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Historical Weather Risks Analysis

REPORT

Country: Democratic Republic of Congo

Location coordinates: -4.89, 15.17.

Prepared By: OpenWeather LTD, 30 St Mary's Axe, The City Of London, London, Greater London, EC3A 8BF, United Kingdom

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Background

1. Introduction & Objective

1.1 Business Context:

OpenWeather to provide ABC ltd. with a comprehensive historical climate risk analysis for the telecom tower site. Telecom towers are vulnerable to various climate-related disruptions such as extreme heat, high winds, severe storms, flooding, and abrupt temperature swings. Understanding past patterns will enable ABC ltd. to better prepare, mitigate risks, and improve their resilience strategy against future climate variability.

1.2 Report Objective:

Create a data-driven historical climate risk analysis that:

- Identifies major weather risks at the tower location.
- Defines critical weather thresholds and frequency of risk events.
- Provides insights into long-term climatic trends and patterns affecting tower operations and infrastructure integrity.

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2. Scope of Analysis

2.1 Geographic Coverage:

- The operational locations as provided in the site inventory.
- Each location (latitude/longitude) is mapped to relevant historical weather data from OpenWeather OWHL weather model.

2.2 Time Frame for Historical Analysis:

- Analyse a minimum of the past 10 years of historical weather data (recommended 10–20 years if data is available) to establish long-term trends.
- Data granularity: daily observations with the possibility of event-level details (e.g., maximum daily gust, daily max/min temperatures, and weather alerts).

2.3 Weather Data Parameters to Include:

- **Wind:** Maximum wind gusts, average sustained wind speeds, wind direction.
- **Temperature:** Daily max and min temperatures, average temperatures, extreme high/low temperature events.
- **Precipitation & Storms:** Rainfall intensity, frequency of heavy rainfall events, thunderstorm occurrences.
- **Snow, icing**
- **Humidity**
- **Lighting:** How often Lighting occurs per each location
- **Cloud cover:** Clear sky vs exact cloud coverage

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3. Climate Risk Factors & Thresholds

3.1 Determination of Risk Thresholds:
Set industry-relevant thresholds based on telecommunications industry guidelines and engineering standards. Leverage references from the provided links and industry best practices. Proposed initial thresholds include:

- **High Wind Risk (at various heights) :**
    - **Wind Gust Thresholds:**
        - **Moderate Risk:** 25-40 m/s
        - **High Risk:** 40-57 m/s
        - **Severe Risk:** 58+ m/s
          These thresholds can be refined in consultation with ABC ltd. structural engineers.
- **Extreme Heat Risk:**
    - **High Temperature Thresholds:**
        - **Moderate Risk:** Daily max temperature ≥ 35°C
        - **High Risk:** Daily max temperature ≥ 40°C
          Consider local climate baselines. Tiers may be set based on local norms to identify anomalies (e.g., temperatures 5-10°C above seasonal average).

- **Severe Storms & Precipitation:**
    - **Very heavy rain**: Greater than 8 mm per hour.
    - **Heavy rain**: Greater than 4 mm per hour, but less than 8 mm per hour
    - **Moderate rain**: Greater than 0.5 mm per hour, but less than 4.0 mm per hour.
    - **Slight rain**: Less than 0.5 mm per hour.
    - **Lightning & Thunderstorms**: Count of days with thunderstorms per month/year. Number of lighting strikes per location
    - **Flood Conditions:** Identify proxy indicators if flood data is available (e.g., a certain rainfall threshold combined with local flood advisories).

- **Humidity & Corrosion Risks:**
    - Identify periods of persistently high humidity > 80% over multiple days if relevant to equipment cooling and corrosion.

3.2 Analytical Techniques:

- **Event Frequency Analysis:** Count how often each location exceeds defined risk thresholds (e.g., number of high-wind days per year over 10 years).
- **Statistical Trend Analysis:** Evaluate trends over time. For example, is there an upward trend in days exceeding 35°C?
- **Seasonal Pattern Analysis:** Identify if certain seasons consistently show elevated risk (e.g., monsoon months for heavy rainfall, summer months for extreme heat).
- **Correlation with Alerts:** Compare frequency of risk events to historical advisories issued, aligning threshold-exceeding events with local alert systems.

Executive Summary

This report analyses climate risks for the ABC ltd. site in Sona-Bata, it is not highlighting risks from temperature and wind. However, high humidity poses long-term corrosion risks to equipment. Precipitation — though mostly moderate — includes occasional heavy rainfall events and rare very heavy rainfall, which could lead to localiced flooding and erosion.

1. Climate Zone Description

Sona-Bata, located in the Kongo Central province of the Democratic Republic of the Congo,, with an elevation of about 560 metres above sea level.The region has a tropical wet and dry climate, characterized by two seasons: wet and dry. It experiences, on average, high temperatures all year round, with an extremely rainy period and a relatively drier one.

Climate Sona-bata: Weather By Month

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Nov	Oct	Dec	Year
Record high °C (°F)	37.07 (98.73)	38.07 (100.53)	40.07 (104.13)	39.07 (102.33)	36.06 (96.91)	36.06 (96.91)	38.07 (100.53)	39.07 (102.33)	39.07 (102.33)	39.07 (102.33)	37.07 (98.73)	36.06 (96.91)	40.07 (104.13)
Average high °C (°F)	30.83 (87.49)	31.8 (89.24)	32.23 (90.01)	31.56 (88.81)	31.4 (88.52)	30.79 (87.42)	30.86 (87.55)	30.95 (87.71)	31.41 (88.54)	30.83 (87.49)	30.45 (86.81)	29.78 (85.6)	31.08 (87.94)
Daily mean °C (°F)	27.21 (80.98)	27.93 (82.27)	28.23 (82.81)	27.88 (82.18)	27.58 (81.64)	26.49 (79.68)	26.2 (79.16)	26.52 (79.74)	27.42 (81.36)	27.47 (81.45)	27.12 (80.82)	26.53 (79.75)	27.22 (81.0)
Average low °C (°F)	22.28 (72.1)	22.59 (72.66)	22.74 (72.93)	22.79 (73.02)	22.28 (72.1)	19.85 (67.73)	19.22 (66.6)	20.3 (68.54)	21.75 (71.15)	22.78 (73.0)	22.62 (72.72)	22.2 (71.96)	21.78 (71.2)
Record low °C (°F)	19.03 (66.25)	0.0 (0)	18.03 (64.45)	19.03 (66.25)	19.03 (66.25)	16.03 (60.85)	16.03 (60.85)	17.03 (62.65)	19.03 (66.25)	19.03 (66.25)	20.04 (68.07)	18.03 (64.45)	0.0 (0)
Average precipitation mm (inches)	123.27 (4.85)	93.04 (3.66)	89.65 (3.53)	107.94 (4.25)	70.35 (2.77)	1.28 (0.05)	0.7 (0.03)	1.39 (0.05)	9.7 (0.38)	89.22 (3.51)	139.17 (5.48)	143.71 (5.66)	72.45 (2.85)
Average precipitation days (≥ 1.0 mm)	19.68	16.3	16.67	18.58	13.11	0.0	0.0	0.36	3.19	12.02	19.49	20.4	11.65
Average relative humidity (%)	84.25	81.72	81.27	83.5	82.5	74.3	67.69	64.57	65.54	73.82	82.96	85.94	77.34
Mean monthly sunshine hours	10.44	10.1	10.21	10.14	7.62	9.56	11.04	10.65	10.86	8.4	9.85	11.15	10.0

2. Methodology

To analyze weather data, an approach has been chosen to identify trends and seasonality in time series data of weather parameters.

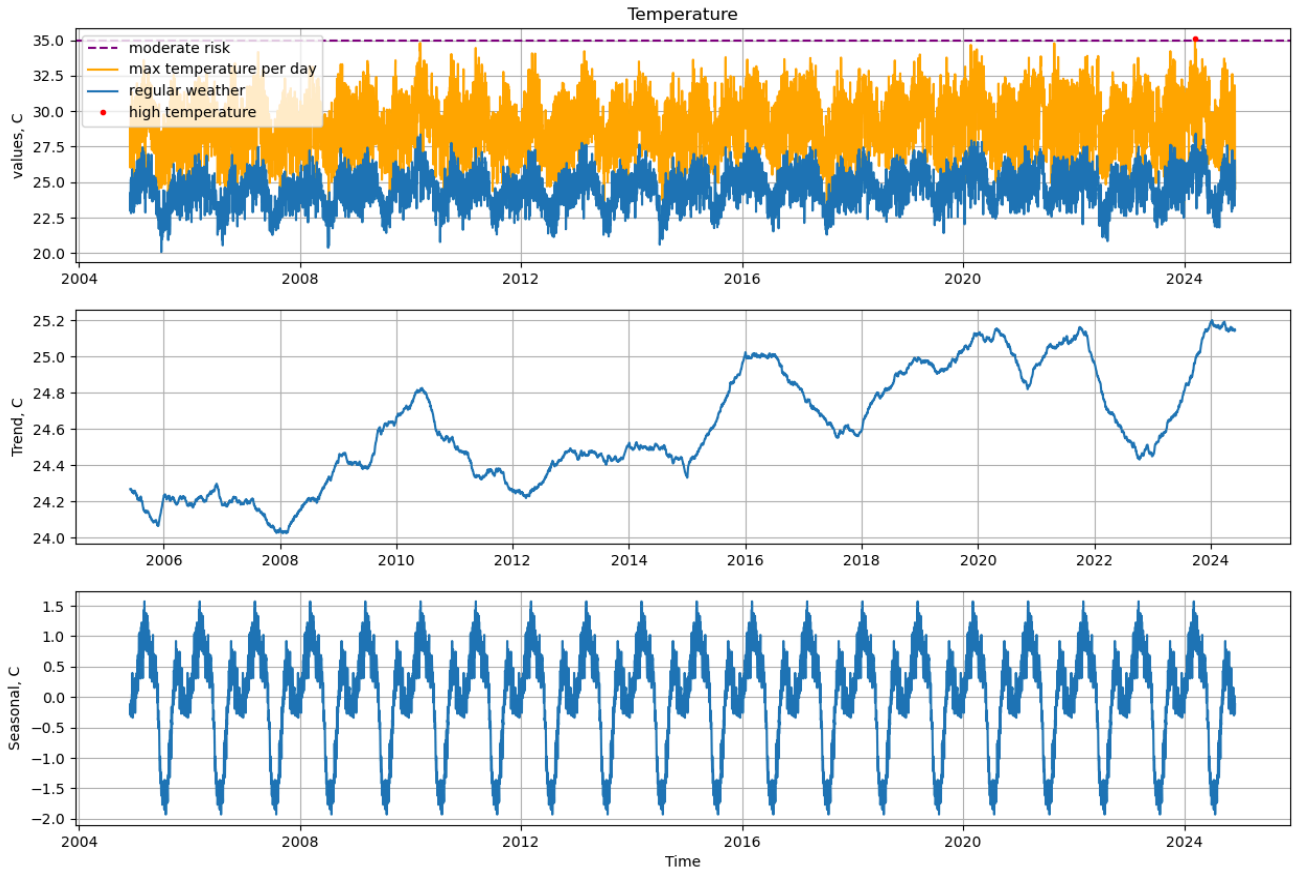
- On the trend chart, you can observe long-term changes, such as an overall increase or decrease in temperature over several years.
- The seasonality graph shows regular fluctuations related to the cycle, for example, monthly or annual changes in temperature or precipitation.

These graphs help to analyze the behavior of weather data in detail, identify key patterns and anomalies, and generate more accurate forecast

3. Location Analysis

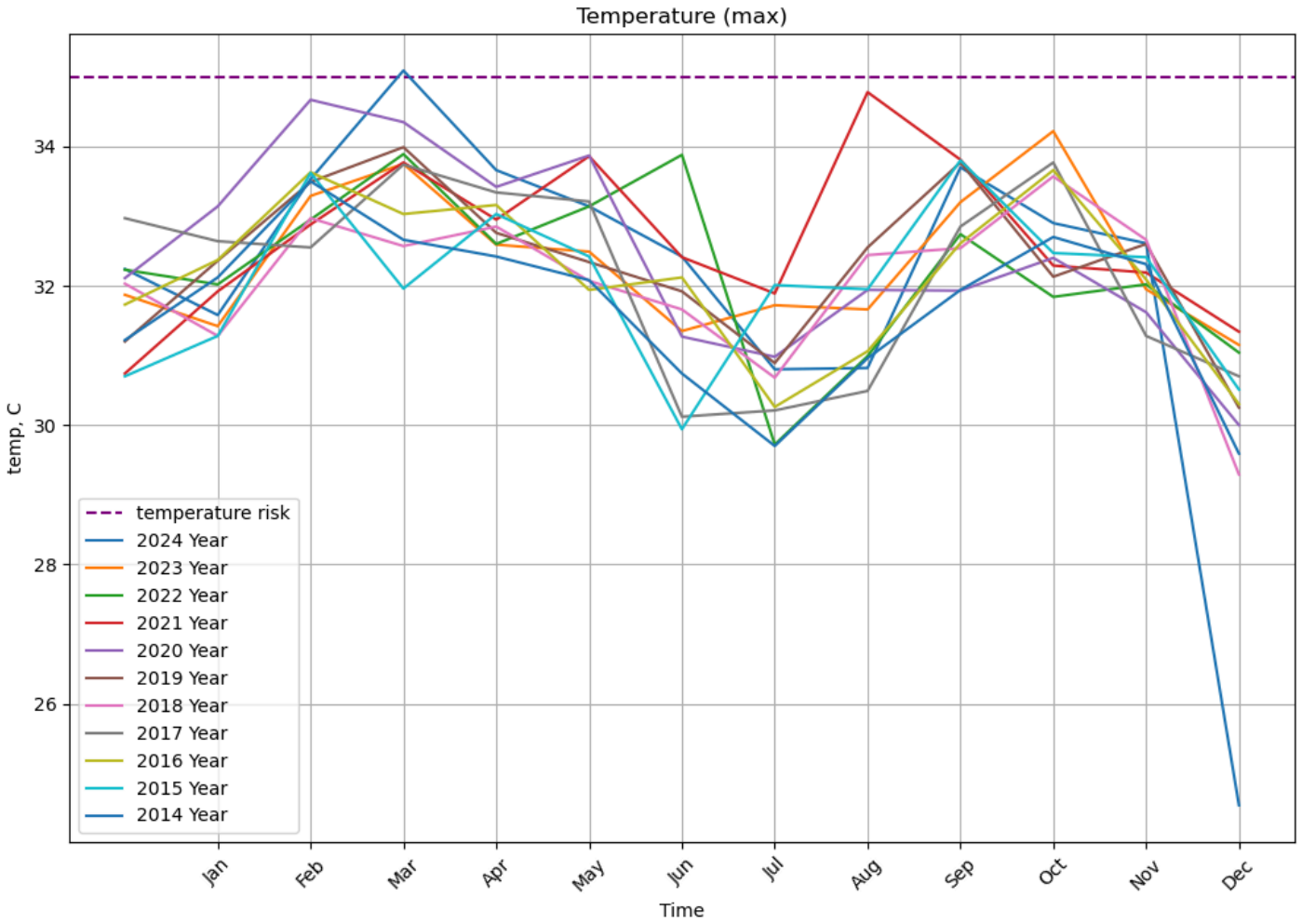
Temperature

On the charts, you can see only one risky day with temperatures (maximum values per day) exceeding the norm for this location. The general trend indicates an increase in temperature (with low dynamics).



Time series charts for 20 years of observations of average and maximum temperatures.

Charts of trends and seasonality by average temperatures.

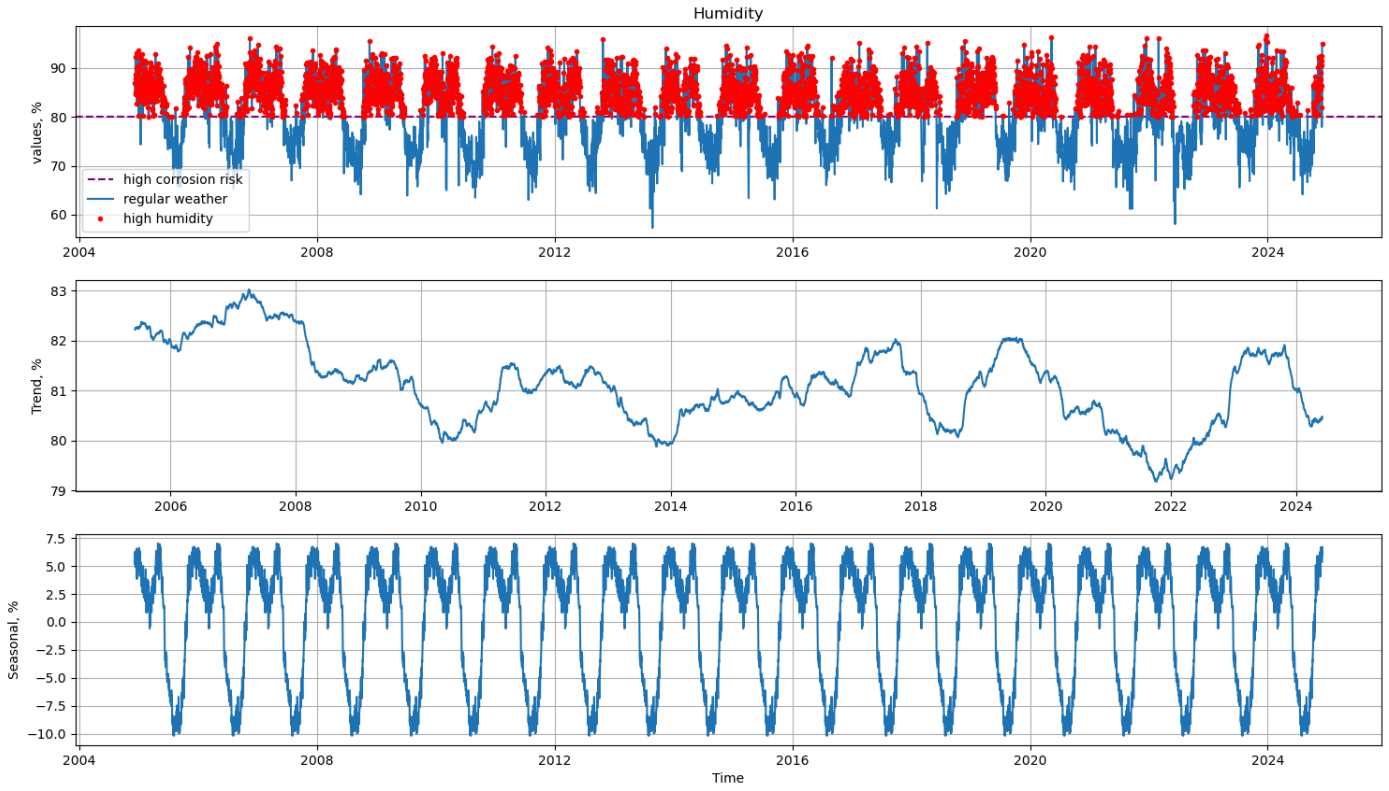


Maximum temperature values by month for 10 years.

On these charts, you can see only one risky day with temperatures (maximum values per day) exceeding the norm for this location. The general trend indicates an increase in temperature (with low dynamics).

Relative humidity

The data affecting metal corrosion at a given humidity level is 61% (4451 days) of the total number of days, which is typical for this location.

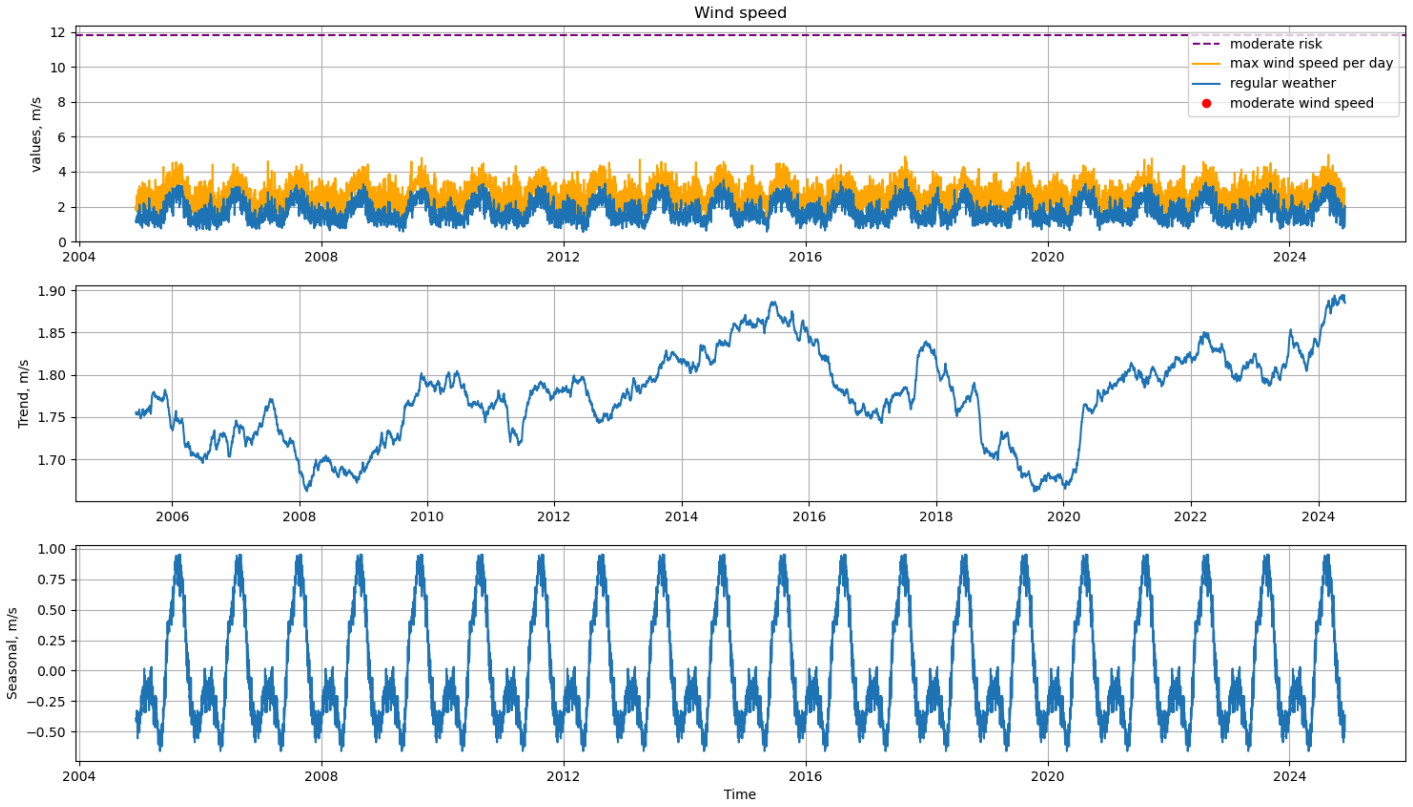


Time series charts for 20 years of observations of average relative humidity.

Charts of trends and seasonality by average humidity.

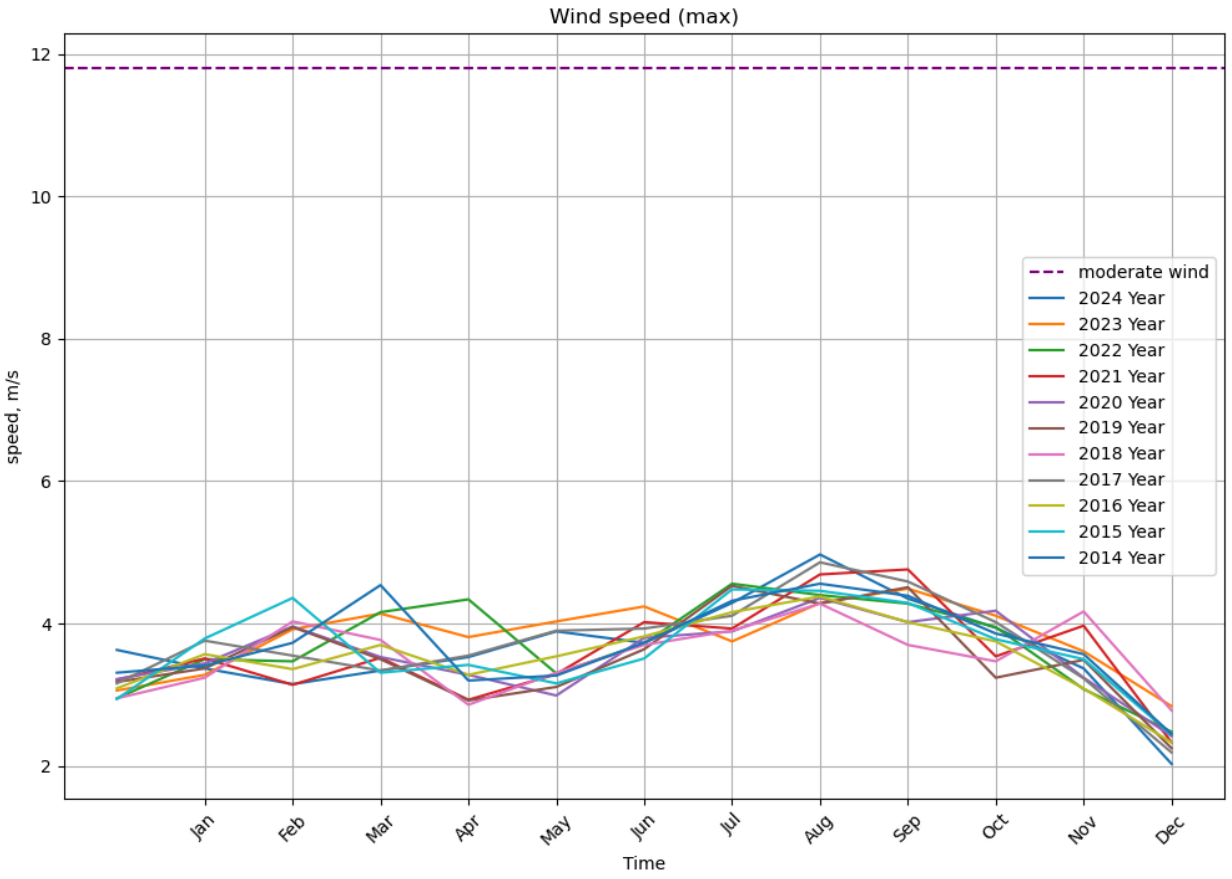
Wind speed

No risky days were found for the wind speed parameter. This parameter is in the normal order.



Time series graphs for 20 years of observations of average and maximum wind speeds.

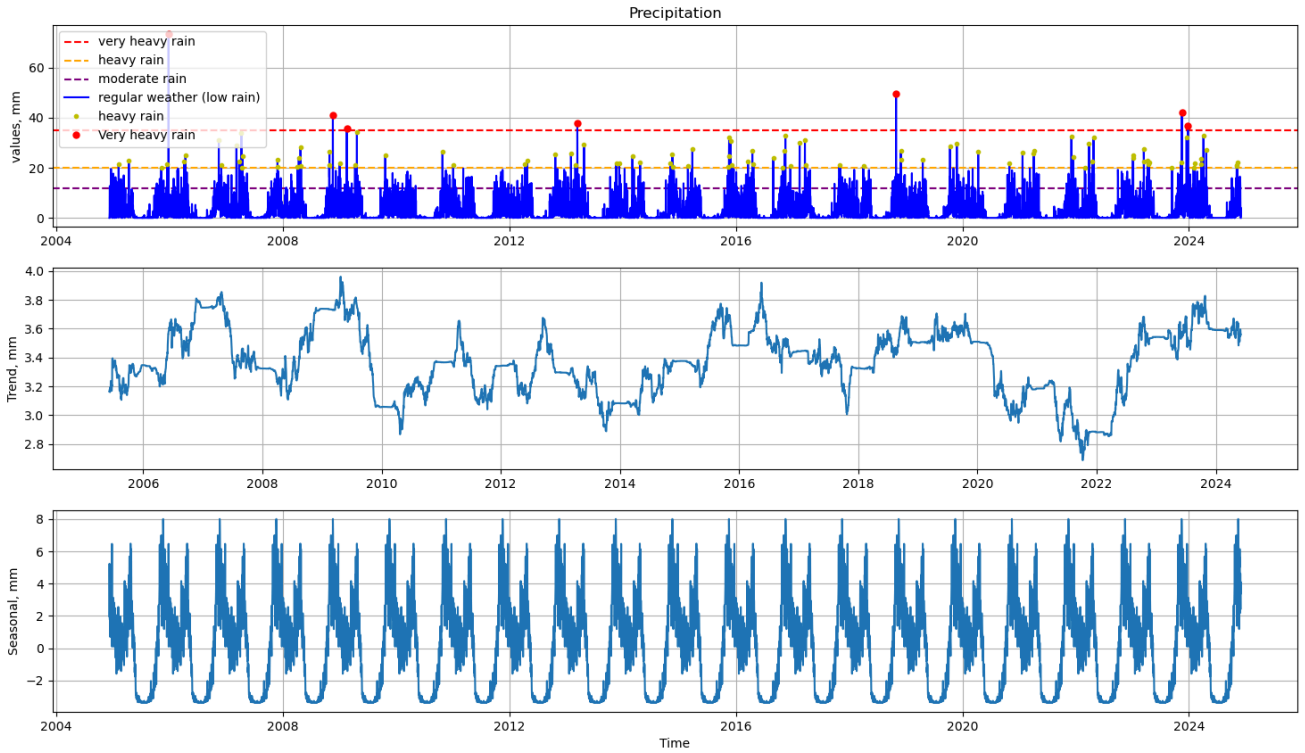
Charts of trends and seasonality based on average wind speeds.



The maximum values of wind speed by month for 10 years.

Precipitation

The number of days with heavy rain is 102. Of these, the very heavy rains were in 7 days.



Time series graphs for 20 years of observations of daily precipitation values.

Charts of precipitation trends and seasonality.

Risk event probability

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Table of frequency of occurrence of risk events relative to the total number of days (N=7300).

Location	Temp. Risk, %	Wind Risk, %	Hum. Risk, %	Moderate Rain Risk,%	High Rain Risk, %	Very High Rain Risk, %
	0.014	0.205	1.986	5.84	1.3	0.096

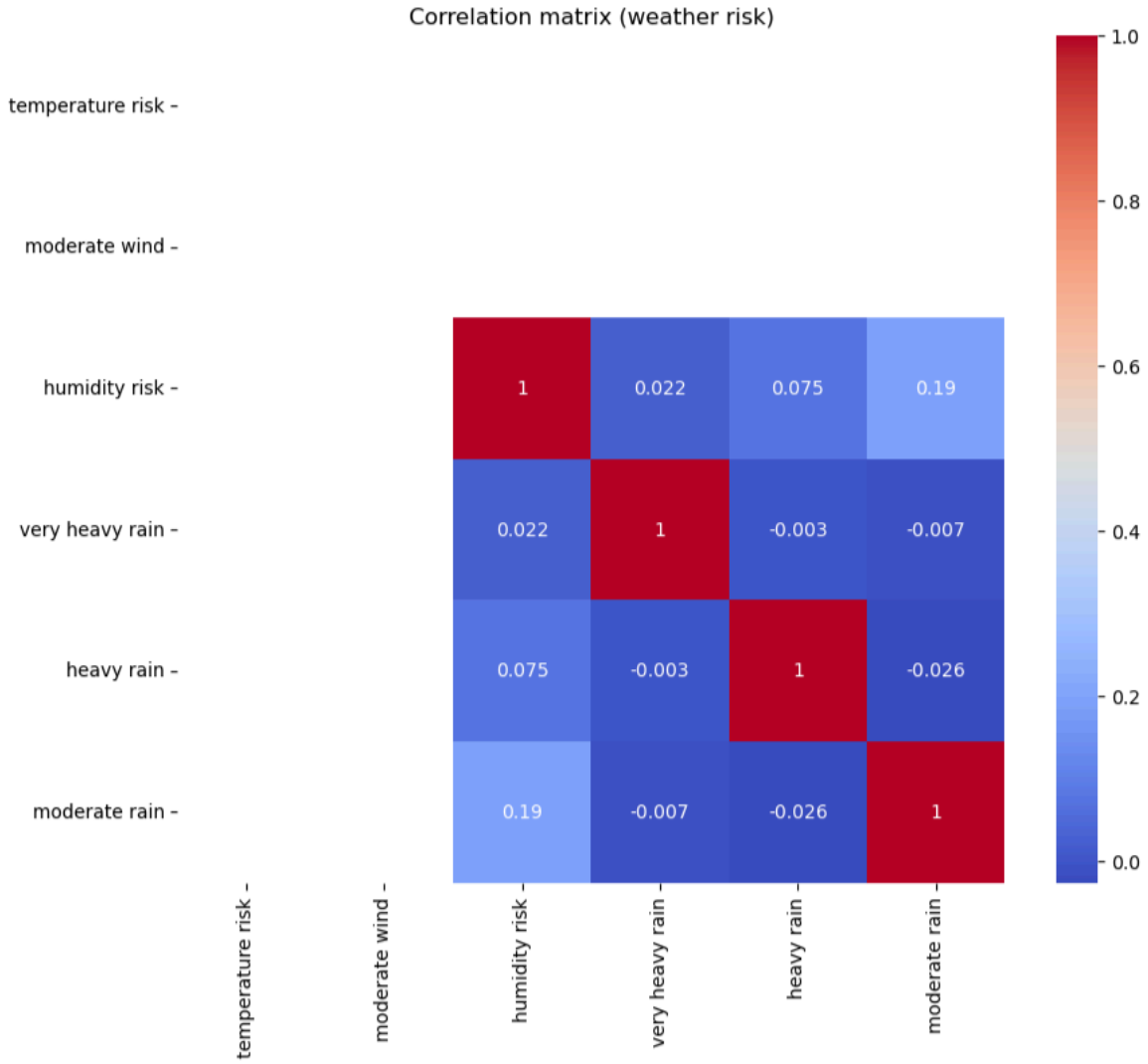
Correlation analysis displays the (linear) independence of weather data, excluding high humidity, which obviously increases during rain. The table above shows the main frequency of risky days as a percentage for all the parameters considered. According to these data, it is possible to judge the climate features of a given location: high humidity and precipitation.

This table has been added in order to indicate the independence of phenomena, which can be useful for building comprehensive risk assessments that take into account not just one risk parameter individually, but a certain weighted ratio over different time intervals [for example, a risk index that takes into account the combination of dangerous wind, precipitation and humidity in 3 hours, when assessing the general danger of localization.]

A more applied example of correlation analysis is the search for correlations between weather risks and equipment failure. In this case, you will need to calculate the correlations between these parameters in pairs and consider values from -1 to 1, where 1 is a direct linear relationship and 0 is linear independence. These parameters will help you decide which weather factors have the greatest impact in case of equipment failure.

Most of the parameters represent a linear correlation between temperature and humidity risk factors.

Correlation matrix of risks (there are no samples for risky days in terms of temperature and wind speed due to the absence of anomalies in these data).



Correlation matrix of risks (there are no samples for risky days in terms of temperature and wind speed due to the absence of anomalies in these data).

Lighting:

For the location within a radius of 20km no lightning events were observed for the past 10 years.

4. Risk Implications:

Temperature

Infrastructure Risks:

- **Low Risk**: With only one risky day recorded over the period analysed, temperature does not present a significant direct threat to the structural integrity of the site at this location.
- **Localised Stress Risk**s: While the frequency of extreme heat is low, isolated peaks could still strain cooling systems if maintenance is neglected. Over time, even these rare events could contribute to cumulative wear on critical systems.

Operational Risks:

- **Minimal Impact**: The low frequency of risky temperature days means operational risks related to workforce safety or equipment overheating are minimal.

Wind Speed

Infrastructure Risks:

- **Negligible Risk:** The data indicates that wind speeds have consistently remained below risk thresholds, suggesting no immediate threat to structural or equipment stability.
- **Maintenance Implications:** Although wind poses no critical risk, routine checks should ensure that prolonged exposure to moderate winds does not lead to loosening of bolts or other minor damages on tower structures.

Operational Risks:

- **No Disruptions Expected:** With no historical record of risky wind speeds, operational interruptions due to wind are unlikely. Maintenance schedules or logistics planning are not constrained by this parameter at this site.

Relative Humidity

Infrastructure Risks:

- **Corrosion Risks:** The average relative humidity, consistently high in tropical climates, poses a chronic risk to metal components through accelerated oxidation and corrosion. Persistent humidity >80% creates ideal conditions for rust, which is particularly detrimental to connectors, fasteners, and outdoor equipment casings.
- **Cooling System Efficiency:** High humidity can reduce the effectiveness of cooling systems by impairing evaporation processes, potentially leading to overheating.

Operational Risks:

- **Signal Degradation:** Increased atmospheric moisture may affect microwave and satellite signal propagation, reducing communication reliability.
- **Workforce Health:** Prolonged exposure to high humidity can exacerbate heat stress, compounding risks for outdoor workers.

Precipitation

Infrastructure Risks:

- **Erosion and Foundation Stability:** Persistent moderate to high rainfall can gradually erode soil stability around the tower foundations, especially if drainage systems are insufficient.
- **Flooding Risks:** Rare very high rainfall events, while infrequent, can lead to significant flooding around the tower site. These events can damage equipment, affect structural integrity, and cause ground instability.

Operational Risks:

- **Access Delays:** Heavy rains can render access roads muddy or impassable, delaying maintenance and repairs. This is particularly concerning during the wet season when the frequency of such events is higher.
- **Equipment Downtime:** Prolonged wet conditions may increase the likelihood of water ingress into electrical or mechanical systems if weatherproofing measures are compromised.

5. Risk related recommendations

Recommendations tailored to the specific use case can be provided in case of provision of the exact risks regularly faced at the location.