the future. However, historical data show that Arctic air masses can still cause severe cold spells in the region, highlighting the continued risk of extreme cold under current climate conditions.

At the Project site level, the climate is influenced by its location within the Shu-Ili Low Hill Terrain, which experiences significant annual temperature variations. January temperatures at the Project site average between -7°C and -11°C, with recorded extremes reaching as low as -46°C. Despite the uneven terrain, which helps moderate temperature fluctuations, the Project area remains susceptible to severe frosts during winter due to Arctic air intrusions.

Climate projections indicate an increase in minimum temperatures in the future, reducing the frequency and intensity of extreme cold events over time. Nonetheless, the historical prevalence of severe cold in the Jambyl Region and the potential for localized Arctic air intrusions suggest that extreme cold remains a pertinent hazard in the current climate context.

Given the historical prevalence of extreme cold in the region, the climatic conditions at the Project site, and the potential for Arctic air mass-driven cold events, the extreme cold hazard has been scoped in for the climate change risk assessment.

9.3.1.3.4 Drought Hazard

According to the Baseline Report, the Project area experiences significant drought hazards due to its semi-arid climate and historical patterns of dry periods. Droughts in the region are characterized by prolonged periods of insufficient precipitation, exacerbated by high temperatures that lead to increased evaporation rates and reduced soil moisture. Historical data indicate that the area is prone to extended dry spells, with approximately 140–160 days of drought annually during the warmer months from April to October.

Climate change projections suggest that drought events may become more frequent and intense in the future due to increasing temperatures and shifting precipitation patterns.

Given this information, drought has been scoped in for the climate change risk assessment.

9.3.1.3.5 Water stress Hazard

Water stress is a hazard which is strictly linked to drought. Even if predicted data show future increasing trends in both annual accumulated precipitations and highest precipitations amount in a 1-day period, this cannot prevent excluding the possibility of extended Water scarcity periods.

Given this information, Water stress has been scoped in for the climate change risk assessment.

9.3.1.3.6 Severe Storms Hazard

According to the Baseline Report, the Jambyl Region experiences severe storms, including snowstorms and blizzards, during the winter months of January and February. These storms are characterized by strong winds reaching speeds of up to 45 m/s, often resulting in the formation of deep snowdrifts.

At the Project site level, located within the Shu-Ili Low Hill Terrain, severe snowstorms and blizzards also occur during the winter months from December to February. Strong winds in the Project area frequently generate deep snowdrifts, particularly during storm events.

Given the occurrence of severe storms in the region and at the Project site, and the potential for these events to intensify due to climate change, the severe storms hazard has been scoped in for the climate change risk assessment.

9.3.1.3.7 Extreme Precipitations and Precipitation Variability Hazard

According to the Baseline Report, the Jambyl Region experiences heavy rainfall primarily during the warmer months from May to September. Precipitation levels are generally low across the region, ranging from 140–220 mm annually in the plains and increasing to 400–500 mm in the mountainous areas of the Kyrgyz Alatau. Precipitation is distributed unevenly throughout the year, with the majority occurring during the winter-spring period. In lowland areas such as the Sarysu and Shu districts, intense rainfall during these warmer months can lead to localized flooding, while in mountainous and foothill areas, heavy rainfall increases the risk of landslides and mudflows.

At the Project site, annual precipitation levels range from 150–300 mm, with nearly half of this occurring during the warmer months from April to October. The precipitation pattern in the Project area aligns with the broader regional trend, featuring a peak in spring and summer. However, heavy rainfall is less common at the Project site compared to other parts of the Jambyl Region.

Given this information and in consideration of the predicted future increasing trends in both annual accumulated precipitations and highest precipitation amount in a 1-day period, extreme precipitation and precipitation variability have been scoped in for the climate change risk assessment.

9.3.1.3.8 Wildfires Hazard

According to the THINK HAZARD portal, wildfire risk in the Moiynkum District is classified as high, with a greater than 50% chance of significant wildfires occurring in any given year. According to the Baseline Report, the Jambyl Region experiences heightened wildfire risks during the summer months (July–September), particularly in steppe zones. In recent decades, large-scale wildfires have been recorded in the steppes of the Jambyl Region, including areas designated for forest and wildlife protection, such as the Sekseul Dala steppes and the Shu River area.

At the Project site, located in the Moiynkum District, drought conditions and the ignition of dry vegetation are common during the summer months, triggering steppe fires. Several wildfire events have been documented near the Project site, particularly in areas with saxaul trees and reeds.

Based on this assessment, and also taking into consideration that fact that predicted data show increasing trends for all different metrics related to temperature (average annual mean temperatures, average annual maximum temperatures) which could increase the possibility of wildfires, wildfire hazards has been scoped in for the climate change risk assessment of the Project area.

9.3.1.3.9 Hail Hazard

According to Kazakhstan's 8th National Communication on Climate Change, the country has been experiencing an increasing frequency of extreme hydro-meteorological events, including hailstorms. Hailstorms have been recorded with growing frequency, and data shows a rise in the number of hail events from one in 2017 to four in 2021.

Given the potential of hailstorms, hail hazard has been scoped in for the climate change risk assessment.

9.3.1.3.10 Strong Wind Hazard

According to the Baseline Report, strong winds are a recurring hazard in the Jambyl Region, particularly from May to September. The region's semi-arid climate, combined with its mountainous terrain and local wind conditions such as mountain-valley winds and foehns, increases the frequency and intensity of these wind events. The prevailing wind directions across most of the region are from the east and northeast, with wind speeds averaging between 2.5 m/s and 3.5 m/s. However, in some areas, wind speeds can reach as high as 45 m/s during extreme events. Given the projected rise in extreme weather events due to climate change, the frequency and intensity of these strong wind events are expected to increase.

In the Project area, located in the Moiynkum district of the Jambyl Region, strong winds are a significant feature, with wind velocities reaching up to 40 m/s. These winds are prevalent from the east and northeast and occur for up to 100 hours annually.

Thus, this hazard has been scoped in for the climate change risk assessment.

9.3.1.4 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 whether the selected climate-related hazard hits the Project site, how the Project will be impacted.

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

Table 1: Exposure assessment

Hazard	Element exposed	Exposure	Justification
Flooding Hazard	Infrastructure	Yes	If flooding occurs, substations, battery energy storage systems, and the foundations of wind turbines could be affected due to water ingress. Overhead lines and underground cables are less exposed but could face disruptions if the surrounding infrastructure is damaged. Access roads could also be affected by localized flooding, impacting site accessibility.
Extreme Heat and Temperature Variability Hazard	Infrastructure	Yes	Extreme heat and increasing temperatures can reduce the efficiency of wind turbines, overhead lines, and substations due to thermal stress. The battery energy storage system is particularly sensitive to overheating, which can degrade its performance and safety.
Extreme Cold Hazard	Infrastructure	Yes	Extreme cold could cause material brittleness in overhead lines and wind turbine components. Ice

Hazard	Element exposed	Exposure	Justification
			formation may reduce turbine efficiency and damage blades. Battery energy storage systems may experience reduced capacity and performance. Access roads could be obstructed by ice and snow accumulation, impacting Project logistics.
Drought Hazard	Infrastructure	Yes	Drought is unlikely to directly damage infrastructure such as turbines, overhead lines, underground cables, substations, or the battery energy storage system. However, prolonged drought may indirectly affect turbine foundations in areas where soil is composed of expansive clays or unconsolidated materials. Reduced soil moisture due to drought can cause shrinkage or subsidence, potentially leading to instability or settlement issues beneath the foundations.
Water Stress Hazard	Infrastructure	Yes	Water stress is unlikely to directly damage infrastructure such as turbines, overhead lines, underground cables, substations, or the battery energy storage system. However, prolonged water scarcity conditions may indirectly affect turbine foundations in areas where soil is composed of expansive clays or unconsolidated materials. Reduced soil moisture due to Water stress can cause shrinkage or subsidence, potentially leading to instability or settlement issues beneath the foundations.
Severe Storms Hazard	Infrastructure	Yes	Severe storms with high winds and lightning could damage wind turbine blades, overhead lines, and substations. Battery energy storage systems could be indirectly affected due to electrical surges or physical damage to connected components.
Extreme Precipitations and Precipitation Variability Hazard	Infrastructure	Yes	Extreme precipitation and increasing precipitations can cause localized flooding, which may damage substations and battery energy storage systems due to water ingress. Wind turbines and overhead lines could experience mechanical stress and reduced performance. Access roads could also be inundated or washed out, impairing site access.
Wildfires Hazard	Infrastructure	Yes	Wildfires, if they occur, can directly damage wind turbine bases, substations, and battery energy storage systems. Underground cables and access roads are not directly affected but may face indirect risks.
Hail Hazard	Infrastructure	Yes	Hailstorms could damage wind turbine blades, overhead lines, and substations. The battery storage system and underground cables are less exposed but could face indirect impacts if connected components are damaged. Access roads could also be damaged by hail, especially if large hailstones create debris or erode road surfaces.
Strong Wind Hazard	Infrastructure	Yes	Strong winds can exert excessive mechanical stress on wind turbines, potentially damaging blades and structures. Overhead lines and substations are also exposed. Underground cables and access roads are not directly affected but may face indirect risks.

As per Table 1, the Project was considered exposed to all relevant climate-related hazards potentially affecting the Project site. Therefore, they were scoped in for further assessment.

9.3.1.5 Hazards input data

Climate Score Global 3.1, implemented by Jupiter Intelligence[13], 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") [14]:

- Optimistic scenario: projected socioeconomic global changes towards sustainability (SSP1). Carbon dioxide emissions start declining by 2020 and go to zero by 2100 (RCP2.6).
- Intermediate scenario: projected socioeconomic global changes do not shift markedly from historical patterns (SSP2). Emissions reach the peak around 2040, then decline (RCP4.5).
- Pessimistic scenario: projected socioeconomic global changes towards deeper fossil-fuelled development (SSP5). Emissions continue to rise throughout the entire 21st century (RCP8.5).

Data come in a spreadsheet where a given location (identified with longitude and latitude coordinates) is assigned multiple metrics (data type numerical values or bands) and qualitative classes for each hazard.

Table 2 shows as an example the metrics provided to characterize the Extreme Heat hazard while Figure 17 provides an example of classification criteria:

Table 2: Overview of all metrics provided to characterize the Extreme Heat hazard.

Metric	Description	Example
HT_daysExceeding*C_mean	Days per year with temperature >35°C or >38°C based on the mean of the high-temperature distribution from Global Circulation Models[15](GCMs).	14
HT_daysExceeding*C_band	Band that HT_daysExceeding*C_mean maps to.	10-20 days
HT_daysExceeding*C_lower	Days per year with temperature >35°C or >38°C based on the 5th percentile of the high-temperature distribution from GCMs.	10
HT_daysExceeding*C_upper	Days per year with temperature >35°C or >38°C based on the 95th percentile of the high-temperature distribution from GCMs.	19

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

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

[15] Global Circulation Models (GCMs) are numerical models representing physical processes in the atmosphere, ocean, cryosphere and land surface. They are the most advanced tools currently available for simulating the response of the global climate system to increasing greenhouse gas concentrations.

Metric	Description	Example
HT_daysExceeding99Pct_mean	Days per year with temperature exceeding the local historical 99th percentile temperature based on the mean of the high temp. distribution from GCMs.	5
HT_daysExceeding99Pct_band	Band that HT_daysExceeding99Pct_mean maps to.	5-10 days
HT_daysExceeding99Pct_lower	Days per year with temperature exceeding the local historical 99^{th} percentile temperature based on the 5^{th} percentile of the high-temperature distribution from GCMs.	7
HT_daysExceeding99Pct_upper	Days per year with temperature exceeding the local historical 99^{th} percentile temperature based on the 95^{th} percentile of the high-temperature distribution from GCMs	1

Metric	Tier	Label	Min Value	Max Value
daysExceeding*C daysExceeding99Pct	Lowest	< 5 days	0	5
daysExceeding*C daysExceeding99Pct	Low	5-10 days	5	10
daysExceeding*C daysExceeding99Pct	Medium	10-20 days	10	20
daysExceeding*C daysExceeding99Pct	High	20-30 days	20	30
daysExceeding*C daysExceeding99Pct	Highest	> 30 days	30	365

Figure 17: Classification criteria for the metrics of Extreme Heat hazard.

9.3.1.6 *Hazards Characterization*

Jupiter's Hazard input data were obtained for the Project location, identified through the coordinates of a representative point, selected for the Project site considered, where relevant components are located. Figure 18 shows the location of the representative point and the Project layout.

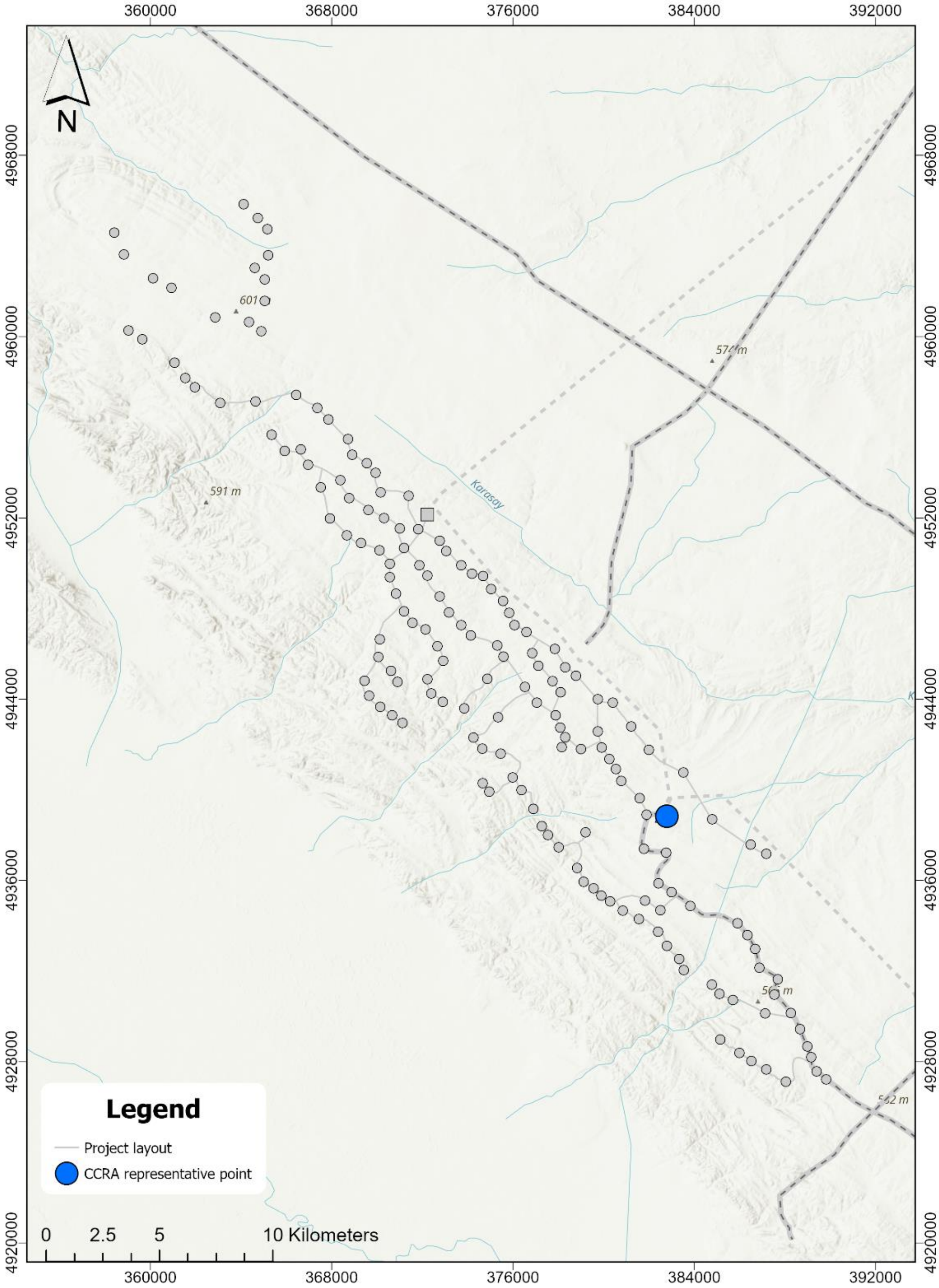

Figure 18: Representative point location within the Project layout.

Among all possible metrics available, the most representative were selected for each hazard. They are shown in Table 3:

Table 3: Most representative metrics selected to characterize each hazard.

Hazard	Type	Metric
FLOODING	Acute	Depth of the water (in meters) at the 100-year return period
EXTREME HEAT	Acute	Days per year with temperature > 38°C
TEMPERATURE VARIABILITY	Chronic	Average mean surface air temperature (°C)
EXTREME COLD	Acute	Days per year with temperature < -10°C
DROUGHT	Acute	Months per year where the rolling 6-month average Standardized Precipitation Evapotranspiration Index is below -2
WATER STRESS	Chronic	Total water stress: human water demand / water supply for the local and upstream watersheds
SEVERE STORMS	Acute	Number of days per year where environmental conditions are conducive to severe thunderstorm formation
EXTREME PRECIPITATIONS	Acute	Maximum daily total water equivalent precipitation (in mm) experienced at the 100-year return period
PRECIPITATIONS VARIABILITY	Chronic	Annual accumulated precipitation (mm)
WILDFIRES	Acute	Annual probability of wildfires
HAIL	Acute	Number of days per year where large hail (>2 in / 5 cm in diameter) is possible
STRONG WIND	Acute	Maximum 1-minute sustained wind speed (in km/hr) experienced at the 100-year return period

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 time period 2020-2100 covered by Jupiter data. However, the temporal scope of the assessment is shorter, as the Project lifecycle is estimated to be around 25-30 years, which include the construction of the wind farm from March 2026 to November 2028 (33 months) and operations later on. Accordingly the assessment considers three time periods namely near future (2030), medium future (2040) and distant future (2060).

Based on the selected metrics and available scenarios, the following key considerations describe the current and future levels of each hazard across all available emission scenarios. Different colours refer to the 3 different emission scenarios (green lines: optimistic; orange lines: intermediate; red lines: pessimistic). Different styles refer to the 3 different statistics of each metric (solid line: mean; dashed line: 95th percentile (upper); dotted line: 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 a smaller 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 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.

9.3.1.6.1 Flooding Hazard

For the flooding hazard, the metric used to assess this hazard is the "depth of water (in meters) at the 100-year return period," and all values fall below the threshold for any significant flooding hazard.

In all scenarios (SSP1-2.6, SSP2-4.5, and SSP5-8.5) and across all time frames (near, medium, and distant future), the depth of water at the 100-year return period remains at 0 meters, corresponding to the **Lowest** hazard level, indicating no significant flooding risk at the Project site throughout the study period.

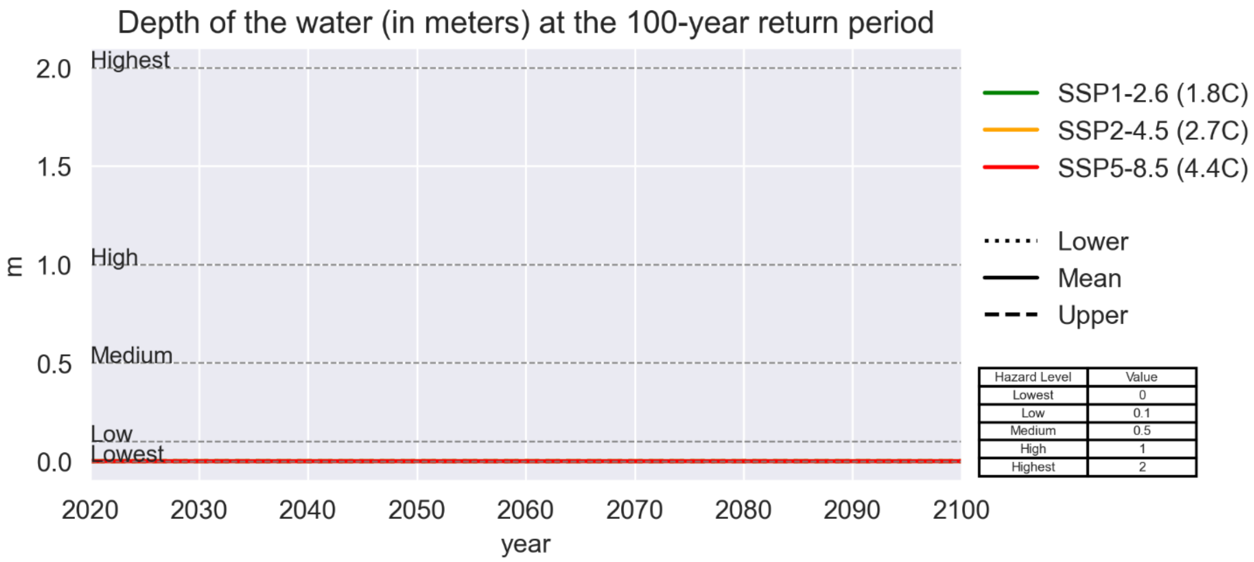

Figure 19: Flooding hazard, represented by depth of the water (in meters) at the 100-year return period.

9.3.1.6.2 Extreme Heat Hazard

For the extreme heat hazard, the metric used to assess this hazard is "days per year with temperature >38°C".

In the near future (2030), under all scenarios (SSP1-2.6, SSP2-4.5, and SSP5-8.5), the number of days exceeding 38°C is projected to range between 13.2 and 13.9 days per year, which corresponds to a **Medium** hazard level. This indicates a consistent hazard level, reflecting only a slight increase from present-day conditions.

For the medium future (2040), the number of extreme heat days rises further to 14.7 days under SSP1-2.6, 15.4 days under SSP2-4.5, and 17.2 days under SSP5-8.5. Despite the increase, the hazard level remains **Medium** across all scenarios.

In the distant future (2060), the number of extreme heat days continues to climb, reaching 16.4 days under SSP1-2.6, 20.6 days under SSP2-4.5, and 27.7 days under SSP5-8.5. The hazard level remains **Medium** for all scenarios, though the rise in days is more significant under SSP5-8.5.

Overall, the analysis highlights a steady increase in extreme heat days across all scenarios within the temporal scope of the assessment, while the **Medium** hazard level remains consistent through 2060.

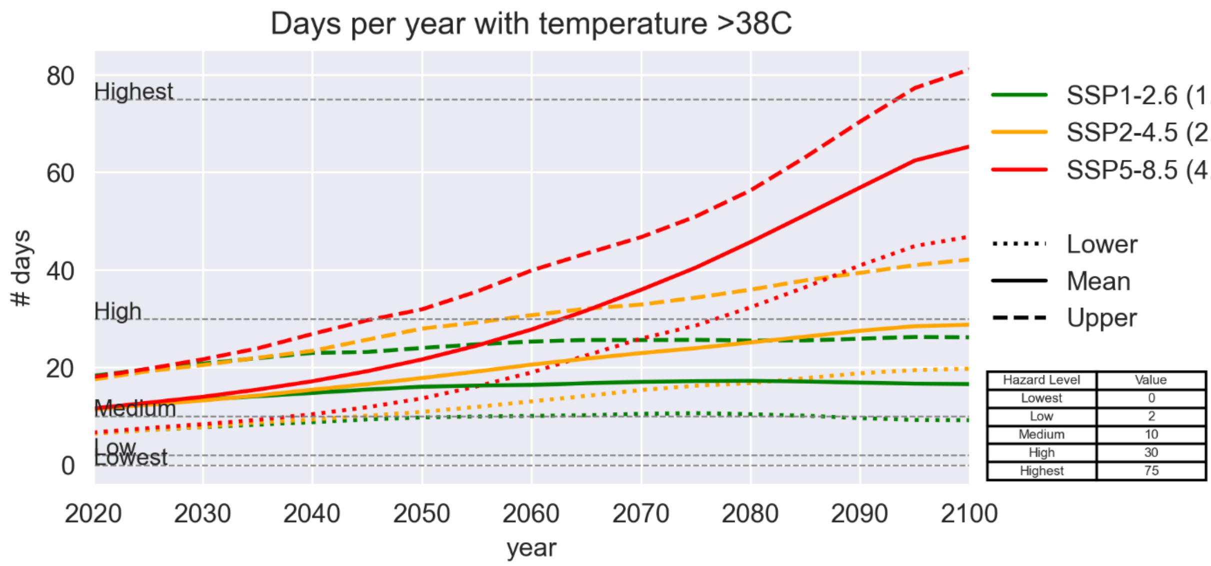

Figure 20: Extreme heat hazard, represented by the days per year with temperature > 38°C.

Table 4: Extreme heat hazard, represented by the days per year with temperature > 38°C.

year	SSP1-2.6	SSP2-4.5	SSP5-8.5
2025	12.6	12.4	12.8
2030	13.4	13.2	14.0
2040	14.8	15.4	17.2
2050	16.0	17.8	21.6
2060	16.4	20.6	27.8
2070	17.0	22.9	35.9
2080	17.2	25.1	45.7
2090	16.9	27.5	56.9
2100	16.6	28.7	65.3

9.3.1.6.3 Temperature Variability Hazard

For the temperature variability hazard, the metric used to assess this hazard is "Average mean surface temperature variations compared to reference period (2020)."

For all different emission scenarios, average mean surface temperatures are predicted to increase. Variations compared to the reference period 2020 range from + 0.5°C, in the near future (2030) and according to all different emission scenarios, to 2.5°C in the distant future (2060) according to the pessimistic scenario. Such variations have been considered as a **Medium** hazard level for all time periods.

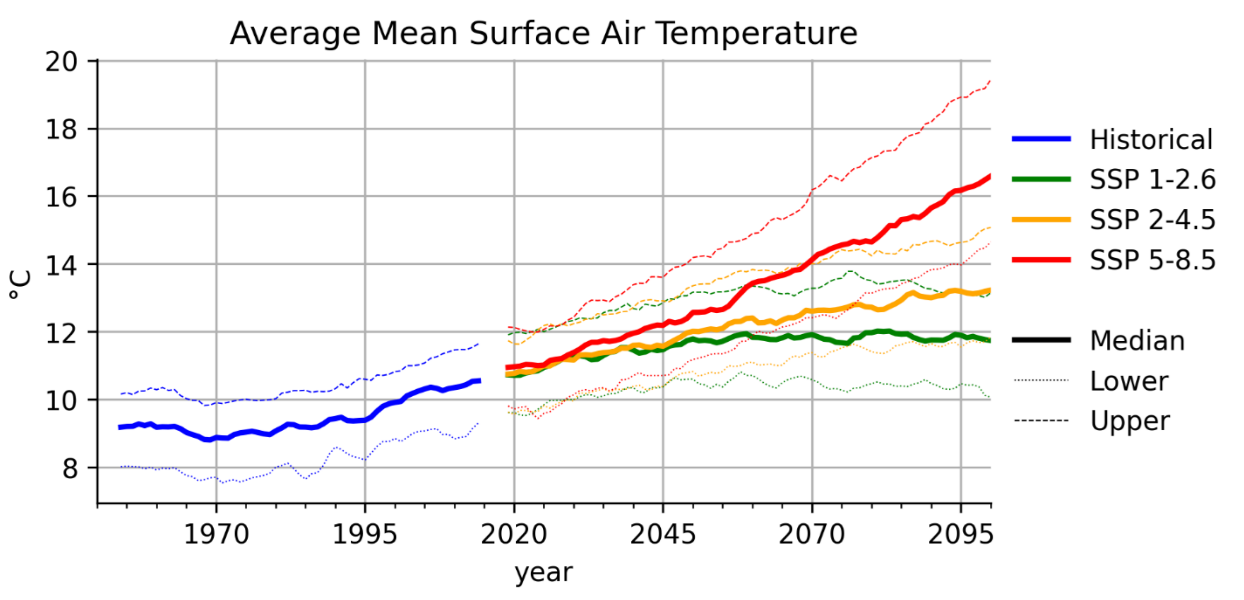

Figure 21: Temperature variability hazard, represented by the Average mean surface temperature.

Table 5: Temperature variability hazard, represented by the Average mean surface temperature variations compared to reference period (2020).

year	SSP1-2.6	SSP2-4.5	SSP5-8.5
2030	0.5	0.4	0.4
2040	0.8	0.8	1.0
2050	1.1	1.2	1.6
2060	1.1	1.6	2.5
2070	1.2	1.8	3.2
2080	1.3	2.0	3.7
2090	1.0	2.2	4.7
2100	1.0	2.5	5.6

9.3.1.6.4 Extreme Cold Hazard

The Extreme Cold hazard, measured by the number of days per year with temperatures below -10°C, is expected to gradually decrease over time across all emission scenarios. Despite this reduction, hazard remain in the **Medium** level for much of the temporal scope.

In the near future (2030), the number of days with extreme cold ranges between 35 days (SSP5-8.5) and 37.7 days (SSP1-2.6), corresponding to a **Medium** hazard level for all scenarios.

By the medium future (2040), the number of extreme cold days decreases slightly, with values ranging from 30.1 days (SSP5-8.5) to 34.2 days (SSP2-4.5). While still within the **Medium** hazard range, the downward trend becomes more evident, especially under the pessimistic scenario (SSP5-8.5).

In the distant future (2060), the trend continues, with extreme cold days dropping further to between 20.2 days (SSP5-8.5) and 27.9 days (SSP2-4.5). Despite this decrease, the **Medium** hazard level persists for all scenarios.

In summary, the Extreme Cold hazard demonstrates a consistent downward trend across all scenarios, reflecting the anticipated warming associated with climate change.

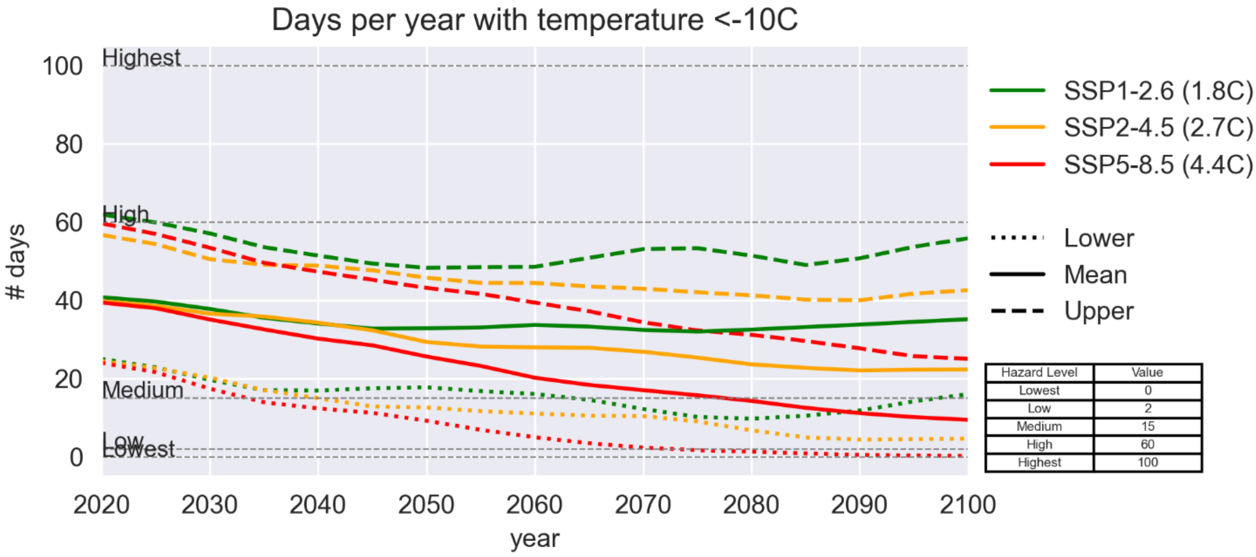

Figure 22: Extreme cold hazard, represented by the days per year with temperature < -10°C.

Table 6: Extreme cold hazard, represented by the days per year with temperature < -10°C.

year	SSP1-2.6	SSP2-4.5	SSP5-8.5
2025	39.6	38.5	37.9
2030	37.7	36.5	35.0
2040	34.0	34.2	30.1
2050	32.8	29.3	25.6
2060	33.6	27.9	20.2
2070	32.4	26.8	17.0
2080	32.5	23.6	14.2
2090	33.7	22.0	11.1
2100	35.1	22.3	9.4

9.3.1.6.5 Drought Hazard

The Drought hazard, measured by the number of months per year where the rolling 6-month average Standardized Precipitation Evapotranspiration Index (SPEI) is below -2, demonstrates a consistent increase over time, particularly under the pessimistic emission scenario.

In the near future (2030), drought conditions occur for approximately 0.5 months per year under the optimistic scenario (SSP1-2.6), corresponding to a **High** hazard level. For the intermediate scenario (SSP2-4.5), the hazard remains at **Medium** with 0.47 months, while the pessimistic scenario (SSP5-8.5) records 0.51 months, also within the **Medium** range but nearing the threshold for **High**.

By the medium future (2040), the hazard levels show a slight divergence among scenarios. The optimistic scenario records 0.69 months, maintaining a **High** hazard level. The intermediate scenario stabilizes at 0.46

months, corresponding to a **Medium** hazard level, while the pessimistic scenario rises to 0.62 months, solidifying its position within the **High** hazard category.

In the distant future (2060), all scenarios indicate an increasing risk of drought. Under SSP1-2.6, the number of months is 0.61, consistent with the **High** hazard level. For SSP2-4.5, the metric rises to 0.64 months, transitioning into the **High** category. The pessimistic scenario shows a significant increase to 0.92 months, remaining firmly in the **High** hazard level.

These findings highlight the growing hazard levels of drought over time, with hazard levels reaching **High** across all scenarios by 2060.

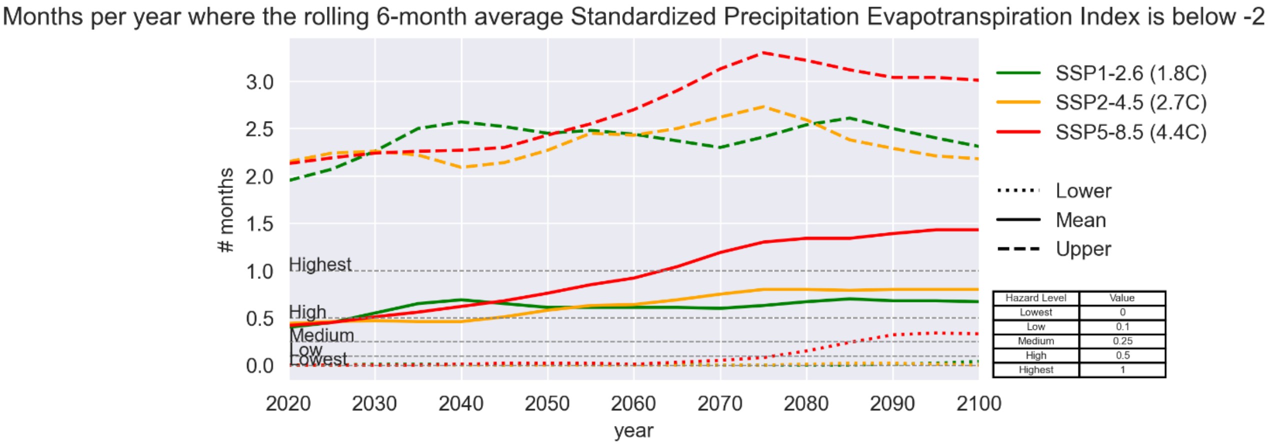

Figure 23: Drought hazard, represented by the months per year where the rolling 6-month average Standardized Precipitation Evapotranspiration Index is below -2

Table 7: Drought hazard, represented by the months per year where the rolling 6-month average Standardized Precipitation Evapotranspiration Index is below -2

year	SSP1-2.6	SSP2-4.5	SSP5-8.5
2025	0.45	0.46	0.45
2030	0.55	0.47	0.51
2040	0.69	0.46	0.62
2050	0.61	0.58	0.76
2060	0.61	0.64	0.92
2070	0.60	0.75	1.19
2080	0.67	0.80	1.34
2090	0.68	0.80	1.39
2100	0.67	0.80	1.43

9.3.1.6.6 Water stress Hazard

The Water stress hazard, measured by the metric "Total water stress: human water demand / water supply for the local and upstream watersheds" does not seem a significant hazard at the Project location, at present and in the future. In fact, values for the selected metric correspond to a **Lowest** hazard level for all emission scenarios and time periods.

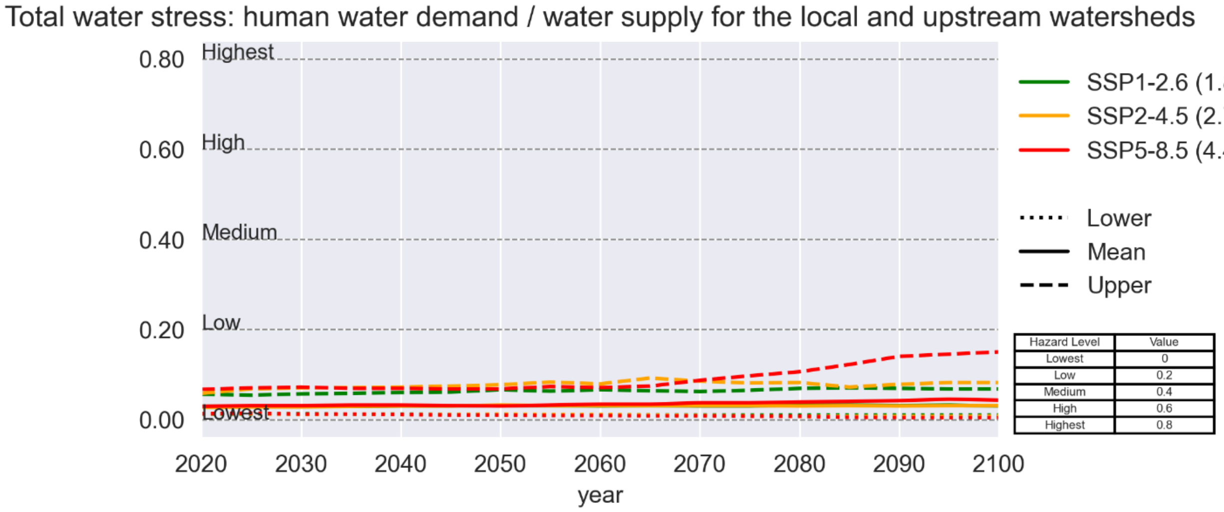

Figure 24: Water stress hazard, represented by the Total water stress: human water demand / water supply for the local and upstream watersheds

Table 8: Water stress hazard, represented by the Total water stress: human water demand / water supply for the local and upstream watersheds

year	SSP1-2.6	SSP2-4.5	SSP5-8.5
2025	0.029	0.028	0.031
2030	0.03	0.028	0.031
2040	0.03	0.03	0.032
2050	0.031	0.032	0.03
2060	0.03	0.031	0.034
2070	0.03	0.031	0.037
2080	0.032	0.03	0.039
2090	0.031	0.03	0.042
2100	0.03	0.031	0.043

9.3.1.6.7 Severe Storms Hazard

The Severe Storm hazard, measured by the number of days per year where environmental conditions are conducive to severe thunderstorm formation, exhibits a stable pattern over time, with slight increases under all scenarios.

In the near future (2030), the optimistic scenario (SSP1-2.6) records 2.9 days per year, corresponding to the **Lowest** hazard level. Similarly, the intermediate scenario (SSP2-4.5) shows 2.8 days, also categorized as **Lowest** level. The pessimistic scenario (SSP5-8.5) reports a slightly higher value of 35 days, remaining within the **Lowest** hazard level.

By the medium future (2040), the hazard levels display a modest increase. Under SSP1-2.6, the metric slightly decreases to 2.9 days but remains in the **Lowest** level. The intermediate scenario rises to 3.0 days, still classified as **Lowest**, while the pessimistic scenario increases further to 3.7 days, maintaining its position in the **Lowest** hazard level.

In the distant future (2060), the hazard levels remain negligible across all scenarios. SSP1-2.6 records 2.9 days, SSP2-4.5 records 3.3 days, and SSP5-8.5 shows 4.2 days, with all values staying within the **Lowest** hazard classification.

Overall, severe storm conditions at the Project site are not expected to represent a critical hazard throughout the near, medium, and distant future, as hazard levels remain in the **Lowest** category for all scenarios up to 2060.

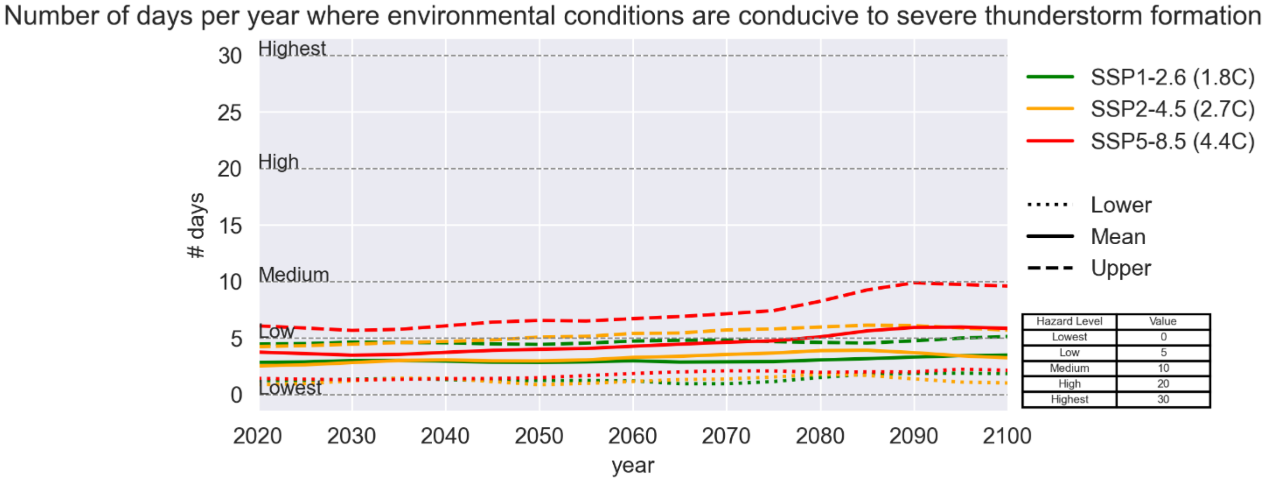

Figure 25: Severe storm hazard, represented by the number of days per year where environmental conditions are conducive to severe thunderstorm formation

Table 9: Severe storm hazard, represented by the number of days per year where environmental conditions are conducive to severe thunderstorm formation

year	SSP1-2.6	SSP2-4.5	SSP5-8.5
2025	2.9	2.6	3.6
2030	3.0	2.8	3.5
2040	2.9	3.0	3.7
2050	2.8	3.0	4.0
2060	3.0	3.3	4.3
2070	2.9	3.5	4.6
2080	3.0	3.9	5.1
2090	3.3	3.7	5.9
2100	3.5	3.2	5.8

9.3.1.6.8 Extreme Precipitation Hazard

The Extreme Precipitation hazard, represented by the maximum daily total water equivalent precipitation (in mm) experienced at the 100-year return period, consistently remains in the **Lowest** hazard level across all emission scenarios throughout the near, medium, and distant future.

In the near future (2030), the optimistic scenario (SSP1-2.6) records a value of 76 mm, firmly within the **Lowest** hazard level. Similarly, the intermediate scenario (SSP2-4.5) shows the same value of 76 mm, and the pessimistic scenario (SSP5-8.5) records 77 mm, all classified as **Lowest** hazard level.

By the medium future (2040), there is a marginal increase in the metric values. SSP1-2.6 records 78 mm, SSP2-4.5 shows 78 mm, and SSP5-8.5 rises slightly to 79 mm. Despite these increases, all scenarios remain in the **Lowest** hazard level.

In the distant future (2060), the trend of gradual increases continues. The optimistic scenario records 79 mm, the intermediate scenario increases to 81 mm, and the pessimistic scenario reaches 86 mm. These values still fall within the **Lowest** hazard range.

Overall, extreme precipitation levels at the Project site are expected to remain at the **Lowest** hazard level under all scenarios through 2050.

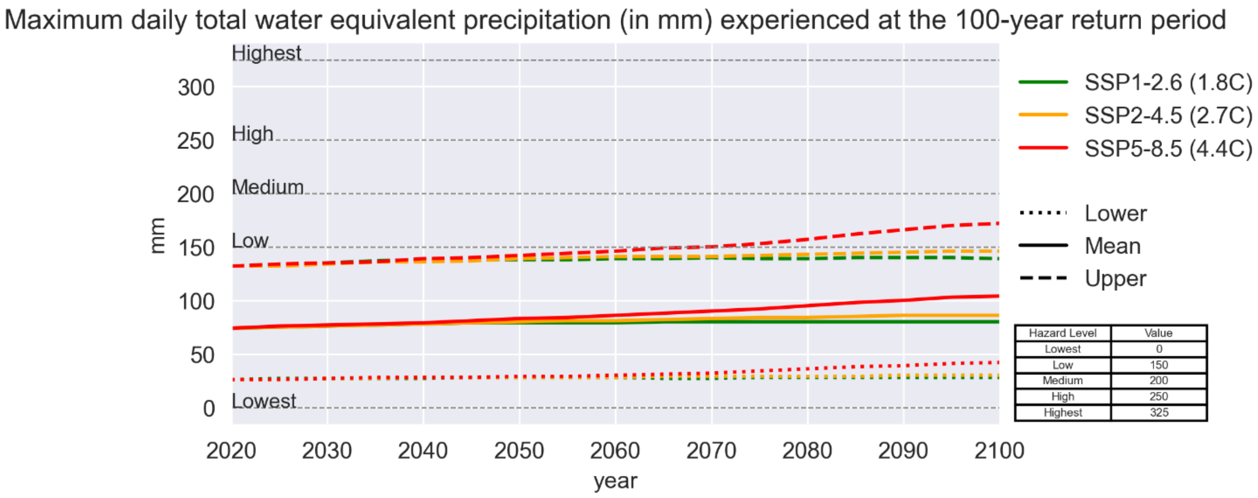

Figure 26: Extreme precipitation hazard, represented by the maximum daily total water equivalent precipitation (in mm) experienced at the 100-year return period.

Table 10: Extreme precipitation hazard, represented by the maximum daily total water equivalent precipitation (in mm) experienced at the 100-year return period.

year	SSP1-2.6	SSP2-4.5	SSP5-8.5
2025	75.0	75.0	76.0
2030	76.0	76.0	77.0
2040	78.0	78.0	79.0
2050	79.0	80.0	83.0
2060	79.0	81.0	86.0
2070	80.0	83.0	90.0
2080	80.0	84.0	95.0
2090	80.0	86.0	100.0
2100	80.0	86.0	104.0

9.3.1.6.9 Precipitations Variability

For the Precipitation Variability hazard, the metric used to assess this hazard is the "annual accumulated precipitations variations compared to reference period (2020)".

Annual precipitations predictions show a slight increasing trends, more pronounced for the intermediate and pessimistic scenarios, little bit less for evident for the optimistic scenario. Predictions also show fluctuations across the different time periods. Increments range from -0.8 to +18.9 mm in the near future (2030), from +9.2 to +13.0 mm in the medium future (2040) and from -5.7 to +22.7 mm in the distant future (2060). Considering the little amount of predicted variations, changing precipitation hazard has been assessed **Low** level for all scenarios and time periods.

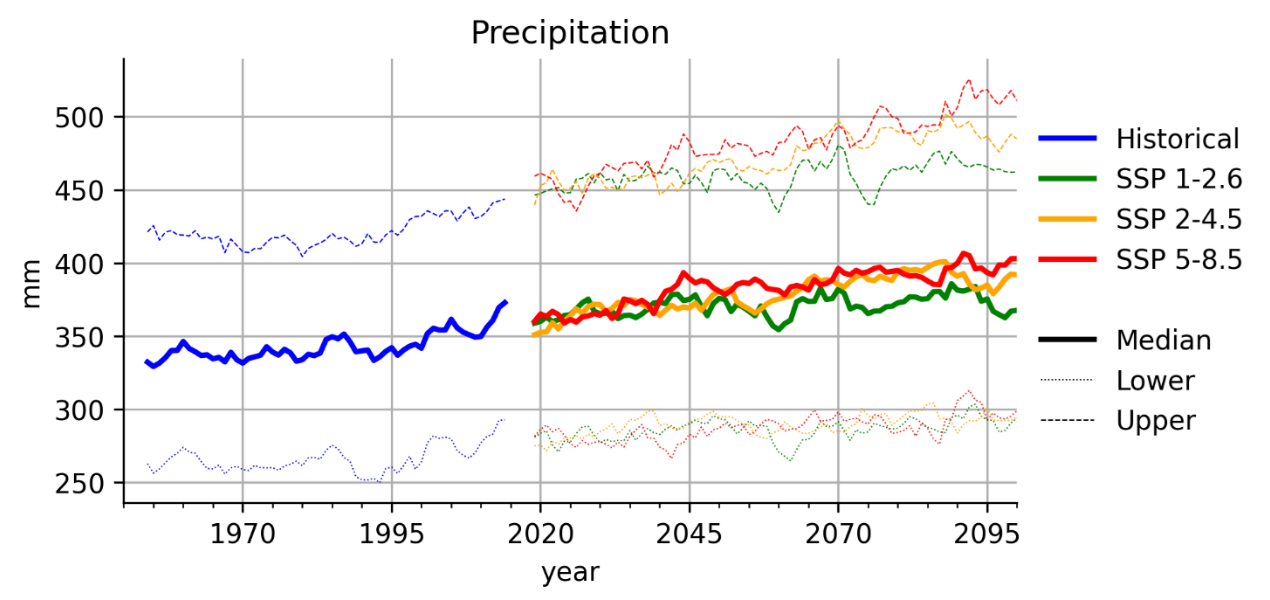

Figure 27: Precipitations variability hazard, represented by the annual accumulated precipitations.

Table 11: Precipitations variability hazard, represented by the annual accumulated precipitations variations compared to reference period (2020).

year	SSP1-2.6	SSP2-4.5	SSP5-8.5
2030	5.2	18.9	-0.8
2040	13.0	11.5	9.2
2050	15.7	27.8	15.6
2060	-5.7	22.7	16.1
2070	22.1	32.8	31.2
2080	12.7	41.8	29.8
2090	21.3	38.4	34.8
2100	7.6	39.4	37.9

9.3.1.6.10 Wildfires Hazard

The Wildfire hazard, represented by the annual probability of wildfire, consistently falls within the **Highest** hazard level across all emission scenarios throughout the near, medium, and distant future.

In the near future (2030), the optimistic scenario (SSP1-2.6) records an annual wildfire probability of 6.3%, while the intermediate scenario (SSP2-4.5) records 6.3%, and the pessimistic scenario (SSP5-8.5) shows 6.5%. All values exceed the threshold for the **Highest** hazard level (>0.7%).

By the medium future (2040), the wildfire probability increases further, with SSP1-2.6 showing 6.7%, SSP2-4.5 recording 6.8%, and SSP5-8.5 reaching 7.1%. These values remain well within the **Highest** hazard classification.

In the distant future (2050), the optimistic scenario reaches 6.9%, the intermediate scenario rises to 7.5%, and the pessimistic scenario records a significant increase to 8.5%. All scenarios continue to fall under the **Highest** hazard classification.

Overall, wildfire probability at the Project site is projected to remain at the **Highest** hazard level through 2060 under all scenarios.

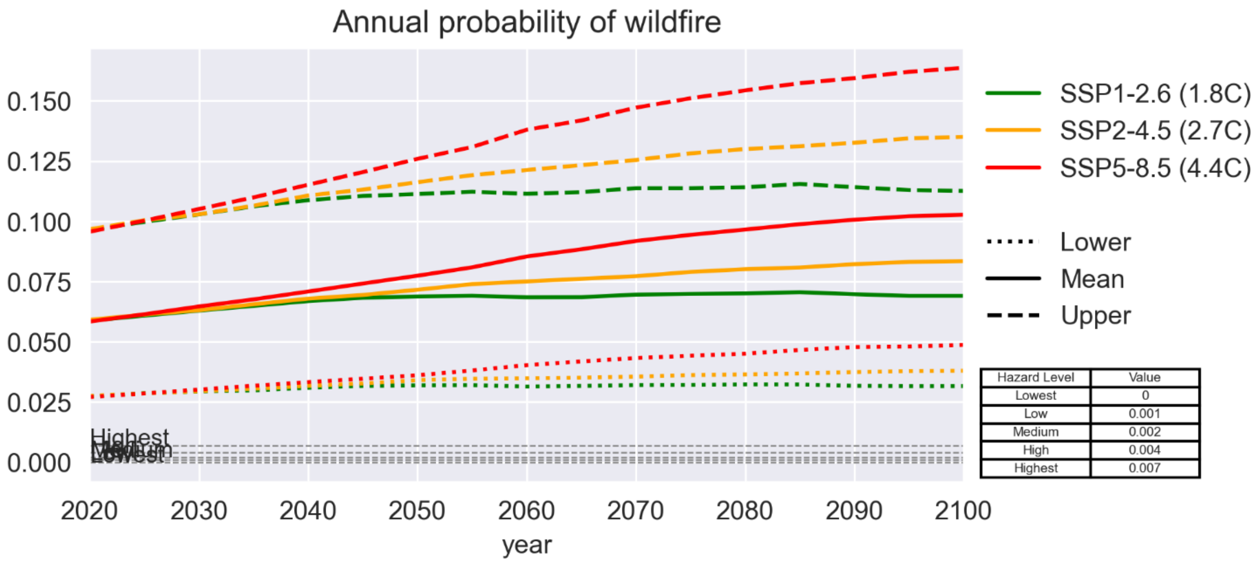

Figure 28: Wildfires hazard, represented by the annual probability of wildfire

Table 12: Wildfires hazard, represented by the annual probability of wildfire

year	SSP1-2.6	SSP2-4.5	SSP5-8.5
2025	6.1%	6.1%	6.1%
2030	6.3%	6.3%	6.5%
2040	6.7%	6.8%	7.1%
2050	6.9%	7.2%	7.7%
2060	6.8%	7.5%	8.5%
2070	7.0%	7.7%	9.2%
2080	7.0%	8.0%	9.7%
2090	7.0%	8.2%	10.1%
2100	6.9%	8.3%	10.3%

9.3.1.6.11 Hail Hazard

The Hail hazard, represented by the number of days per year where large hail (>2 in / 5 cm in diameter) is possible, consistently remains within the **Lowest** hazard level across all emission scenarios through the near, medium, and distant future.

In the near future (2030), the optimistic (SSP1-2.6) and intermediate (SSP2-4.5) scenarios report no days with large hail, while the pessimistic scenario (SSP5-8.5) records 0.01 days per year, placing all scenarios within the **Lowest** hazard classification (0–0.1 days).

By the medium future (2040), no days with large hail are observed across all scenarios, maintaining the **Lowest** hazard level.

In the distant future (2060), the optimistic and intermediate scenarios continue to show no days with large hail, while the pessimistic scenario reports 0.01 days per year. These values remain within the **Lowest** hazard level.

Overall, the risk of large hail events at the Project site is projected to stay minimal through 2060 under all scenarios, consistently falling into the **Lowest** hazard classification.

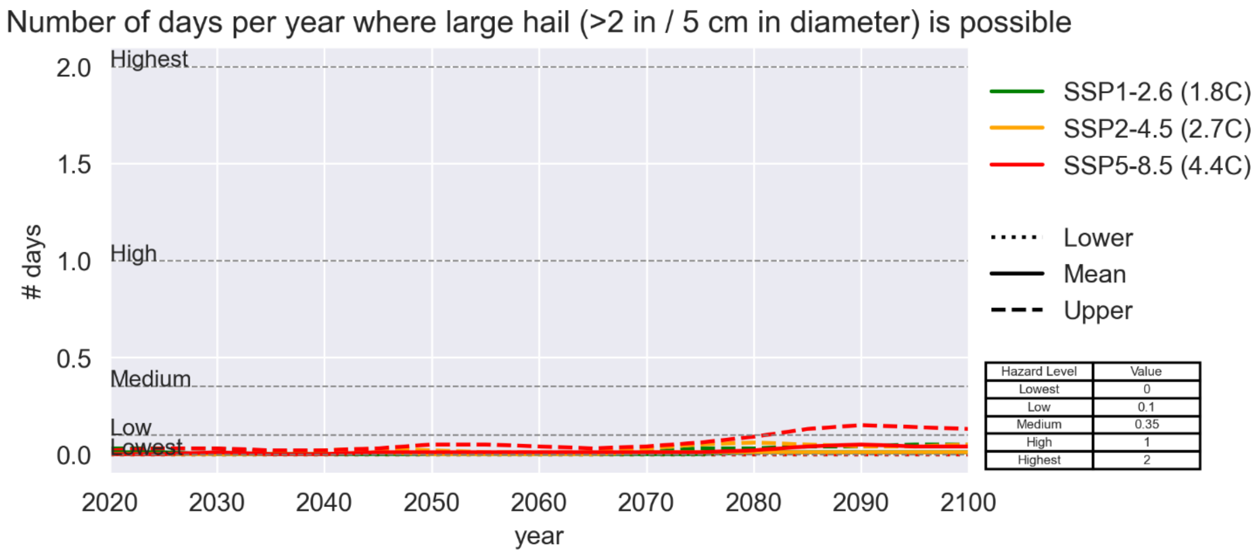

Figure 29: Hail hazard, represented by the number of days per year where large hail (>2 in / 5 cm in diameter) is possible

Table 13: Hail hazard, represented by the number of days per year where large hail (>2 in / 5 cm in diameter) is possible

year	SSP1-2.6	SSP2-4.5	SSP5-8.5
2025	0.01	0.00	0.00
2030	0.00	0.00	0.01
2040	0.00	0.00	0.00
2050	0.00	0.00	0.01
2060	0.00	0.00	0.01
2070	0.00	0.01	0.01
2080	0.01	0.01	0.02
2090	0.01	0.01	0.05
2100	0.01	0.01	0.04

9.3.1.6.12 Strong Wind Hazard

The Strong Wind hazard, represented by the maximum 1-minute sustained wind speed (in km/hr) experienced at the 100-year return period, remains stable across all emission scenarios throughout the near, medium, and distant future, with values consistently around 161 km/h, corresponding to a **Medium** hazard level according to Jupiter global classification.

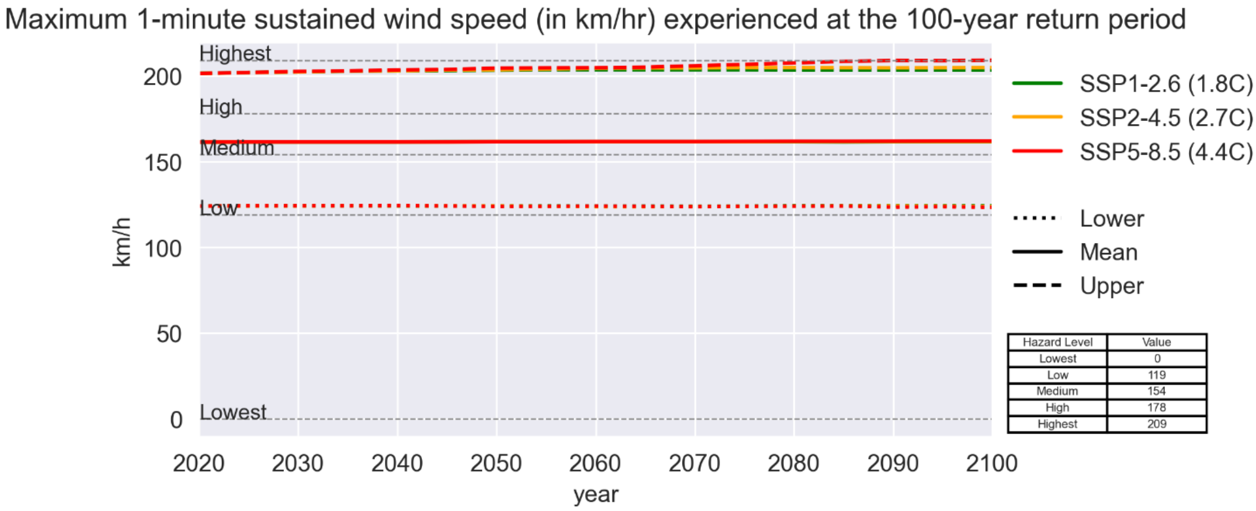

Figure 30: Strong Wind hazard, represented by the maximum 1-minute sustained wind speed (in km/hr) experienced at the 100-year return period

Table 14**: Strong Wind hazard, represented by the maximum 1-minute sustained wind speed (in km/hr) experienced at the 100-year return period**

year	SSP1-2.6	SSP2-4.5	SSP5-8.5
2025	161.4	161.4	161.4
2030	161.4	161.4	161.4
2040	161.4	161.4	161.4
2050	161.5	161.5	161.5
2060	161.5	161.5	161.6
2070	161.5	161.5	161.6
2080	161.5	161.6	161.8
2090	161.5	161.6	161.9
2100	161.5	161.6	162.0

9.3.2 Assessment of Sensitivity, Adaptative Capacity and Vulnerability

9.3.2.1 Sensitivity

For each hazard, the Sensitivity was qualitatively assessed based on the identification of the most relevant impacts that could affect each individual Project components and the Project overall. This assessment has been performed withing an internal workshop with WSP experts, taking into consideration all relevant information available in related literature and considering the peculiarities of this Project.

The final step was to assign a class of Sensitivity ("High", "Medium" or "Low") for each Project component and for the Project overall, entailing all information related to all different potential impacts collected through the assessment process, their numerosity, reliability, completeness and severity.

The table below shows the definitions of all different Sensitivity levels:

Table 15: Sensitivity classes definition.

SENSITIVITY CLASS	SENSITIVITY CLASS DESCRIPTION
Low	The potential impact could cause minor or negligible damages to the asset integrity and functionality. This would result in minor or negligible consequences for the Project operativity.
Medium	The potential impact could cause significant damages to the asset integrity and functionality. This would result in relevant consequences for the Project operativity.
High	The potential impact could cause compromise the asset integrity and functionality. This would result in major consequences for the project operativity.

A conservative approach has been adopted assigning a higher Sensitivity class whenever the assessment was uncertain due to inconsistent information.

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

9.3.2.1.1 Sensitivity to Flooding

The overall Sensitivity of the Project to flooding has been assigned as “**MEDIUM**.” This classification is based on the potential for flooding to disrupt critical infrastructure, which could lead to operational delays and safety concerns. The sensitivity of the wind farm Project components to flooding is outlined below:

- **Wind Turbines:** Flooding poses a risk to the stability of wind turbines, particularly to their foundations and bases. Water ingress could potentially undermine the structural integrity of the turbines, leading to mechanical failures or operational downtimes. Although wind turbines are generally elevated, floodwaters could still affect their structural stability, particularly during extreme events. The Sensitivity of wind turbines to flooding has been assigned as “**MEDIUM”**.
- **Overhead Lines:** Overhead power lines are relatively less exposed to flooding, but they are still vulnerable to disruptions if surrounding infrastructure is affected by water. Flooding could cause physical damage to supporting structures or create debris that may interfere with the lines, leading to electrical faults and power outages. The Sensitivity of overhead lines to flooding has been assigned as “**LOW”**.
- **Underground Cables:** Underground cables are typically protected from surface flooding, but if the flooding affects the surrounding infrastructure (such as substation buildings or turbine bases), it could lead to disruptions in the cables' functionality. Water ingress into the area surrounding the cables could cause damage to insulation, leading to potential power failures or safety hazards. The Sensitivity of underground cables to flooding has been assigned as “**LOW”**.
- **Substations:** Substations are highly sensitive to flooding due to their electrical equipment and power distribution systems. Water ingress could cause short circuits, equipment malfunctions, or even fires. Flooding can also disrupt the operational capacity of substations, leading to power outages that affect the entire wind farm’s operations. The Sensitivity of substations to flooding has been assigned as “**HIGH”**.

- **Battery Energy Storage System:** The Battery Energy Storage System is vulnerable to flooding, particularly because water can damage the system's electrical components and infrastructure. Water ingress could result in malfunction or complete failure of the storage system, leading to loss of energy storage capacity and potential safety hazards, including fire risks in extreme cases. The Sensitivity of battery energy storage system to flooding has been assigned as "**MEDIUM"**.
- **Access Roads:** Flooding could damage access roads by causing erosion, washouts, or water pooling, potentially limiting site accessibility for maintenance or emergency response. This could delay repairs and affect overall operations. The Sensitivity of access roads to flooding has been assigned as "**LOW"**.

9.3.2.1.2 Sensitivity to Extreme Heat

The overall Sensitivity of the Project to extreme heat and temperature variability have been assigned as "**MEDIUM**." This classification is based on the potential impacts of extreme heat events, especially related to material and infrastructure degradation, and to the risk of reduced efficiency in critical systems. The sensitivity of the wind farm Project components to extreme heat and temperature variability is outlined below:

- **Wind Turbines**: Extreme heat temperature can lead to a reduction in the efficiency of wind turbines, as high temperatures can cause thermal stress, potentially resulting in mechanical issues or failures. This effect can diminish the turbines' operational capacity and efficiency during prolonged heat events. The Sensitivity of wind turbines to extreme heat has been assigned as "**MEDIUM"**.
- **Overhead Lines**: Overhead power lines are susceptible to sagging and deformation during extreme heat due to thermal expansion. This can lead to electrical faults, disruptions in power supply, and safety hazards. The sensitivity of these lines to extreme heat and increasing temperatures could result in power outages affecting the functioning of the wind farm. The Sensitivity of overhead lines to extreme heat has been assigned as "**MEDIUM"**.
- **Underground Cables**: Underground cables may experience insulation breakdown and potential failures under prolonged high temperatures. Although typically more insulated from surface temperature fluctuations, extreme heat can still cause degradation of the materials over time. The Sensitivity of underground cables to extreme heat has been assigned as "**LOW"**.
- **Substations**: Extreme heat can negatively impact substations by increasing the risk of overheating and electrical faults. High temperatures may reduce the efficiency of the substation equipment, causing malfunctions and potential power disruptions. The risk of fire or equipment damage could increase if cooling systems are unable to operate effectively under extreme conditions. The Sensitivity of substations to extreme heat has been assigned as "**MEDIUM"**.
- **Battery Energy Storage System**: The Battery Energy Storage System is sensitive to extreme heat. High temperatures can cause batteries to overheat, which may lead to reduced performance, shorter lifespan, and potential safety hazards, including the risk of thermal runaway in some cases. The Sensitivity of battery energy storage system to extreme heat has been assigned as "**MEDIUM"**.
- **Access Roads:** No direct impact of the extreme heat hazard for access roads are anticipated. The Sensitivity of access roads to extreme heat has been assigned as "**LOW"**.

9.3.2.1.3 Sensitivity to Temperature variability

The potential impacts to the Project overall and to all main Project components due to chronic increasing temperatures have been considered similar but less severe compared to those identified for Extreme Heat hazard (see 9.3.2.1.2). Thus, the **overall Sensitivity of the** Project **to temperature variability has been assigned as "LOW."** The detail of the Sensitivity of each Project component is presented in the Physical Risk Assessment chapter 9.3.3

9.3.2.1.4 Sensitivity to Extreme Cold

The overall Sensitivity of the Project to extreme cold has been assigned as "**MEDIUM**." This classification stems from the potential for extreme cold temperatures to cause damage to key Project components, including structural elements, mechanical systems, and electrical infrastructure.

Below are the specific sensitivities of each Project component to extreme cold:

- **Wind Turbines:** Extreme cold can lead to material brittleness in wind turbine components, particularly the blades and structural parts. The low temperatures may increase the likelihood of cracking or failure in these materials. Additionally, the formation of ice on the blades can significantly reduce turbine efficiency, further impacting power generation capacity. If ice builds up, it can also cause physical damage to the blades, leading to expensive repairs or downtime. Sensitivity of wind turbines to extreme cold has been assigned as "**MEDIUM**".
- **Overhead Lines:** Overhead power lines are susceptible to contraction in extremely cold temperatures, which can increase tension and potentially cause the lines to snap or suffer damage. This could result in power outages and disrupt the operation of the wind farm. Additionally, ice formation on power lines can add significant weight, further exacerbating the risk of line failure. Sensitivity of overhead lines to extreme cold has been assigned as "**MEDIUM**".
- **Underground Cables:** While underground cables are generally protected from the direct effects of extreme cold, the surrounding ground may freeze and impact the cables' insulation and performance. In areas with high moisture content, freeze-thaw cycles can cause ground movement, which may damage the cables or their protective casing, leading to potential electrical failures. Sensitivity of underground cables to extreme cold has been assigned as "**LOW**".
- **Substations:** Extreme cold temperatures can cause equipment within substations to contract, potentially leading to operational disruptions or failures. The brittleness of materials in these conditions can increase the likelihood of cracking or damage to essential components such as transformers, circuit breakers, and switches. Additionally, cold temperatures may cause lubricants and fluids used in substation equipment to thicken, impairing their functionality and performance. Sensitivity of substations to extreme cold has been assigned as "**MEDIUM**".
- **Battery Energy Storage System:** The battery energy storage system is sensitive to extreme cold, as low temperatures can reduce the system's capacity and efficiency. Cold temperatures can also lead to a decline in battery performance, shortening its lifespan and reducing the overall energy storage capability. In some cases, the system may experience complete failure, which would disrupt power supply and potentially compromise the safety of the facility. Sensitivity of battery energy storage system to extreme cold has been assigned as "**MEDIUM**".
- **Access Roads:** Extreme cold can make access roads icy and slippery, potentially disrupting transportation to and from the site. This could delay maintenance activities or emergency responses during cold weather events. Sensitivity of access roads to extreme cold has been assigned as "**LOW**".

9.3.2.1.5 Sensitivity to Drought

The overall Sensitivity of the Project to drought and water stress has been assigned as "**LOW**." Drought is unlikely to directly damage infrastructure such as wind turbines, overhead lines, underground cables, substations, the battery energy storage system, or access roads. However, prolonged drought conditions may have indirect effects on certain Project components, primarily related to the stability of turbine foundations and soil integrity.

Below are the specific sensitivities of each Project component to drought:

- **Wind Turbines:** Drought may indirectly affect the foundations of wind turbines, particularly in areas where the soil is composed of expansive clays or unconsolidated materials. The reduction in soil moisture levels due to prolonged dry conditions can cause soil shrinkage, which could result in subsidence or instability beneath the turbine foundations. Sensitivity of wind turbines to drought has been assigned as "**LOW"**.
- **Overhead Lines:** No direct impact of the drought hazard for overhead lines are anticipated. Sensitivity of overhead lines to drought has been assigned as "**LOW"**.
- **Underground Cables:** Similarly, underground cables are not directly affected by drought. The soil moisture reduction could potentially lead to shifts in the surrounding earth, but the impact on the cables would be minimal in most cases. Soil movement could be a concern in specific areas where expansive clays or unconsolidated soils are present, but this is not expected to pose a significant risk to cable integrity. Sensitivity of underground cables to drought has been assigned as "**LOW"**.
- **Substations:** No direct impact of the drought hazard for the substations are anticipated. Sensitivity of substations to drought has been assigned as "**LOW"**.
- **Battery Energy Storage System:** No direct impact of the drought hazard for the battery energy storage system are anticipated. Sensitivity of battery energy storage system to drought has been assigned as "**LOW"**.
- **Access Roads:** No direct impact of the drought hazard for access roads are anticipated. Sensitivity of access roads to drought has been assigned as "**LOW"**.

9.3.2.1.6 Sensitivity to Water Stress

The potential impacts to all main Project components due to chronic Water stress are the same as those related to drought. Thus, the overall Sensitivity of the Project to Water stress has been assigned as "**LOW**."

The detail of the Sensitivity of each Project component is presented in the Physical Risk Assessment chapter 9.3.3

9.3.2.1.7 Sensitivity to Severe Storms

The overall Sensitivity of the Project to severe storms has been assigned as "**HIGH**." Severe storms, characterized by high winds, heavy rainfall, and lightning, could cause significant damage to various components of the Project. These events could result in structural and material damage, including electrical hazards. The following outlines the sensitivities of each Project element to severe storms:

- **Wind Turbines:** Severe storms with high winds pose a direct threat to wind turbines. Strong gusts can damage the turbine blades or even destabilize the structure, potentially leading to mechanical failure. Additionally, high winds could cause vibrations that affect turbine performance and safety. Lightning strikes, which often accompany severe storms, can also damage electrical components and cause system failures. Sensitivity of wind turbines to severe storms has been assigned as "**HIGH"**.
- **Overhead Lines:** Overhead transmission lines are highly vulnerable to the impacts of severe storms. High winds can cause the lines to sag or snap, while fallen debris and trees may damage the lines or infrastructure. Lightning strikes could cause electrical surges, leading to faults or damage to the transmission network, resulting in power outages and operational disruptions. Sensitivity of overhead lines to severe storms has been assigned as "**HIGH"**.
- **Underground Cables:** Although underground cables are less susceptible to direct physical damage from high winds or debris, extreme rainfall from severe storms could cause localized flooding, leading to soil

erosion or instability around the cable trench. This could result in infrastructure disruption or damage over time. Sensitivity of underground cables to severe storms has been assigned as "**MEDIUM"**.

- **Substations:** Substations, being vital electrical hubs, are prone to damage from severe storms. High winds can damage substation buildings and structures, while lightning strikes can cause electrical surges, igniting fires or causing equipment failures. Local flooding from heavy rainfall could undermine the integrity of the substation's foundation or cause water ingress, leading to operational shutdowns. Sensitivity of substations to severe storms has been assigned as "**HIGH"**.
- **Battery Energy Storage System:** Battery energy storage systems are susceptible to electrical surges caused by lightning or storms with intense electrical activity. Lightning strikes could damage electrical components, causing system failures or reducing performance. Additionally, high winds or debris from storms could indirectly affect the system if they cause damage to connected components. Sensitivity of battery energy storage system to severe storms has been assigned as "**HIGH"**.
- **Access Roads:** Severe storms may cause erosion, flooding, or debris accumulation on access roads, rendering them impassable or hazardous. Damage to access roads could delay emergency response, maintenance, or transportation of materials, resulting in Project disruptions and safety risks. Sensitivity of access roads to severe storms has been assigned as "**MEDIUM"**.

9.3.2.1.8 Sensitivity to Extreme Precipitation

The overall Sensitivity of the Project to extreme precipitation and has been assigned as "**MEDIUM**." Extreme precipitation events, particularly heavy rainfall, can cause damage to infrastructure, disrupt operations, and pose safety risks. These events can overwhelm drainage systems, lead to flooding, and increase the risk of structural failures. The following outlines the sensitivities of each Project component to extreme precipitation:

- **Wind Turbines:** Extreme precipitation can lead to water accumulation around the turbine bases, potentially causing soil erosion or instability beneath the foundations. Heavy rainfall and waterlogging could also increase mechanical stress on turbine components, leading to reduced performance and potential damage. Furthermore, precipitation combined with high winds may increase the risk of blade damage or mechanical failure. Sensitivity of wind turbines to extreme precipitation has been assigned as "**MEDIUM"**.
- **Overhead Lines:** Overhead transmission lines are vulnerable to the effects of extreme precipitation. Heavy rainfall can cause localized flooding that undermines the foundation of supporting towers, weakening their structural integrity. Floodwaters can also increase the likelihood of electrical faults and short circuits, leading to power outages. Moreover, waterlogged soil may cause the towers to settle or become misaligned, further threatening the stability of the network. Sensitivity of overhead lines to extreme precipitation has been assigned as "**MEDIUM"**.
- **Underground Cables:** While underground cables are generally less exposed to direct damage from heavy rainfall, extreme precipitation can overwhelm drainage systems and cause waterlogging around the cables. Excessive water accumulation could lead to soil erosion, affecting the stability of cable trenches and potentially causing operational disruptions or damage to the cables over time. Sensitivity of underground cables to extreme precipitation has been assigned as "**LOW"**.
- **Substations:** Substations are sensitive to extreme precipitation due to the risk of flooding and water ingress. Prolonged heavy rainfall can overwhelm drainage systems, flooding substations and affecting electrical components. Water ingress may cause corrosion, electrical faults, and damage to equipment, resulting in potential outages and requiring costly repairs. Additionally, excessive water can undermine substation foundations, compromising structural integrity. Sensitivity of substations to extreme precipitation has been assigned as "**MEDIUM"**.

- **Battery Energy Storage System:** Extreme precipitation could impact battery energy storage systems through water ingress and flooding, leading to potential equipment malfunctions or reduced performance. Waterlogging and flooding could cause physical damage to the system's electrical components, interrupting functionality and causing safety hazards. Sensitivity of battery energy storage system to extreme precipitation has been assigned as "**MEDIUM"**.

- **Access Roads:** Extreme precipitation can cause significant damage to access roads through flooding, erosion, or the accumulation of debris. Impassable roads may delay emergency response, maintenance, or material delivery, further disrupting Project operations and compromising safety. Sensitivity of access roads to extreme precipitation has been assigned as "**MEDIUM"**.

9.3.2.1.9 Sensitivity to Precipitation Variability

The potential impacts to the Project overall and to all main Project components due to chronic increasing precipitations have been considered similar but less severe compared to those identified for Extreme Precipitation hazard (see 9.3.2.1.8). Thus, the overall Sensitivity of the Project to precipitation variability has been assigned as "**LOW**." The detail of the Sensitivity of each Project component is presented in the Physical Risk Assessment chapter 9.3.3

The potential impacts to the Project overall and to all main Project components due to chronic increasing temperatures have been considered similar but less severe compared to those identified for Extreme Heat hazard (see 9.3.2.1.2).

9.3.2.1.10 Sensitivity to Wildfires

The overall Sensitivity of the Project to wildfires has been assigned as "**HIGH**." Wildfires, if they occur, can pose serious damage to infrastructure and operations. The potential for direct and indirect damage to critical infrastructure, particularly in fire-prone areas, makes it an important hazard for the Project. The following outlines the sensitivities of each Project component to wildfires:

- **Wind Turbines:** Wind turbines, particularly their bases and structural components, are vulnerable to wildfires. High temperatures and flames can degrade or destroy the foundation, mechanical components, and electrical systems of the turbines. Additionally, smoke and heat can interfere with the operation of the turbines, reducing their efficiency or causing malfunctions. Fire damage could lead to prolonged downtime and significant repair or replacement costs. Sensitivity of wind turbines to wildfires has been assigned as "**HIGH"**.

- **Overhead Lines:** Overhead power lines are highly susceptible to damage from wildfires. The heat from fires can cause the lines to sag or melt, potentially leading to power outages. Nearby trees or vegetation that catch fire may fall onto the lines, causing structural damage or electrical faults. These failures could lead to widespread power outages, impacting the infrastructure and on-site repair operations. Sensitivity of overhead lines to wildfires has been assigned as "**HIGH"**.

- **Underground Cables:** Underground cables are generally less exposed to direct damage from wildfires, as the fire primarily impacts surface infrastructure. Wildfires can also affect the stability of the ground above the cables, leading to potential risks of erosion or collapse that could damage the cables or interfere with their operation. Sensitivity of underground cables to wildfires has been assigned as "**LOW"**.

- **Substations:** Substations are particularly vulnerable to wildfires, as the heat from flames can directly damage electrical equipment, transformers, and other components. Fire can lead to electrical faults, power outages, and potentially catastrophic failures, disrupting the Project's operations. In addition, fires can damage the physical structure of the substation, requiring extensive repairs. Sensitivity of substations to wildfires has been assigned as "**HIGH"**.

- **Battery Energy Storage System:** Battery energy storage systems are sensitive to fire hazards, as fires can directly impact the stored energy units and associated electrical components. Heat from nearby wildfires could ignite flammable materials or cause thermal runaway in the battery systems. Such incidents could result in fires or explosions, endangering infrastructure and leading to significant operational disruptions. Sensitivity of battery energy storage system to wildfires has been assigned as "**HIGH"**.
- **Access Roads:** Wildfires can cause severe damage to access roads, including melting asphalt, eroding unpaved roads, or blocking paths with fallen trees or debris. Damaged or blocked roads could hinder emergency response, evacuation, or maintenance efforts, delaying critical operations and increasing safety risks. Sensitivity of access roads to wildfires has been assigned as "**MEDIUM"**.

9.3.2.1.11 Sensitivity to Hail

The overall Sensitivity of the Project to hail has been assigned as "**MEDIUM**." Hailstorms can cause substantial damage to infrastructure, particularly to components that are exposed to the elements. The following outlines the sensitivities of each Project component to hail:

- **Wind Turbines:** Wind turbine blades are especially vulnerable to hailstorms. Hail impacts can cause surface damage, leading to reduced efficiency, degradation of materials, and potentially compromising the structural integrity of the blades. Severe hail can cause cracks, dents, or chips, requiring costly repairs or replacements. Hail could also impact the tower and mechanical components of the turbines, leading to operational disruptions. Sensitivity of wind turbines to hail has been assigned as "**MEDIUM"**.
- **Overhead Lines:** Overhead power lines are susceptible to hail. The accumulation of hail can increase the weight on the lines, leading to sagging or even breakage. Additionally, the impact of hailstones can damage the insulation and cause electrical faults, potentially leading to power outages. Such outages could disrupt the operation of the wind farm, including the wind turbines and associated infrastructure, and delay necessary repairs. Sensitivity of overhead lines to hail has been assigned as "**MEDIUM"**.
- **Underground Cables:** Underground cables are generally less exposed to hailstorms compared to overhead lines. However, they may still be indirectly affected if surrounding infrastructure such as access roads, substations, or overhead lines are damaged by hail. If the damage leads to operational delays or the failure of connected systems, underground cables could be indirectly impacted. Sensitivity of underground cables to hail has been assigned as "**LOW"**.
- **Substations:** Substations are vulnerable to hailstorms, especially the electrical components, such as transformers and switchgear. Hail could damage the external protective surfaces and stress the mechanical systems, increasing the risk of operational failure. Prolonged exposure to hail could also increase wear and tear on the equipment, leading to costly repairs and potential power outages. Sensitivity of substations to hail has been assigned as "**MEDIUM"**.
- **Battery Energy Storage System:** While the battery storage system is generally less exposed to hailstorms compared to other Project components, the associated external infrastructure, such as transformers, cooling systems, and protection devices, could be damaged. This damage could lead to system failures or the degradation of battery performance, requiring costly repairs and operational downtime. Sensitivity of battery energy storage system to hail has been assigned as "**LOW"**.
- **Access Roads:** Hailstorms can impact access roads by causing erosion, potholes, or the accumulation of hail and ice. These conditions can make roads slippery and hazardous, hindering the movement of equipment and vehicles. Damaged roads could delay emergency response, routine maintenance, or material deliveries, potentially disrupting Project timelines and operations. Accumulated hail and ice can also increase safety risks accessing the site. Sensitivity of access roads to hail has been assigned as "**MEDIUM"**.

9.3.2.1.12 Sensitivity to Strong Wind

The overall Sensitivity of the Project to strong winds has been assigned as "**MEDIUM**." Strong winds can place significant mechanical stress on various Project components, potentially leading to damage or operational disruptions. The following outlines the sensitivities of each Project component to strong winds:

- **Wind Turbines:** Wind turbines are directly exposed to strong winds, and the mechanical stress exerted on them can be considerable. High winds can damage the turbine blades, leading to cracks, fractures, or even complete blade failure. Additionally, the mechanical components of the turbines (such as the nacelle and gearbox) may be subjected to excess forces, potentially affecting their operational efficiency or leading to costly repairs. Turbines that are not designed to withstand specific wind conditions may experience structural damage, which could halt power generation and result in operational downtime. Sensitivity of wind turbines to strong wind has been assigned as "**MEDIUM"**.

- **Overhead Lines:** Overhead transmission lines could be affected by strong winds. Strong winds can cause the lines to sway, potentially leading to sagging, snapping, or falling, especially if the lines are old or not adequately maintained. Additionally, strong winds can damage or displace insulation materials, resulting in electrical faults, outages, or fires. Such power disruptions could interfere with the functioning of the wind turbines, substations, and other critical infrastructure, requiring repairs and causing operational delays. Sensitivity of overhead lines to strong wind has been assigned as "**MEDIUM"**.

- **Underground Cables:** Underground cables are less exposed to the direct impacts of strong winds, making them more resilient to wind-related hazards. However, if strong winds cause damage to above-ground infrastructure, such as overhead lines or substations, the indirect impacts could disrupt the functionality of the underground cables, particularly if the damage leads to broader system failures. Sensitivity of underground cables to strong wind has been assigned as "**LOW"**.

- **Substations:** Substations can be affected by strong winds, particularly in terms of structural integrity. While substations are generally designed to withstand harsh weather conditions, high winds can cause vibrations or oscillations, which, over time, could weaken structural components. In the event of extreme wind conditions, substations may suffer from equipment failures or structural damage, leading to power outages and operational disruptions. Additionally, debris blown by strong winds can damage the external infrastructure, including fencing and control panels, creating safety hazards and complicating repairs. Sensitivity of substations to strong wind has been assigned as "**MEDIUM"**.

- **Battery Energy Storage System:** The battery storage system is less directly affected by strong winds, but associated infrastructure, such as transformers and cooling systems, may be vulnerable. Wind-driven debris or structural damage to external components could affect the functionality of the storage system. Additionally, any disruption to the power supply, such as outages caused by damaged transmission lines, could impact the battery system's performance. Sensitivity of battery energy storage system to strong wind has been assigned as "**LOW"**.

- **Access Roads:** Strong winds can cause indirect damage to access roads by uprooting trees, scattering debris, or creating hazardous conditions. Blocked or damaged roads could hinder the movement of repair crews, emergency responders, and maintenance teams, delaying critical operations and increasing safety. Sensitivity of access roads to strong wind has been assigned as "**LOW"**.

9.3.2.2 Adaptative Capacity

The Adaptive Capacity, similar to Sensitivity, was assessed qualitatively by identifying the most relevant measures that have been incorporated into the design of various Project components in this CCRA. These measures aim to avoid, prevent, or reduce the potential impacts caused by climate-related hazards. This assessment was conducted during an internal workshop with WSP experts, considering all relevant available information.

The final step was to assign a class of Adaptive Capacity ("High", "Medium" or "Low") for each Project component and for the Project overall, entailing all information collected through the assessment process, also considering their relative importance, reliability and completeness.

The table below shows the definitions of all different Adaptive Capacity levels:

Table 16:

ADPTIVE CAPACITY CLASS	ADPTIVE CAPACITY CLASS DESCRIPTION
Low	The measures allow to slightly mitigate the consequences of the related potential impact.
Medium	The measures allow to significantly mitigate the consequences of the related potential impact.
High	The measures allow to avoid or prevent the consequences of the related potential impact.

A conservative approach has been adopted assigning a lower Adaptive Capacity class whenever the assessment was uncertain due to inconsistent information.

The following are considerations that apply to all hazards; their evaluation helped with an overall identification of the Adaptive Capacity versus climate change-related events in the Project region:

- Kazakhstan has developed several frameworks to address climate risks and promote sustainable development. The National Climate Change Adaptation Plan, currently under development with support from the United Nations Development Programme ("UNDP"), integrates climate adaptation into strategic planning, focusing on infrastructure and energy systems (UNDP, 2022)[16]. Additionally, the Kazakhstan 2050 Strategy sets a vision for the country's sustainable economic growth, targeting climate-resilient development and infrastructure (Kazakhstan 2050 Strategy)[17].
- The Updated NDC, submitted in 2023, commits Kazakhstan to achieving carbon neutrality by 2060 while strengthening adaptation measures to reduce vulnerabilities to climate change (NDC 2023)[18]. Further, the Strategy of the Republic of Kazakhstan on Achieving Carbon Neutrality by 2060 outlines specific pathways for transitioning to a low-carbon economy and increasing resilience in key sectors (Carbon Neutrality Strategy 2060)[19].
- Lastly, the Concept for the Transition to a "Green Economy" provides a policy framework for sustainable and efficient development through green initiatives, emphasizing renewable energy and resilience to climate impacts (IEA Green Economy Concept)[20].

[16] https://www.undp.org/kazakhstan/press-releases/undp-launches-Project-integrate-climate-adaptation-strategic-planning-kazakhstan

[17] https://strategy2050.kz/en/page/multilanguage/

[18] https://unfccc.int/sites/default/files/NDC/2023-06/12updated%20NDC%20KAZ_Gov%20Decree313_19042023_en_cover%20page.pdf

[19] https://www.undp.org/kazakhstan/publications/kazakhstan-strategy-carbon-neutrality-2060.

[20] https://www.oecd.org/environment/outreach/Kazakhstan_Green_Economy_Strategy_2013.pdf

- Turbines were selected based on their specifications and resilience to certain climatic conditions, including features such as fire protection, anti-icing measures, and operational capacity under extreme weather conditions, as detailed under the individual hazard chapters below.
- An Emergency Preparedness and Response Plan ("EPRP") will be developed for the Project to ensure that all potential emergency situations, including extreme weather events, can be managed effectively.
- A HAZID (Hazard Identification) Report has been prepared for the Project to identify measures that will mitigate the impact of extreme events. The HAZID Report will be regularly reviewed and updated to ensure that all potential hazards are addressed with effective preventive or corrective measures. It will also guide the implementation of mitigation strategies for various climate-related events, ensuring the Project's ongoing resilience.

9.3.2.2.1 Adaptive Capacity to Flooding

The adaptive capacity to flooding will rely on several planned measures:

- **Wind Turbines:**
  - A hydrological study will be conducted to assess flood risks across the site.
  - The drainage philosophy for the site will be reviewed and implemented to manage surface water effectively and reduce the risk of water ingress into turbine foundations.
  - Geotechnical surveys will determine the suitability of the soil and terrain for flood-resilient infrastructure in turbine locations.
  - Reinforced foundations will be used in turbine designs to minimize the risk of flooding.

The adaptive capacity of wind turbines to flooding has been assessed as "**HIGH"**.

- **Overhead Lines:**
  - To the best of our knowledge, no specific measures have been identified for overhead lines.

The adaptive capacity of overhead lines to flooding has been assessed as "**LOW"**.

- **Underground Cables:**
  - To the best of our knowledge, no specific measures have been identified underground cables.

The adaptive capacity of underground cables to flooding has been assessed as "**LOW"**.

- **Substations:**
  - A hydrological study will be conducted to assess flood risks across the site.
  - Geotechnical surveys will determine the suitability of the soil and terrain for flood-resilient infrastructure.
  - The drainage philosophy for the site will be reviewed and implemented to manage surface water effectively and reduce the risk of water ingress into substations.

The adaptive capacity of substations to flooding has been assessed as "**MEDIUM"**.

- **Battery Energy Storage System:**
  - A hydrological study will be conducted to assess flood risks across the site.
  - Geotechnical surveys will determine the suitability of the soil and terrain for flood-resilient infrastructure.

  - The drainage philosophy for the site will be reviewed and implemented to manage surface water effectively and reduce the risk of water ingress into BESS.

The adaptive capacity of battery energy storage system to flooding has been assessed as "**MEDIUM”**.

- **Access Roads:**
  - To the best of our knowledge, no specific measures have been identified for access roads.

The adaptive capacity of access roads to flooding has been assessed as "**LOW”**.

Considering these measures, the adaptive capacity to flooding of the Project overall has been assessed as "**MEDIUM**," given the proactive hydrological study, drainage systems, and structural improvements, although the effectiveness will depend on the outcomes of the hydrological study and the proper execution of the drainage system.

9.3.2.2.2 Adaptive Capacity to Extreme Heat and Temperature Variability

To address the risks of extreme heat and temperature variability, the following measures will be implemented:

- **Wind Turbines:**
  - Wind turbines will be designed to shut down at predetermined high temperatures to prevent overheating.
  - Heat-reflective coatings or materials will be used in the design of turbine towers and to minimize thermal absorption.

The adaptive capacity of wind turbines to extreme heat and temperature variability has been assessed as "**HIGH”**.

- **Overhead Lines:**
  - To the best of our knowledge, no specific measures have been identified for overhead lines.

The adaptive capacity of overhead lines to extreme heat and temperature variability has been assessed as "**LOW”**.

- **Underground Cables:**
  - To the best of our knowledge, no specific measures have been identified underground cables.

The adaptive capacity of underground cables to extreme heat and temperature variability has been assessed as "**LOW”**.

- **Substations:**
  - Heat-reflective coatings or materials will be used in the design of substations to minimize thermal absorption.

The adaptive capacity of substations to extreme heat and temperature variability has been assessed as "**MEDIUM”**.

- **Battery Energy Storage System:**
  - The battery management system (“BMS”) will monitor external temperatures to ensure safe operation of the BESS.

- Collaboration with battery suppliers will confirm that the BESS can function effectively under extreme heat conditions.
- Heat-reflective coatings or materials will be used in the design of BESS to minimize thermal absorption.

The adaptive capacity of battery energy storage system to extreme heat and temperature variability has been assessed as "**HIGH**".

- **Access Roads:**
  - To the best of our knowledge, no specific measures have been identified for access roads.

The adaptive capacity of access roads to extreme heat and temperature variability has been assessed as "**LOW**".

With these measures in place, the adaptive capacity to extreme heat and temperature variability of the Project overall has been assessed as "**MEDIUM**," due to the reliance on operational temperature monitoring and the lack of extensive pre-installed cooling systems for all infrastructures.

9.3.2.2.3 Adaptive Capacity to Extreme Cold

The following measures will be adopted to enhance resilience to extreme cold:

- **Wind Turbines:**
  - An icing philosophy will be developed, which may include manual shutdowns, real-time ice detection integrated with SCADA, and the use of drones for ice removal.
  - The feasibility of de-icing systems for turbine blades will be reviewed, with potential integration of advanced technologies such as icing operation control, which adjusts turbine parameters based on meteorological conditions and technical specifications to prevent icing.
  - Materials and designs will be selected to mitigate risks of brittleness and mechanical stress in extreme cold, supported by preheating systems to maintain operational temperatures.
  - Ice-free wind sensors with high reliability will be employed to ensure safe and efficient turbine operation under icy conditions.
  - Ice-free blade technology will be used, incorporating hydrophobic anti-icing paint to prevent water accumulation on blade surfaces, reducing icing risks effectively.

The adaptive capacity of wind turbines to extreme cold has been assessed as "**HIGH**".

- **Overhead Lines:**
  - To the best of our knowledge, no specific measures have been identified for overhead lines.

The adaptive capacity of overhead lines to extreme cold has been assessed as "**LOW**".

- **Underground Cables:**
  - To the best of our knowledge, no specific measures have been identified underground cables.

The adaptive capacity of underground cables to extreme cold has been assessed as "**LOW**".

- **Substations:**
  - Real-time ice detection systems integrated with SCADA will be installed to provide proactive ice management.

The adaptive capacity of substations to extreme cold has been assessed as "**MEDIUM”**.

- **Battery Energy Storage System:**
  - Preheating systems for BESS will be installed to maintain operational temperatures in extreme cold conditions.
  - Real-time ice detection systems integrated with SCADA will be installed to provide proactive ice management.

The adaptive capacity of battery energy storage system to extreme cold has been assessed as "**HIGH”**.

- **Access Roads:**
  - To the best of our knowledge, no specific measures have been identified for access roads.

The adaptive capacity of access roads to extreme cold has been assessed as "**LOW”**.

The adaptive capacity to extreme cold of the Project overall has been assessed as "**HIGH**," as the measures include operational responses and manual interventions.

9.3.2.2.4 Adaptive Capacity to Drought and Water Stress

Planned measures to address potential impacts of drought and Water stress include:

- **Wind Turbines:**
  - Geotechnical surveys will be conducted to identify soil types and assess risks of shrinkage or subsidence beneath turbine foundations.

The adaptive capacity of wind turbines to drought and water stress has been assessed as "**MEDIUM”**.

- **Overhead Lines:**
  - To the best of our knowledge, no specific measures have been identified for overhead lines.

The adaptive capacity of overhead lines to drought and water stress has been assessed as "**LOW”**.

- **Underground Cables:**
  - To the best of our knowledge, no specific measures have been identified for underground cables.

The adaptive capacity of underground cables to drought and water stress has been assessed as "**LOW”**.

- **Substations:**
  - To the best of our knowledge, no specific measures have been identified for substations.

The adaptive capacity of substations to drought and water stress has been assessed as "**LOW”**.

- **Battery Energy Storage System:**
  - To the best of our knowledge, no specific measures have been identified for BESS.

The adaptive capacity of battery energy storage system to drought and water stress has been assessed as "**LOW”**.

- **Access Roads:**
  - To the best of our knowledge, no specific measures have been identified for access roads.

The adaptive capacity of access roads to drought and water stress has been assessed as "**LOW"**.

Given the limited adaptive measures defined for the Project, the adaptive capacity to drought and water stress of the Project overall has been assessed as "**LOW**."

9.3.2.2.5 Adaptive Capacity to Severe Storms

To manage risks associated with severe storms, the following measures will be implemented:

- **Wind Turbines:**
  - Wind turbines will incorporate overspeed protection systems and undergo integrated load analysis to ensure structural stability.
  - Lightning protection systems will be installed on all electrical equipment, following IEC 61400-24 standards.
  - Real-time weather monitoring systems will be set up to support operational decision-making and provide early warnings.

The adaptive capacity of wind turbines to severe storms has been assessed as "**HIGH"**.

- **Overhead Lines:**
  - To the best of our knowledge, no specific measures have been identified for overhead lines.

The adaptive capacity of overhead lines to severe storms has been assessed as "**LOW"**.

- **Underground Cables:**
  - To the best of our knowledge, no specific measures have been identified underground cables.

The adaptive capacity of underground cables to severe storms has been assessed as "**LOW"**.

- **Substations:**
  - Lightning protection systems will be installed on all electrical equipment, following IEC 61400-24 standards.
  - Real-time weather monitoring systems will be set up to support operational decision-making and provide early warnings.

The adaptive capacity of substations to severe storms of the Project overall has been assessed as "**MEDIUM"**.

- **Battery Energy Storage System:**
  - Lightning protection systems will be installed on all electrical equipment, following IEC 61400-24 standards.
  - Real-time weather monitoring systems will be set up to support operational decision-making and provide early warnings.

The adaptive capacity of battery energy storage system to severe storms has been assessed as "**MEDIUM"**.

- **Access Roads:**
  - To the best of our knowledge, no specific measures have been identified for access roads.

The adaptive capacity of access roads to severe storms has been assessed as "**LOW"**.

Given the inclusion of advanced protection systems and operational measures, the adaptive capacity to severe storms has been assessed as "**MEDIUM**," as these measures will significantly reduce the risk of storm-related damages.

9.3.2.2.6 Adaptive Capacity to Extreme Precipitation and Precipitation Variability

The following measures will be employed to mitigate risks associated with extreme precipitation and precipitation variability:

- **Wind Turbines:**
  - A hydrological study will be conducted to assess flood risks across the site.
  - The drainage philosophy for the site will be reviewed and implemented to manage surface water effectively and reduce the risk of water ingress into turbine foundations.

The adaptive capacity of wind turbines to extreme precipitation and precipitation variability has been assessed as "**MEDIUM**".

- **Overhead Lines:**
  - To the best of our knowledge, no specific measures have been identified for overhead lines.

The adaptive capacity of overhead lines to extreme precipitation and precipitation variability has been assessed as "**LOW**".

- **Underground Cables:**
  - To the best of our knowledge, no specific measures have been identified underground cables.

The adaptive capacity of underground cables to extreme precipitation and precipitation variability has been assessed as "**LOW**".

- **Substations:**
  - A hydrological study will be conducted to assess flood risks across the site.
  - The drainage philosophy for the site will be reviewed and implemented to manage surface water effectively and reduce the risk of water ingress into substations.

The adaptive capacity of substations to extreme precipitation and precipitation variability has been assessed as "**MEDIUM**".

- **Battery Energy Storage System:**
  - A hydrological study will be conducted to assess flood risks across the site.
  - The drainage philosophy for the site will be reviewed and implemented to manage surface water effectively and reduce the risk of water ingress into BESS.

The adaptive capacity of battery energy storage system to extreme precipitation and precipitation variability has been assessed as "**MEDIUM**".

- **Access Roads:**
  - To the best of our knowledge, no specific measures have been identified for access roads.

The adaptive capacity of access roads to extreme precipitation and precipitation variability has been assessed as "**LOW**".

Considering these measures, the adaptive capacity to extreme precipitation and precipitation variability of the Project overall has been assessed as "**MEDIUM**," as the reliance on drainage and surface water management systems will determine the effectiveness of these adaptations.

9.3.2.2.7 Adaptive Capacity to Wildfires

The following measures will be adopted to address wildfire risks:

- **Wind Turbines:**
  - Vegetation control will be incorporated into site design to prevent fire spread to critical infrastructures, including wind turbines.
  - Smoke, heat, and flame detection systems will be installed, including single-point detectors such as temperature sensors, flame detectors, and smoke detectors, to provide early warning of fire events. These systems will send feedback signals to the main control and trigger alarms via SCADA when activated.
  - Automatic fire-fighting systems will be installed in critical areas such as electrical cabinets and brake discs. The systems will feature aerosol fire extinguishing devices with temperature-sensitive activation and magnetic power generation elements for immediate response to fire hazards.
  - Dry powder fire extinguishers will be deployed near high-speed brake discs, equipped with thermal sensors to prevent brake-related fires.
  - Flame-retardant materials will be used for cables and electrical components, meeting strict industry standards. Cables will also be protected with advanced anti-abrasion measures to reduce risks of short circuits and arc discharge.
  - Temperature sensors will be installed in restricted spaces, such as inside electrical cabinets and the wheel hub, for real-time over-temperature protection.
  - The wind turbine design will adhere to lightning protection standards to minimize fire risks from lightning strikes.

The adaptive capacity of wind turbines to wildfires has been assessed as "**HIGH”**.

- **Overhead Lines:**
  - To the best of our knowledge, no specific measures have been identified for overhead lines.

The adaptive capacity of overhead lines to wildfires has been assessed as "**LOW”**.

- **Underground Cables:**
  - To the best of our knowledge, no specific measures have been identified underground cables.

The adaptive capacity of underground cables to wildfires has been assessed as "**LOW”**.

- **Substations:**
  - Vegetation control will be incorporated into site design to prevent fire spread to critical infrastructure such as the substations.
  - Smoke and heat detection systems will be installed to provide early warning of fire events.

The adaptive capacity of substations to wildfires has been assessed as "**MEDIUM”**.

- **Battery Energy Storage System:**
  - Vegetation control will be incorporated into site design to prevent fire spread to critical infrastructure such as the BESS.
  - Smoke and heat detection systems will be installed to provide early warning of fire events.

The adaptive capacity of battery energy storage system to wildfires has been assessed as "**MEDIUM”**.

- **Access Roads:**
  - To the best of our knowledge, no specific measures have been identified for access roads.

The adaptive capacity of access roads to wildfires has been assessed as "**LOW”**.

With these measures, the adaptive capacity to wildfires of the Project overall has been assessed as "**HIGH**," as these proactive measures are well-established and effective in mitigating wildfire risks to infrastructures.

9.3.2.2.8 Adaptive Capacity to Hail

To mitigate risks associated with hail, the following measures will be implemented:

- **Wind Turbines:**
  - Wind turbine blades will be designed to withstand the impact forces from hailstorms, using advanced materials and coatings.
  - Maintenance and inspection procedures will be implemented to address potential hail-related damage promptly.

The adaptive capacity of wind turbines to hail has been assessed as "**MEDIUM”**.

- **Overhead Lines:**
  - To the best of our knowledge, no specific measures have been identified for overhead lines.

The adaptive capacity of overhead lines to hail has been assessed as "**LOW”**.

- **Underground Cables:**
  - To the best of our knowledge, no specific measures have been identified underground cables.

The adaptive capacity of underground cables to hail has been assessed as "**LOW”**.

- **Substations:**
  - Maintenance and inspection procedures will be implemented to address potential hail-related damage promptly.

The adaptive capacity of substations to hail has been assessed as "**MEDIUM”**.

- **Battery Energy Storage System:**
  - Maintenance and inspection procedures will be implemented to address potential hail-related damage promptly.

The adaptive capacity of battery energy storage system to hail has been assessed as "**MEDIUM”**.

- **Access Roads:**

- To the best of our knowledge, no specific measures have been identified for access roads.

The adaptive capacity of access roads to hail has been assessed as "**LOW”**.

Given the focus on wind turbine resilience and protective measures for critical infrastructures, the adaptive capacity of the Project overall to hail has been assessed as "**MEDIUM**."

9.3.2.2.9 Adaptive Capacity to Strong Winds

The following measures will be employed to address risks from strong winds:

- **Wind Turbines:**
  - Wind turbines will be equipped with overspeed protection systems and designed using integrated load analysis.
  - Turbine foundations will be designed to account for site-specific wind conditions.
  - Maintenance and inspection procedures will be established to ensure that wind turbines and infrastructure remain structurally sound during high wind events.

The adaptive capacity of wind turbines to strong winds has been assessed as "**HIGH”**.

- **Overhead Lines:**
  - To the best of our knowledge, no specific measures have been identified for overhead lines.

The adaptive capacity of overhead lines to strong winds has been assessed as "**LOW”**.

- **Underground Cables:**
  - To the best of our knowledge, no specific measures have been identified underground cables.

The adaptive capacity of underground cables to strong winds has been assessed as "**LOW”**.

- **Substations:**
  - Maintenance and inspection procedures will be established to ensure that wind turbines and infrastructure remain structurally sound during high wind events.

The adaptive capacity of substations to strong winds has been assessed as "**MEDIUM”**.

- **Battery Energy Storage System:**
  - BESS foundations will be designed to account for site-specific wind conditions.
  - Maintenance and inspection procedures will be established to ensure that BESS remain structurally sound during high wind events.

The adaptive capacity of battery energy storage system to strong winds has been assessed as "**MEDIUM”**.

- **Access Roads:**
  - To the best of our knowledge, no specific measures have been identified for access roads.

The adaptive capacity of access roads to strong winds has been assessed as "**LOW”**.

With these measures in place, the adaptive capacity to strong winds of the Project overall has been assessed as "**MEDIUM**," as these comprehensive measures provide significant resilience to high wind events.

9.3.2.3 Vulnerability

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 Figure 31:

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

Figure 31: Vulnerability matrix.

The Project overall resulted most vulnerable to Severe Storms, which has been assessed as **High**, as the result of the combination of severe potential impacts (reflected in a **High** sensitivity) and adaptive capacity measures that could be further extended (assessed as **Medium** level). The Project overall resulted with a **Medium** vulnerability to Flooding, Extreme Heat, Extreme Precipitations, Hail, Strong Winds, as the combination of **Medium** sensitivity and **Medium** adaptive capacity levels. The vulnerability to Wildfires has been assessed as **Medium** as well, but in this case it is the result of the combination of severe potential impacts (resulting in **High** sensitivity), partially compensated with extensive adaptation measures (resulting in **High** adaptive capacity). The Project resulted less vulnerable to Extreme Cold, Temperature variability, Precipitation variability, Drought and Water stress, which have been assessed as **Low**.

Table 17: Vulnerability assessment.

Hazard	Sensitivity	Adaptive Capacity	Vulnerability
FLOODING	Medium	Medium	Medium
EXTREME HEAT	Medium	Medium	Medium
TEMPERATURE VARIABILITY	Low	Medium	Low
EXTREME COLD	Medium	High	Low
DROUGHT	Low	Low	Low
WATER STRESS	Low	Low	Low
SEVERE STORMS	High	Medium	High
EXTREME PRECIPITATIONS	Medium	Medium	Medium
PRECIPITATION VARIABILITY	Low	Medium	Low
WILDFIRES	High	High	Medium
HAIL	Medium	Medium	Medium
STRONG WINDS	Medium	Medium	Medium

The details with the Vulnerability assessment of each Project components are presented within chapter 9.3.3 as part of the calculations of climate-related risks.

9.3.3 Physical Risk Assessment

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

Figure 32: Risk matrix.

All three emission scenarios were considered and for time spans of 10 years from 2020 to 2100, consistently with Hazard data availability. However, considering the Project lifespan, comments will focus on the three time periods previously identified: near future (2030), medium future (2040) and distant future (2060).

Risks have been calculated for the Project overall, first, and then for each specific Project component.

9.3.3.1 Risk Assessment for the Project Overall

For the Project overall, here following are the main considerations.

The Risk which seems the most critical is Wildfires, which resulted **High** for all scenarios and time periods.

Extreme cold, Extreme heat, Temperature Variability, Drought and Strong wind should also be taken under consideration as they resulted **Medium** risk level for all three emission scenarios and time periods.

Finally, Flooding, Severe storms, Extreme precipitations, Precipitation variability and Hail resulted less critical, having been assessed as **Low** risk level for all time periods and emission scenarios.

Water stress resulted the least critical, with **Lowest** risk level for all time periods and emission scenarios.

A summary of the outcomes is presented in the following figures showing the assessed evolution of climate-related risks for the Project overall according to different emission scenarios:

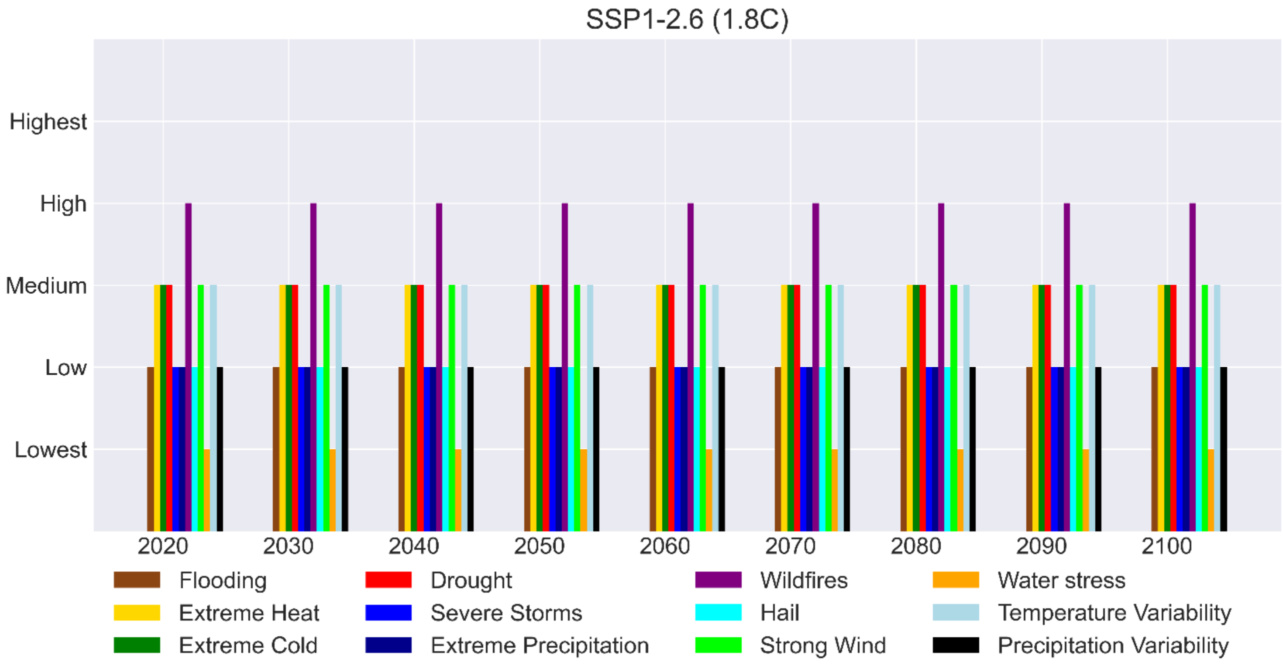

Figure 33: CCRA Results for Optimistic Scenario (SSP1-2.6).

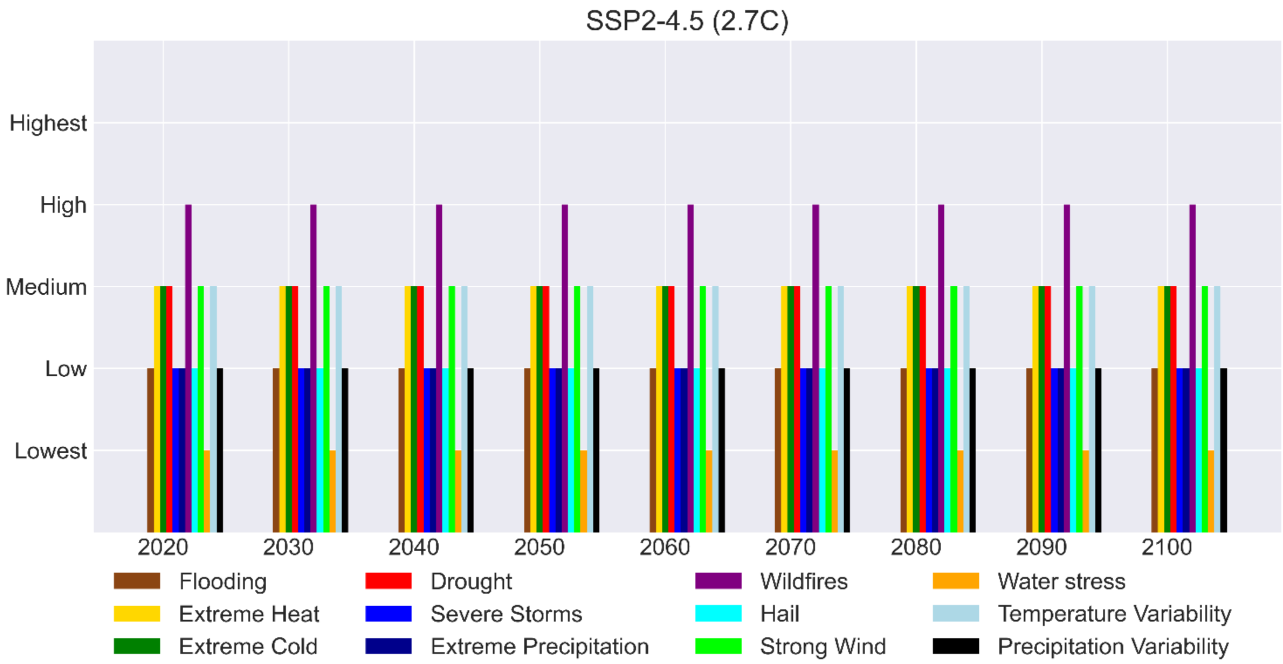

Figure 34: CCRA Results for Intermediate Scenario (SSP2-4.5).

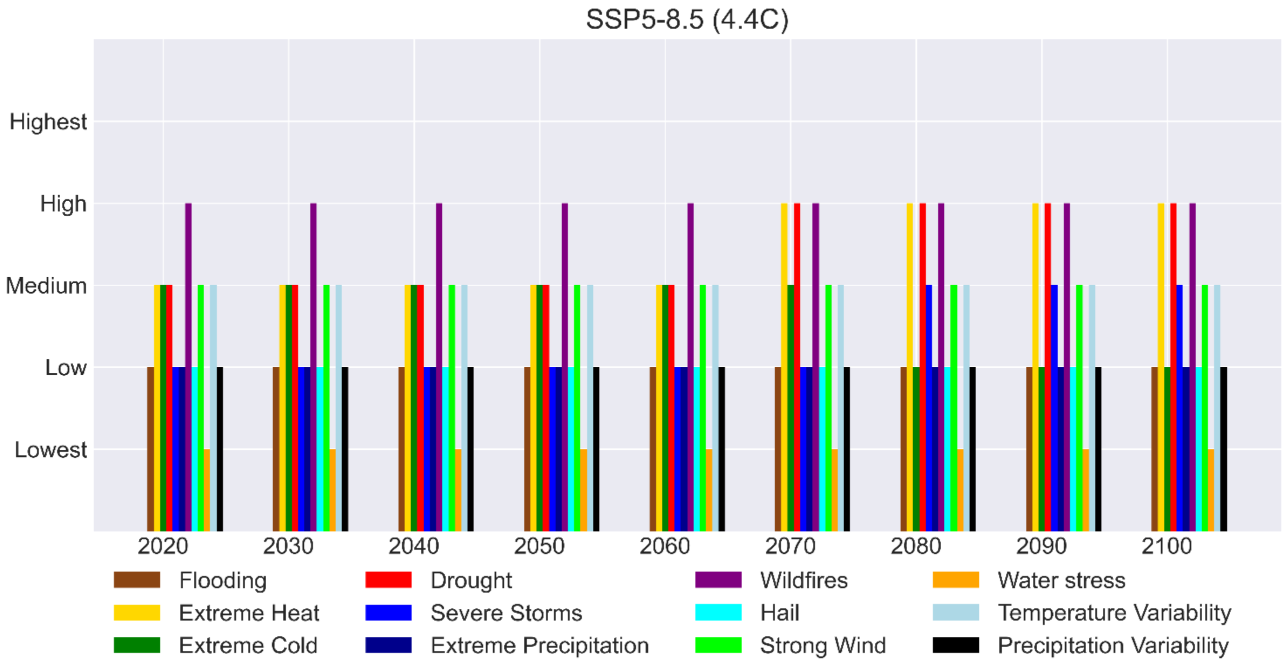

Figure 35: CCRA Results for Pessimistic Scenario (SSP5-8.5).

9.3.3.1.1 Flooding Risk

According to the results of the Risk Assessment, flooding does not appear to be a significant risk for the Project overall, as it was assessed as a “Low” risk for all scenarios between 2020 and 2100, with “Medium” vulnerability combined with the “Lowest” hazard level, covering the near (2030), medium (2040), and distant future (2060) for the Project.

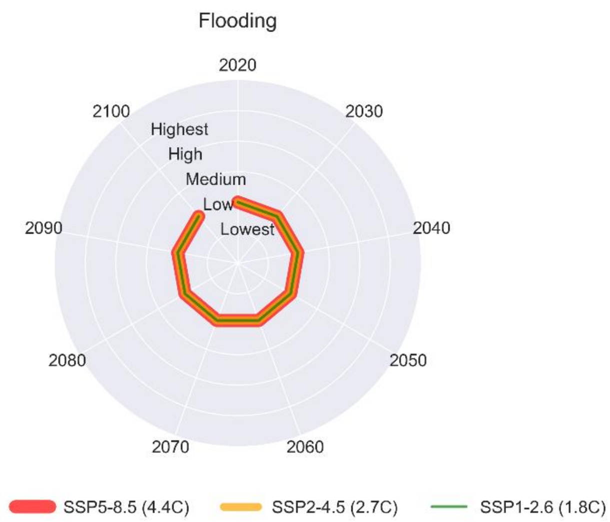

Figure 36: Flooding Risk for the overall Project.

9.3.3.1.2 Extreme Heat Risk

According to the Risk Assessment, extreme heat is assessed as a “Medium” risk up to 2060, with “Medium” hazard levels and vulnerability across all scenarios, covering the near (2030), medium (2040), and distant future (2060) for the Project.

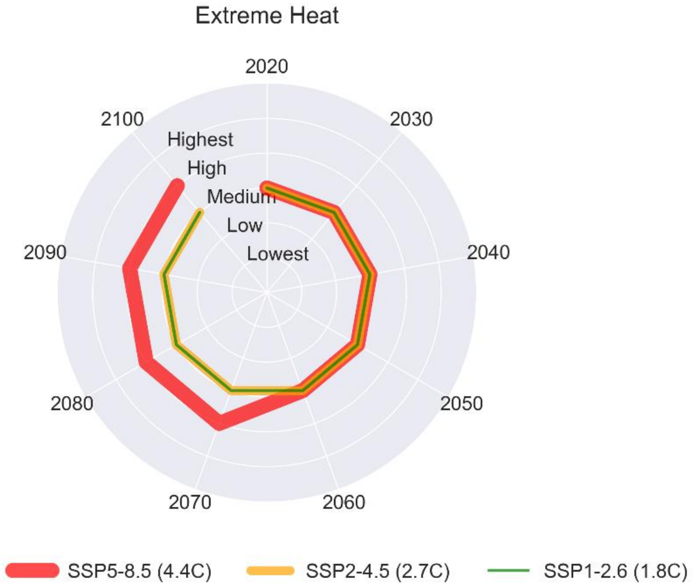

Figure 37: Extreme Heat Risk for the overall Project.

9.3.3.1.3 Temperature Variability

According to the Risk Assessment, temperature variability is assessed as a "Low" risk up to 2060, with "Medium" hazard levels and vulnerability across all scenarios, covering the near (2030), medium (2040), and distant future (2060) for the Project.

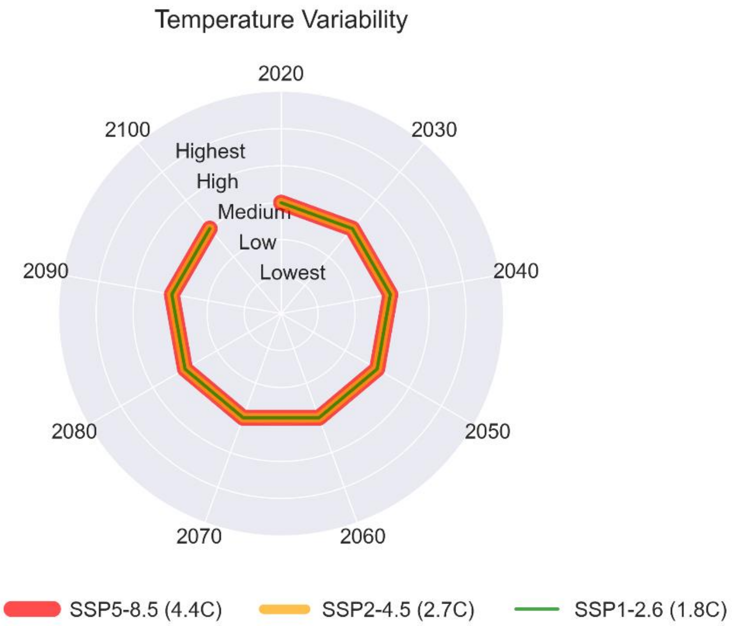

Figure 38: Temperature Variability Risk for the overall Project.

9.3.3.1.4 Extreme Cold Risk

According to the Risk Assessment, extreme cold is assessed as a "Medium" risk up to 2060, with "Medium" hazard levels combined with "Low" vulnerability across all scenarios, covering the near (2030), medium (2040), and distant future (2060) for the Project.

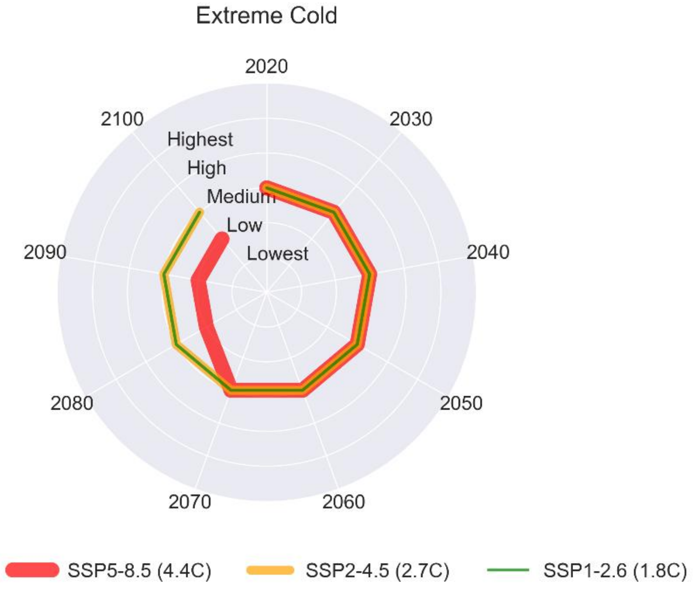

Figure 39: Extreme Cold Risk for the overall Project.

9.3.3.1.5 Drought Risk

According to the Risk Assessment, drought is assessed as a "Medium" risk for the Project up to 2060, with either "Medium" or "High" hazard levels combined with "Low" vulnerability across all scenarios, covering the near (2030), medium (2040), and distant future (2060).

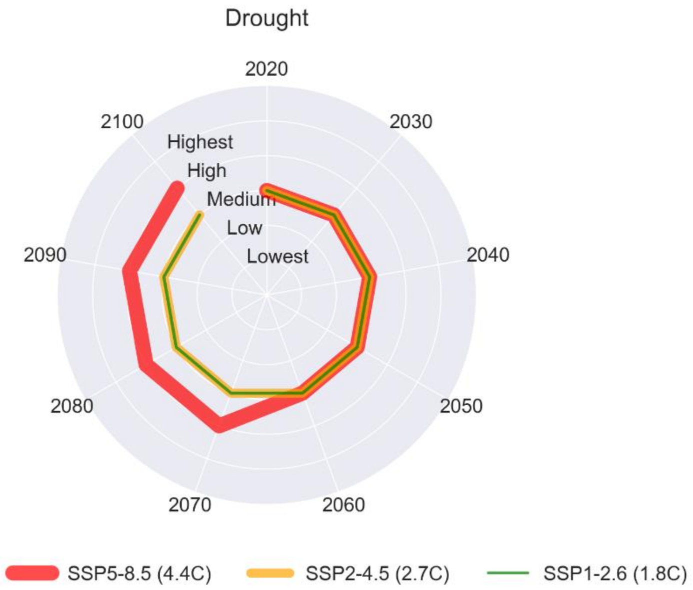

Figure 40: Drought Risk for the overall Project.

9.3.3.1.6 Severe Storms Risk

According to the Risk Assessment, severe storm is assessed as a "Low" risk up to 2060, with "Lowest" hazard levels combined with "High" vulnerability across all scenarios, covering the near (2030), medium (2040), and distant future (2060) for the Project.

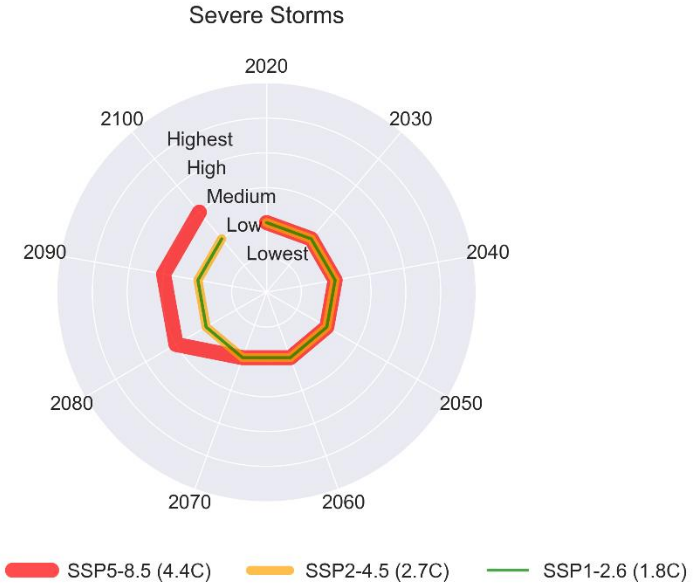

Figure 41: Severe Storms Risk for the overall Project.

9.3.3.1.7 Extreme Precipitations Risk

According to the results of the Risk Assessment, extreme precipitation does not appear to be a significant risk for the Project, as it was assessed as a "Low" risk for all scenarios, with "Medium" vulnerability combined with the "Lowest" hazard level, covering the near (2030), medium (2040), and distant future (2060) for the Project.

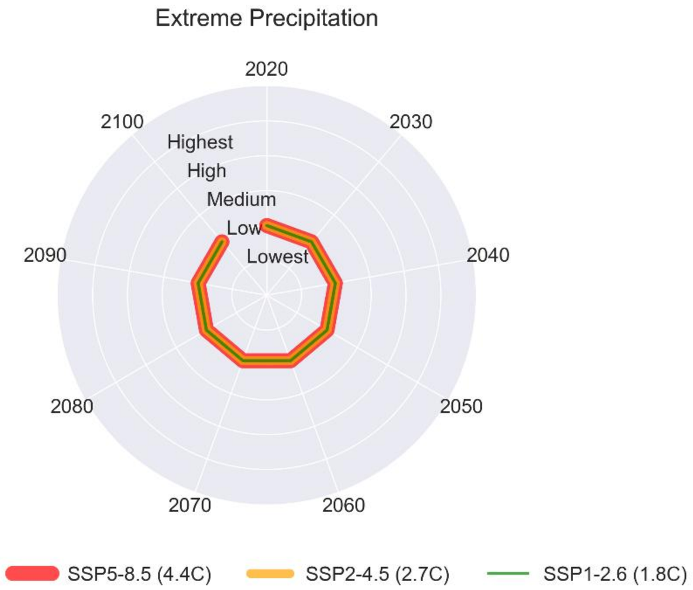

Figure 42: Extreme Precipitations Risk for the overall Project.

9.3.3.1.8 Wildfires Risk

According to the results of the Risk Assessment, wildfires pose a significant risk to the Project, as they were assessed as a "High" risk for all scenarios with "Medium" vulnerability combined with the "Highest" hazard level, covering the near (2030), medium (2040), and distant future (2060) for the Project.

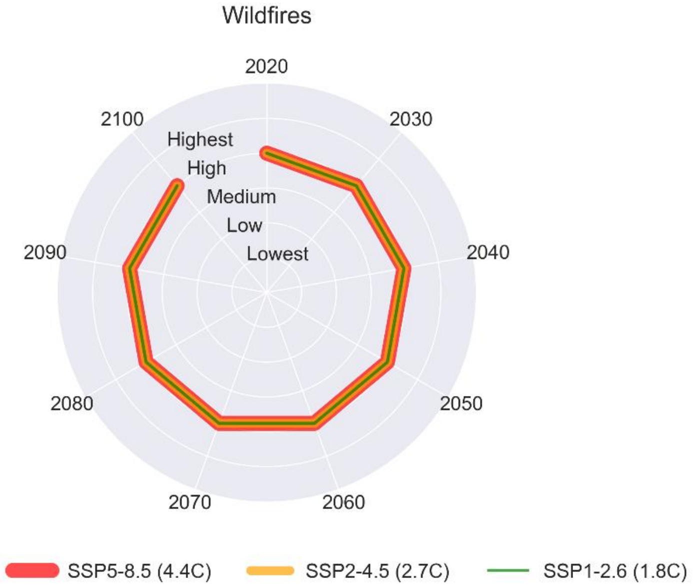

Figure 43: Wildfires Risk for the overall Project.

9.3.3.1.9 Hail Risk

According to the results of the Risk Assessment, hail does not appear to be a significant risk for the Project, as it was assessed as a "Low" risk for all scenarios, with "Medium" vulnerability combined with the "Lowest" hazard level, covering the near (2030), medium (2040), and distant future (2060) for the Project.

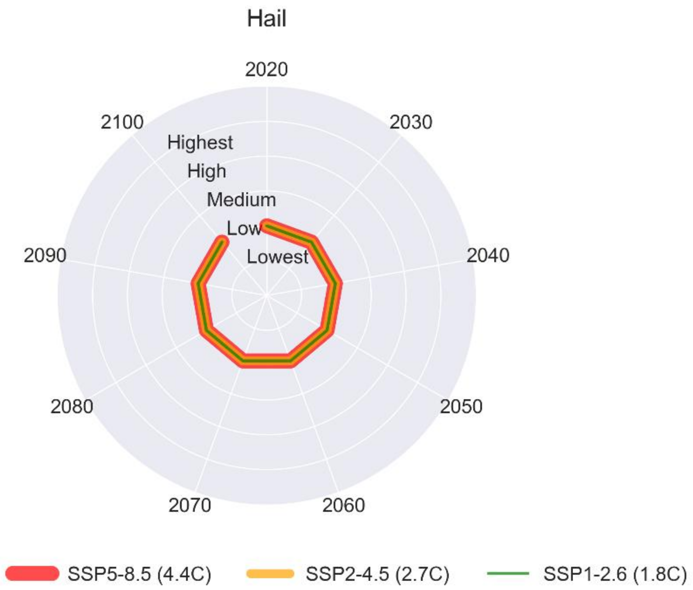

Figure 44: Hail Risk for the overall Project.

9.3.3.1.10 Strong Wind Risk

According to the results of the Risk Assessment, strong wind appears to pose a notable risk for the Project, as it was assessed as a "Medium" risk for all scenarios, with "Medium" hazard levels and vulnerability, covering the near (2030), medium (2040), and distant future (2060) for the Project.

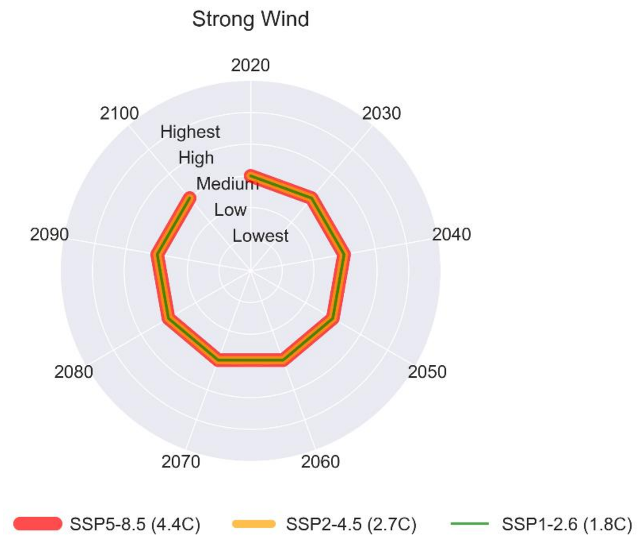

Figure 45: Strong Wind Risk for the overall Project.

9.3.3.2 Risk Assessment for Project Components

As per the risk assessment of different Project components, risks have been calculated considering all three time periods and for the intermediate scenario, SSP2-4.5, The results and main considerations are described in the chapters that follow, related to each climate-related risk.

9.3.3.2.1 Flooding Risk

The table below shows the assessment of the flooding risk at the Project components level:

Table 18: Flooding Risk at Project Components Level (SSP2-4.5)

Project Component	Sensitivity	Adaptive Capacity	Vulnerability	Hazard (2030)	Hazard (2040)	Hazard (2060)	Risk (2030)	Risk (2040)	Risk (2060)
Wind Turbines	Medium	High	Low	Lowest	Lowest	Lowest	Lowest	Lowest	Lowest
Overhead Lines	Low	Low	Low	Lowest	Lowest	Lowest	Lowest	Lowest	Lowest
Underground Cables	Low	Low	Low	Lowest	Lowest	Lowest	Lowest	Lowest	Lowest
Substations	High	Medium	High	Lowest	Lowest	Lowest	Low	Low	Low
Battery Energy Storage System	Medium	Medium	Medium	Lowest	Lowest	Lowest	Low	Low	Low
Access Roads	Low	Low	Low	Lowest	Lowest	Lowest	Lowest	Lowest	Lowest

Based on the above given table, no significant risk has been foreseen for any of the Project components in any time period. In fact all risks have been assessed in between “Low” and “Lowest“ level.

9.3.3.2.2 Extreme Heat Risk

The table below shows the assessment of the extreme heat risk at the Project components level:

Table 19: Extreme Heat Risk at Project Components Level (SSP2-4.5)

Project Component	Sensitivity	Adaptive Capacity	Vulnerability	Hazard (2030)	Hazard (2040)	Hazard (2060)	Risk (2030)	Risk (2040)	Risk (2060)
Wind Turbines	Medium	High	Low	Medium	Medium	Medium	Medium	Medium	Medium
Overhead Lines	Medium	Low	High	Medium	Medium	Medium	High	High	High
Underground Cables	Low	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium
Substations	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Battery Energy Storage System	Medium	High	Low	Medium	Medium	Medium	Medium	Medium	Medium
Access Roads	Low	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium

Based on the above given table, the most critical Project component in terms of extreme heat has been determined as overhead lines, which resulted "High" for all time periods. Apart from that, remaining Project components are also under significant risk for all time periods having been assessed as "Medium" risk level.

9.3.3.2.3 Temperature Variability

The table below shows the assessment of the temperature variability risk at the Project components level:

Table 20: Temperature Variability Risk at Project Components Level (SSP2-4.5)

Project Component	Sensitivity	Adaptive Capacity	Vulnerability	Hazard (2030)	Hazard (2040)	Hazard (2060)	Risk (2030)	Risk (2040)	Risk (2060)
Wind Turbines	Low	High	Lowest	Medium	Medium	Medium	Low	Low	Low
Overhead Lines	Low	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium
Underground Cables	Low	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium
Substations	Low	Medium	Low	Medium	Medium	Medium	Medium	Medium	Medium
Battery Energy Storage System	Low	High	Lowest	Medium	Medium	Medium	Low	Low	Low
Access Roads	Low	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium

Based on the above given table, the most significant Project components in terms of temperature variability have been determined as overhead lines, underground cables, substations and access roads, for all time periods, all with a "Medium" risk level. On the other hand, no significant risk has been foreseen for the wind turbines and BESS for any of the time periods.

9.3.3.2.4 Extreme Cold Risk

The table below shows the assessment of the extreme cold risk at the Project components level:

Table 21: Extreme Cold Risk at Project Components Level (SSP2-4.5)

Project Component	Sensitivity	Adaptive Capacity	Vulnerability	Hazard (2030)	Hazard (2040)	Hazard (2060)	Risk (2030)	Risk (2040)	Risk (2060)
Wind Turbines	Medium	High	Low	Medium	Medium	Medium	Medium	Medium	Medium
Overhead Lines	Medium	Low	High	Medium	Medium	Medium	High	High	High

Project Component	Sensitivity	Adaptive Capacity	Vulnerability	Hazard (2030)	Hazard (2040)	Hazard (2060)	Risk (2030)	Risk (2040)	Risk (2060)
Underground Cables	Low	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium
Substations	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Battery Energy Storage System	Medium	High	Low	Medium	Medium	Medium	Medium	Medium	Medium
Access Roads	Low	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium

Based on the above given table, most critical Project component in terms of extreme cold has been determined as overhead lines, with a "High" risk level for all time periods. Apart from that, remaining Project components are also under significant risk for all time periods, with "Medium" risk level.

9.3.3.2.5 Drought Risk

The table below shows the assessment of the drought risk at the Project components level:

Table 22: Drought Risk at Project Components Level (SSP2-4.5)

Project Component	Sensitivity	Adaptive Capacity	Vulnerability	Hazard (2030)	Hazard (2040)	Hazard (2060)	Risk (2030)	Risk (2040)	Risk (2060)
Wind Turbines	Low	Medium	Low	Medium	Medium	High	Medium	Medium	Medium
Overhead Lines	Low	Low	Low	Medium	Medium	High	Medium	Medium	Medium
Underground Cables	Low	Low	Low	Medium	Medium	High	Medium	Medium	Medium
Substations	Low	Low	Low	Medium	Medium	High	Medium	Medium	Medium
Battery Energy Storage System	Low	Low	Low	Medium	Medium	High	Medium	Medium	Medium
Access Roads	Low	Low	Low	Medium	Medium	High	Medium	Medium	Medium

Based on the above given table, all Project components are expected to be under significant risks in terms of drought, with "Medium" risk level for all time periods.

9.3.3.2.6 Severe Storms Risk

The table below shows the assessment of the severe storms risk at the Project components level:

Table 23: Severe Storms Risk at Project Components Level (SSP2-4.5)

Project Component	Sensitivity	Adaptive Capacity	Vulnerability	Hazard (2030)	Hazard (2040)	Hazard (2060)	Risk (2030)	Risk (2040)	Risk (2060)
Wind Turbines	High	High	Medium	Lowest	Lowest	Lowest	Low	Low	Low
Overhead Lines	High	Low	Highest	Lowest	Lowest	Lowest	Medium	Medium	Medium
Underground Cables	Medium	Low	High	Lowest	Lowest	Lowest	Low	Low	Low
Substations	High	Medium	High	Lowest	Lowest	Lowest	Low	Low	Low
Battery Energy Storage System	High	Medium	High	Lowest	Lowest	Lowest	Low	Low	Low

Project Component	Sensitivity	Adaptive Capacity	Vulnerability	Hazard (2030)	Hazard (2040)	Hazard (2060)	Risk (2030)	Risk (2040)	Risk (2060)
Access Roads	Medium	Low	High	Lowest	Lowest	Lowest	Low	Low	Low

Based on the above given table, most significant Project component in terms of severe storms risk has been determined as overhead lines for all time periods, with a “Medium” risk level. Apart from that, no significant risk has been foreseen for any of the remaining Project components in any time period.

9.3.3.2.7 Extreme Precipitations Risk

The table below shows the assessment of the extreme precipitations risk at the Project components level:

Table 24: Extreme Precipitations Risk at Project Components Level (SSP2-4.5)

Project Component	Sensitivity	Adaptive Capacity	Vulnerability	Hazard (2030)	Hazard (2040)	Hazard (2060)	Risk (2030)	Risk (2040)	Risk (2060)
Wind Turbines	Medium	Medium	Medium	Lowest	Lowest	Lowest	Low	Low	Low
Overhead Lines	Medium	Low	High	Lowest	Lowest	Lowest	Low	Low	Low
Underground Cables	Low	Low	Low	Lowest	Lowest	Lowest	Lowest	Lowest	Lowest
Substations	Medium	Medium	Medium	Lowest	Lowest	Lowest	Low	Low	Low
Battery Energy Storage System	Medium	Medium	Medium	Lowest	Lowest	Lowest	Low	Low	Low
Access Roads	Medium	Low	High	Lowest	Lowest	Lowest	Low	Low	Low

Based on the above given table, no significant risk has been foreseen for any of the Project component in any time period. In fact, all risks range from “Low” to “Lowest” level.

9.3.3.2.8 Wildfires Risk

The table below shows the assessment of the wildfires risk at the Project components level:

Table 25: Wildfires Risk at Project Components Level (SSP2-4.5)

Project Component	Sensitivity	Adaptive Capacity	Vulnerability	Hazard (2030)	Hazard (2040)	Hazard (2060)	Risk (2030)	Risk (2040)	Risk (2060)
Wind Turbines	High	High	Medium	Highest	Highest	Highest	High	High	High
Overhead Lines	High	Low	Highest	Highest	Highest	Highest	Highest	Highest	Highest
Underground Cables	Low	Low	Low	Highest	Highest	Highest	High	High	High
Substations	High	Medium	High	Highest	Highest	Highest	Highest	Highest	Highest
Battery Energy Storage System	High	Medium	High	Highest	Highest	Highest	Highest	Highest	Highest
Access Roads	Medium	Low	High	Highest	Highest	Highest	Highest	Highest	Highest

Based on the above given table, all Project components (especially the overhead lines, substations, BESS and access roads) are expected to be under critical wildfire risk for all time periods. In fact the risks range from high to highest across all different time periods.

9.3.3.2.9 Hail Risk

The table below shows the assessment of the hail risk at the Project components level:

Table 26: Hail Risk at Project Components Level (SSP2-4.5)

Project Component	Sensitivity	Adaptive Capacity	Vulnerability	Hazard (2030)	Hazard (2040)	Hazard (2060)	Risk (2030)	Risk (2040)	Risk (2060)
Wind Turbines	Medium	Medium	Medium	Lowest	Lowest	Lowest	Low	Low	Low
Overhead Lines	Medium	Low	High	Lowest	Lowest	Lowest	Low	Low	Low
Underground Cables	Low	Low	Low	Lowest	Lowest	Lowest	Lowest	Lowest	Lowest
Substations	Medium	Medium	Medium	Lowest	Lowest	Lowest	Low	Low	Low
Battery Energy Storage System	Low	Medium	Low	Lowest	Lowest	Lowest	Lowest	Lowest	Lowest
Access Roads	Medium	Low	High	Lowest	Lowest	Lowest	Low	Low	Low

Based on the above given table, no significant risk has been foreseen for any of the Project component in any time period. In fact, all risks range from “Low” to “Lowest” level.

9.3.3.2.10 Strong Wind Risk

The table below shows the assessment of the strong wind risk at the Project components level:

Table 27: Strong Wind Risk at Project Components Level (SSP2-4.5)

Project Component	Sensitivity	Adaptive Capacity	Vulnerability	Hazard (2030)	Hazard (2040)	Hazard (2060)	Risk (2030)	Risk (2040)	Risk (2060)
Wind Turbines	Medium	High	Low	Medium	Medium	Medium	Medium	Medium	Medium
Overhead Lines	Medium	Low	High	Medium	Medium	Medium	High	High	High
Underground Cables	Low	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium
Substations	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Battery Energy Storage System	Low	Medium	Low	Medium	Medium	Medium	Medium	Medium	Medium
Access Roads	Low	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium

Based on the above given table, most critical Project component in terms of strong wind risk has been determined as overhead lines for all time periods, with a “High” risk level. Apart from that, remaining Project components are also under significant risk for all time periods, all with a “Medium” risk level.

9.3.4 Risk Mitigation Actions and Conclusions

The Climate Change Physical Risk Assessment has identified the most critical climate-related risks associated with the long-term consequences of climate change, considering different emission scenarios throughout the

Project's operational lifetime. Considering that the Project lifespan is approximately 25 years, the assessment focused on the three time periods previously identified: near future (2030), medium future (2040) and distant future (2060).

In terms of Project phases, this study refers mainly to Project operation and decommissioning considering the relevant effects caused by climate change over time.

Considering the results for the Project overall, the assessment has identified wildfires as the most critical climate-related risk with the risk level of “high”, while the drought, extreme heat, extreme cold, and strong wind have been classified as “medium”-risk hazards, and flooding, severe storms, extreme precipitations, and hail have been classified as “low”-risk hazards for all the scenarios during the Project lifetime.

To enhance resilience, the Company will systematically manage climate-related risks and ensure continuous monitoring and improvement over time. A set of mitigation measures will be incorporated in the Environmental and Social Management Plan (EPRP, Natural Resources MP, etc.). This living document should be periodically reviewed and updated, incorporating new scientific data and climate projections.

A set of risk mitigation measures has been identified to help reducing climate risks. While this list is not exhaustive or binding, it provides a solid foundation for further adaptation planning. Actions should be prioritized based on risk levels and their expected timeframe for effectiveness. This section starts with a list of measures that could be beneficial for the Project overall and that would help increasing the level of resilience versus climate change-related risks in general.

After that it follows a list of risk-specific and Project components-specific measures, prioritized from those related to the most critical risks to the least critical, according to the outcomes of the CCRA. Most of the proposed measures below should be considered in the design phase.

All Risks

- Include in the ESMP appropriate mitigation measures to manage and mitigate climate risks while ensuring integration with broader sustainability goals.
- As part of the Emergency Preparedness and Response Plan (EPRP) required within the Project’s Environmental & Social Management System (ESMS), a detailed focus and integration on the control of all hazards is needed.
- Conduct a periodical revision (e.g., every 5 years) of the climate risk assessments to refine adaptation strategies based on new climate projections and the implementation of adaptation measures.
- Ensure regular maintenance of infrastructure to reduce sensitivity to climate-related hazards.
- Incorporate risk mitigation measures into the Project’s design where feasible and ensure their integration into the Contractor’s ESMS to facilitate seamless implementation and long-term effectiveness.

Risk of Wildfires

The following recommended measures can be applied to the Project to mitigate the risk of wildfire on Project, where practical and applicable:

- Heat, flammable gas and smoke detectors are provided at strategic locations inside each BESS container to detect electric fire and thermal runaway at earliest phase; they will alarm in case of any event
- Deploy thermal imaging cameras, infrared sensors, and remote fire monitoring systems at substations, and wind turbines to detect heat anomalies and provide early warnings before ignition occurs.

- Establish firebreak zones and create fuel-reduction areas using gravel, non-flammable barriers, or controlled burns to slow fire spread near wind turbines, substations, and BESS.
- Maintain defensible space by regularly clearing dry vegetation, deadwood, and other combustible materials along access roads and around overhead lines, wind turbines, substations, and BESS to prevent fire spread.
- Ensure adequate access for firefighting vehicles and maintain strategically placed water storage or hydrants at substations, BESS, and near wind turbines to support emergency response.
- Conduct regular inspections of electrical systems and transformers at substations and wind turbines to identify potential fire hazards from electrical faults.
- Place sufficient safety distance between BESS containers to ensure no fire propagation as per BESS manufacturer specifications.
- Construct fire-resistant enclosures, partitions, and physical barriers around substations to prevent fire from spreading between critical components.
- Install gas detectors inside substations to identify hazardous conditions that could lead to fire incidents.
- Implement active cooling systems and controlled venting mechanisms at BESS and wind turbines to prevent overheating and mitigate fire risks.
- Use insulated conductors, spark arresters, and arc protection systems along overhead lines to minimize ignition risks from electrical faults.
- Develop and regularly update fire emergency response plans, including fire suppression drills and evacuation procedures, ensuring coordination across wind turbines, BESS, substations, and access roads.

Risk of Extreme Heat and temperature variability

The following recommended measures can be applied to the Project to mitigate the risk of extreme heat and increasing temperatures on Project, where practical and applicable:

- Use high-temperature resistant conductors on overhead lines to maintain mechanical integrity and reduce sagging during extreme heat.
- Install dynamic line rating systems to overhead lines to monitor real-time conductor temperature and ambient conditions, allowing for adaptive load management and avoiding overheating.
- Increase clearance margins and inspect for thermal sag risks for overhead lines to prevent conductor-ground contact or flashovers during extreme temperature events.
- Implement active and passive cooling systems, including ventilation and phase-change materials, at BESS and substations to regulate temperatures in critical equipment.
- Enhance monitoring systems with additional thermal sensors and predictive analytics at wind turbines, BESS, and substations to detect overheating risks and trigger adaptive responses.
- Optimize operational procedures by adjusting loads, operating hours, or shutdown thresholds during extreme heat events for wind turbines, substations, and BESS to prevent overheating.
- Use advanced heat-resistant materials and coatings in electrical components and mechanical parts of wind turbines, substations, and overhead lines to improve durability under high temperatures.
- Design enclosures and shelters with reflective surfaces and natural cooling features at BESS and substations to minimize internal heat buildup.

- Develop contingency plans for heatwaves, including emergency cooling measures, additional power reserves, and operational adjustments for wind turbines, BESS, and substations to ensure system reliability.

Risk of Extreme Cold

The following recommended measures can be applied to the Project to mitigate the risk of extreme cold on Project, where practical and applicable:

- Reinforce overhead lines structures to withstand increased mechanical loads from ice and snow buildup during extreme cold events.
- Use overhead line conductors and insulators made from materials that retain flexibility and strength in sub-zero temperatures to avoid brittleness and breakage.
- Integrate automated de-icing and anti-icing systems, such as heating elements and ice-resistant coatings, on overhead lines and underground cables to prevent ice buildup and ensure uninterrupted power transmission.
- Apply cold-resistant lubricants, hydraulic fluids, and insulative coatings to wind turbine components and substation equipment to maintain mechanical performance in freezing conditions.
- Develop strategies for ice removal and mitigation, such as remote-controlled mechanical removal and chemical de-icing agents, for access roads to ensure safe transportation and maintenance access.
- Use materials with high impact tolerance and flexibility in the design of overhead lines and underground cables to prevent mechanical degradation and brittleness in extreme cold.
- Establish cold-weather operational protocols, including adjusted maintenance schedules and emergency response plans for substations and BESS, to prevent system failures due to extreme cold conditions.

Risk of Drought and Water Stress

The following recommended measures can be applied to the Project to mitigate the risk of drought and water stress on Project, where practical and applicable:

- Conduct long-term soil moisture and hydrological monitoring at wind turbine foundations and substations to detect early signs of subsidence risks due to prolonged drought conditions.
- Apply soil stabilization techniques, such as bioengineering, deep-rooted vegetation, and geosynthetics, around wind turbines and substations to maintain ground integrity and reduce the risk of foundation settlement.
- Use drought-resistant vegetation and soil treatments in areas with expansive clays near turbine foundations and access roads to minimize soil shrinkage and prevent erosion-related instability.
- Implement controlled irrigation or moisture-retention strategies at critical infrastructure sites, such as substations and wind turbines to mitigate extreme soil drying effects in prolonged drought conditions.
- Develop contingency plans for foundation maintenance at wind turbines and substations in case of significant soil shrinkage, including reinforcement options and adaptive foundation designs for high-risk areas.

Risk of Strong Winds

The following recommended measures can be applied to the Project to mitigate the risk of strong winds on Project, where practical and applicable:

- Use compact or low-profile conductor configurations to reduce wind exposure and minimize line sway.
- Install vibration dampers and spacers on overhead lines to control wind-induced oscillations and prevent mechanical fatigue.
- Use advanced aerodynamic designs and reinforced materials for wind turbine blades and nacelles to minimize wind-induced vibrations and structural stress.
- Strengthen anchoring systems and support structures for overhead lines to reduce the risk of damage or collapse in extreme wind conditions.
- Install real-time wind monitoring systems at wind turbines and substations with automated response capabilities, such as adaptive load redistribution and predictive shutdown mechanisms.
- Enhance structural reinforcements for substation enclosures and BESS housing to withstand high wind loads and prevent damage to critical equipment.
- Conduct regular structural integrity assessments for wind turbines, substations, and BESS foundations to identify and address potential vulnerabilities related to prolonged exposure to strong winds.
- Develop contingency plans for high-wind events, including rapid inspections, emergency shutdown protocols, and accelerated maintenance for wind turbines and electrical infrastructure.
- Apply wind-resistant coatings and protective barriers to exposed components of overhead lines to mitigate wear and potential damage from wind-driven debris.

Risk of Flooding

- Substations and BESS will be eventually elevated to reduce vulnerability to flooding.
- Flood-resistant enclosures and monitoring systems for early detection of water ingress will be incorporated in substations and BESS.
- Design and implement site-specific drainage systems around critical infrastructure and access roads to direct water away, preventing water accumulation.

Risk of Severe Storms

- Reinforced anchoring systems for substations and BESS will be employed to withstand storm-induced mechanical stress.

Risk of Extreme Precipitations and Precipitation variability

- Real-time precipitation monitoring systems will be installed to manage water-related risks and provide early warnings for wind turbines, substations and BESS.
- Rain-resistant enclosures will be used for sensitive equipment in substations and BESS to protect them from water damage.

Risk of Hail

- Real-time weather monitoring systems will be implemented to detect hailstorms and allow for operational adjustments for wind turbines, substations, and BESS.
- Protective covers or shields will be used for sensitive equipment in substations and BESS to minimize hail impacts.

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