

12

Climate



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12 CLIMATE

12.1 INTRODUCTION

This section describes the climate and meteorological patterns relevant to the Aurukun Bauxite Project (the project) and identifies climate extremes in relation to natural and other hazards.

12.2 REGIONAL CLIMATIC PATTERNS

The project is located in western Cape York, Queensland. Cape York has a tropical climate characterised by a distinct wet season (November to April) and dry season (May to October).

The active phases of the monsoon play a role in the seasons and climate of the region. The monsoon occurs during the wet season, resulting from a seasonal reversal of winds that occurs over parts of the tropics. The monsoon results in a zone of low pressure and rising air, bringing heavy rainfall to Cape York.

Climatic data was collected from the closest Bureau of Meteorology (BoM) weather station to the project site, being Weipa Aero (BoM weather station number 027045), located 40 km north-east of the project site. Temperature, rainfall, humidity, and wind data sourced from the Weipa Aero weather station is presented in the following sections.

12.3 TEMPERATURE

Table 12-1 shows monthly mean minimum and maximum daily temperatures at the Weipa Aero weather station from 1992 to 2020. These temperatures are typical of the Cape York climate, with relatively warm temperatures year-round, and slightly cooler temperatures over the dry season.

The highest mean daily maximum temperature at the Weipa Aero weather station is 35.8°C, recorded during November. The lowest mean daily minimum temperature at the weather station is 18.7°C, recorded during August.

Table 12-1 Mean Minimum and Mean Maximum Daily Temperatures

MONTH	MEAN MINIMUM (°C)	MEAN MAXIMUM (°C)
January	24.3	32.0
February	24.2	31.5
March	23.9	31.8
April	22.8	32.3
May	21.4	31.9
June	20.0	31.0
July	18.9	31.0
August	18.7	32.1
September	19.8	34.4

MONTH	MEAN MINIMUM (°C)	MEAN MAXIMUM (°C)
October	21.8	35.7
November	23.5	35.8
December	24.2	34.1
Annual	22.0	32.8

12.4 RAINFALL

The annual rainfall pattern illustrates the tropical climate of the Cape York region, with 97% of the annual rainfall occurring during November to April.

Table 12-2 presents long-term mean, minimum and maximum monthly rainfall and rain days recorded at the Weipa Aero weather station between 1990 and 2020. Mean monthly rainfall ranges from 1.4 mm in July to 501.5 mm in February, with a mean annual rainfall of 1,911.4 mm. The highest monthly rainfall recorded was 986.4 mm in March 2015, with a maximum annual rainfall of 2,719.4 mm.

Table 12-2 Monthly Mean, Minimum and Maximum Rainfall and Rain Days

MONTH	MEAN (mm)	MINIMUM (mm)	MAXIMUM RAINFALL (mm)	RAIN DAYS
January	482.3	0.0	909.8	15.4
February	501.5	127.2	932.6	15.0
March	409.9	149.0	986.4	14.2
April	97.9	0.2	328.0	6.6
May	20.3	0.0	137.8	2.0
June	3.4	0.0	23.6	0.4
July	1.4	0.0	9.2	0.3
August	5.1	0.0	59.2	0.5
September	1.5	0.0	16.6	0.3
October	19.6	0.0	132.6	1.5
November	95.8	2.6	339.6	5.1
December	271.2	59.2	876.0	10.8
Annual	1,911.4	1,206.2	2,719.4	72.1

12.5 RELATIVE HUMIDITY

Table 12-3 provides mean Relative Humidity (RH) values based on measurements collected daily at 9 am and 3 pm from the Weipa Aero weather station for the years 1992 to 2011.

The highest monthly mean RH value was recorded in February for both morning and afternoon values (86% and 76%, respectively). Daily variation of RH ranges from a 10% decrease in humidity from 9 am to 3 pm in January and February, to a 28% decrease across July, August and September.

During the winter months, there is a higher variation in RH in the morning compared to the afternoon, due to a lack of rainfall at this time of year leading to moisture in the air evaporating more substantially over the course of the day.

Table 12-3 Monthly Mean 9 am and 3 pm Relative Humidity from 1992 to 2011

MONTH	MEAN RELATIVE HUMIDITY (%)	
	9 AM	3 PM
January	83	73
February	86	76
March	83	70
April	77	59
May	75	52
June	74	49
July	72	44
August	69	41
September	65	37
October	61	39
November	64	46
December	75	60
Annual	74	54

12.6 WIND

At the Weipa Aero weather station, 71% of winds are from the east to the south-east during the wet season (Diagram 12-1). The winds are predominately moderate in strength, between 3 and 7 m/s, averaging 2.65 m/s with a maximum 30-minute mean of 13.1 m/s.

During the dry season, 95% of winds are from the east to the south-east (Diagram 12-2). The winds are predominately moderate in strength, between 3 and 7 m/s, averaging 3.61 m/s with a maximum 30-minute mean of 11.9 m/s.

Diagram 12-1 Wind Speed and Wind Direction - Wet Season

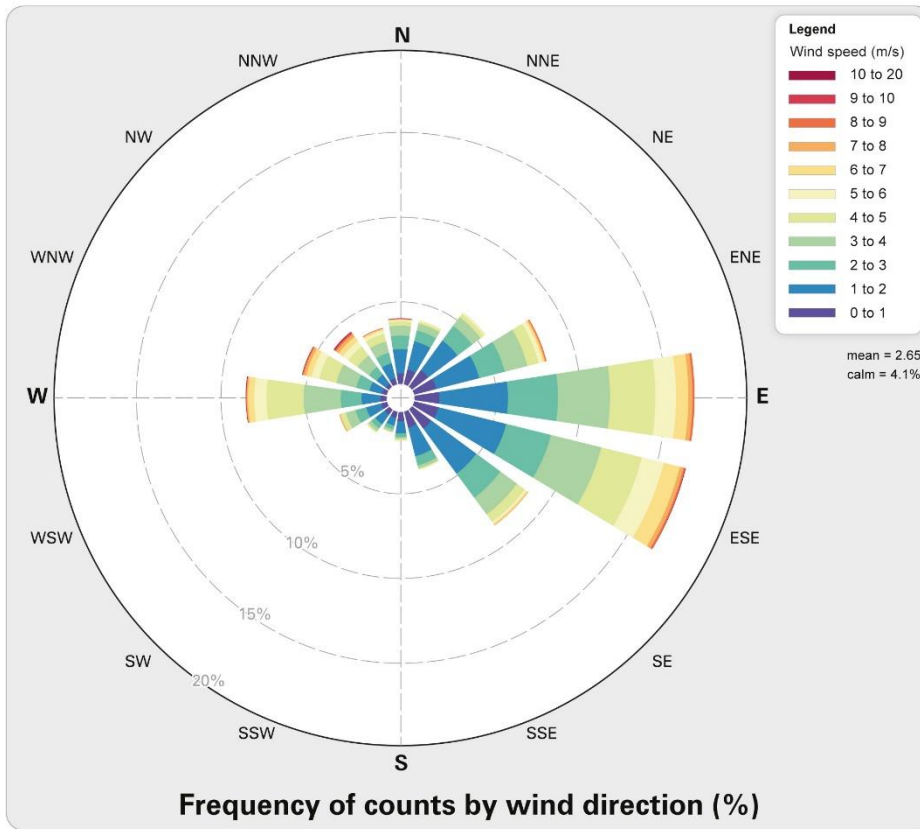
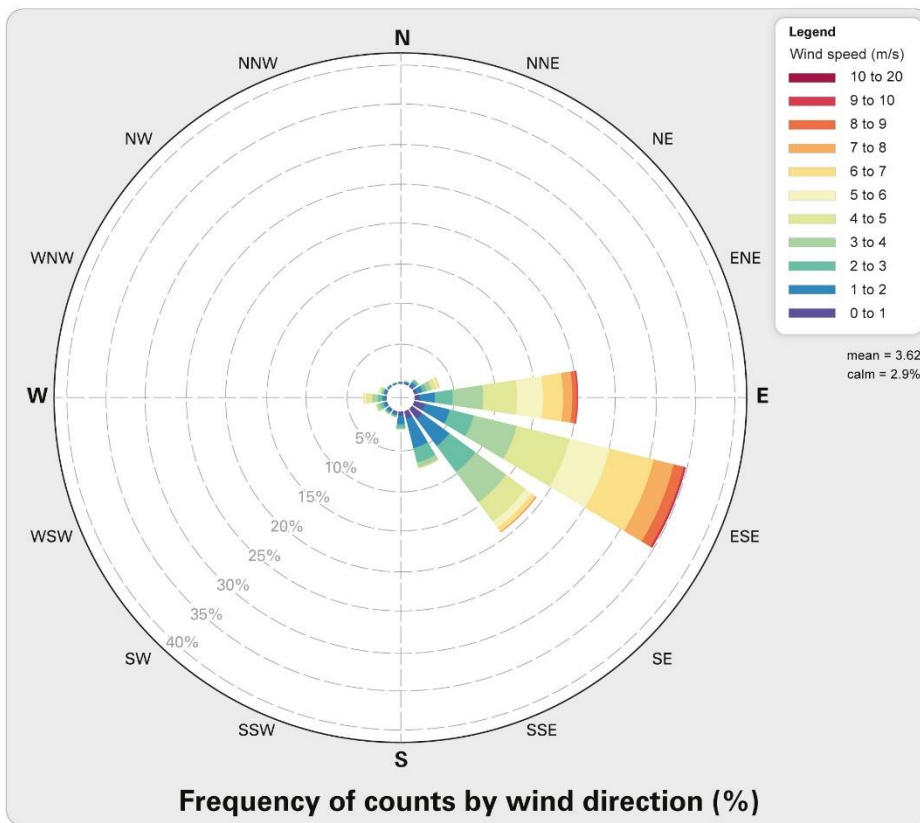


Diagram 12-2 Wind Speed and Wind Direction - Dry Season



12.7 EXTREMES OF CLIMATE

The project site experiences cyclonic winds and monsoonal rains during the wet season. Flooding associated with cyclones, storms and low monsoonal troughs frequently affect the region. Section 7 – Surface Water describes the flood study that was undertaken for the project. This considered extreme flooding conditions, including the Probable Maximum Flood.

The greatest risk of bushfire usually occurs towards the end of the dry season, and before the onset of rain over the wet season. During this time, lower relative humidity, high winds, and lack of rain are common. Key strategies to minimise the risk of bushfire are described in Section 21 – Hazard and Safety. This section also discusses cyclones and the associated risks.

12.8 CLIMATE CHANGE

12.8.1 Changes in Climate Conditions

The BoM and CSIRO play an important role in monitoring, analysing and communicating observed and future changes in Australia's climate (BoM and CSIRO, 2020). The State of the Climate report (BoM and CSIRO, 2020) presented simulations from the latest generation of global climate models, including simulations from the Australian Community Climate and Earth System Simulator (ACCESS) climate model. Queensland is projected to experience the following changes in climate over the coming decades:

- Continued warming, with more extremely hot days and fewer extremely cool days;
- More intense short-duration heavy rainfall events;
- Fewer tropical cyclones, but a greater proportion projected to be of high intensity, with ongoing large variations from year to year;
- More frequent, extensive, intense and longer-lasting marine heatwaves;
- Continued warming and acidification of the surrounding oceans;
- Ongoing sea level rise; and
- More frequent extreme sea levels.

12.8.2 Impacts to the Project

At a local scale, the Cape York region is expected to become hotter and drier, with current predictions displaying increases in both temperature and evaporation. Projected rainfall changes vary substantially, from a 19% decrease to an 18% increase in rainfall levels by 2050 under high emissions (CSIRO, BoM and Climate Change in Australia, 2020).

The following climate conditions have the potential to affect the project:

- Increase in extreme temperatures and a decrease in evaporation rates;
- Increase in rain and flooding associated with a greater number of extreme weather events; and
- Increase in sea levels.

The project's vulnerability to the above climate conditions is discussed in the following sections.

Temperature and Evaporation

The region has experienced a history of frequent (i.e. typically yearly) and often intense bushfires (North Australia Fire Information, 2020). In general, an increase in extreme temperatures, coupled with a decrease in rainfall can result in an increase in the frequency and/or intensity of bushfires. This climatic effect is not expected to significantly alter the fire regime given that it is already characterised by frequent bushfires. In addition, the proponent has developed a Bushfire Management Plan as detailed in Section 21 – Hazard and Safety that includes site specific bushfire management and mitigation strategies.

Changes in evaporation rates are unlikely to have an appreciable influence on water supply as the mine water management system has been sized to maintain a reliable, low risk water supply that allows the continuation of mining operations under a range of climatic conditions (Section 7 – Surface Water).

Furthermore, increases in extreme temperatures have the potential to adversely affect germination and seedling performance in rehabilitated areas. The *Draft Proposed Progressive Rehabilitation and Closure Plan* (Appendix E) commits to including a diverse mix of species within the vegetation communities planted during mine rehabilitation, to maximise the potential for these communities to withstand or adapt to climate change. In addition, a rehabilitation monitoring program will be adopted to determine whether rehabilitation milestone criteria have been achieved and identify areas of rehabilitation that require additional remediation.

Sea Level

Rising sea levels pose a significant threat to coastal communities by amplifying the risks of coastal inundation, storm surge and erosion. BoM and CSIRO (2020) states that the upper end of projected global mean sea level rise could be as high as 0.61 to 1.10 m (depending on location) by the end of the century for a high emissions pathway. The project's infrastructure, including the Coastal Loading Facility, is suitably positioned above the present-day sea level, with the predicted rise in sea level unlikely to impact the project.

Rainfall, Water Supply and Flooding

As a result of climate change, the project site is expected to experience an increase in intense short-duration heavy rainfall events. It is predicted that there will be fewer tropical cyclones, however the cyclones that impact the project site will be of higher intensity, with ongoing large variations from year to year. This may lead to an increase in rain and flooding associated with a greater number of extreme weather events.

The effects of climate change on the proposed water management system for the project would be a potential minor reduction in the long-term accumulated rainfall runoff within the system, but an increase in short-term storm events.

As detailed in Section 7 – Surface Water, the flood study that was undertaken for the project confirms that the proposed mining areas are located outside the 1 in 1,000 year flood extent (0.1% Annual Exceedance Probability), and consequently changes in the number of extreme events is not likely to result in any significant impacts due to flood inundation.

The site drainage system has been designed with capacity to convey rainfall generated by large storm events. However, extreme storm events will still exceed this design capacity under current climate conditions.

The Erosion and Sediment Control Plan detailed in Section 7 – Surface Water will include a program for regular maintenance of all erosion and sediment controls to ensure that they continue to operate effectively. These measures will manage any effects on the site drainage system due to changes in the frequency of extreme rainfall events over the life of the project.

Overall, the site drainage arrangements and the conservatism in the flood modelling assumptions ensure that any increase in extreme rainfall events resulting from climate change are not likely to give rise to any significant additional environmental impacts.

12.8.3 Management and Mitigation

Management and mitigation measures will be put in place to ensure that the project is able to adapt to climate change. These measures will be in accordance with the Queensland government's *Pathways to a Climate Resilient Queensland – Queensland Climate Adaptation Strategy 2017 – 2030* (Department of Environment and Heritage Protection, 2017b) and will include:

- Designing robust site drainage infrastructure and a mine water management system to account for variability of mine water supply due to climate change;
- Designing the mine water management system to allow for extreme rainfall and flooding events;
- Designing and building mine infrastructure (such as the Fines Containment Area) to engineering specifications to ensure safety during extreme events;
- Implementing the Bushfire Management Plan as detailed in Section 21 – Hazard and Safety that includes site specific bushfire management and mitigation strategies;
- Following waste management procedures, including waste minimisation and storage and handling, to reduce the risk of disease, including mosquito borne diseases (which may be exacerbated by climate change); and
- The proponent working cooperatively with government and other industry sectors to address adaptation to climate change, where practicable.