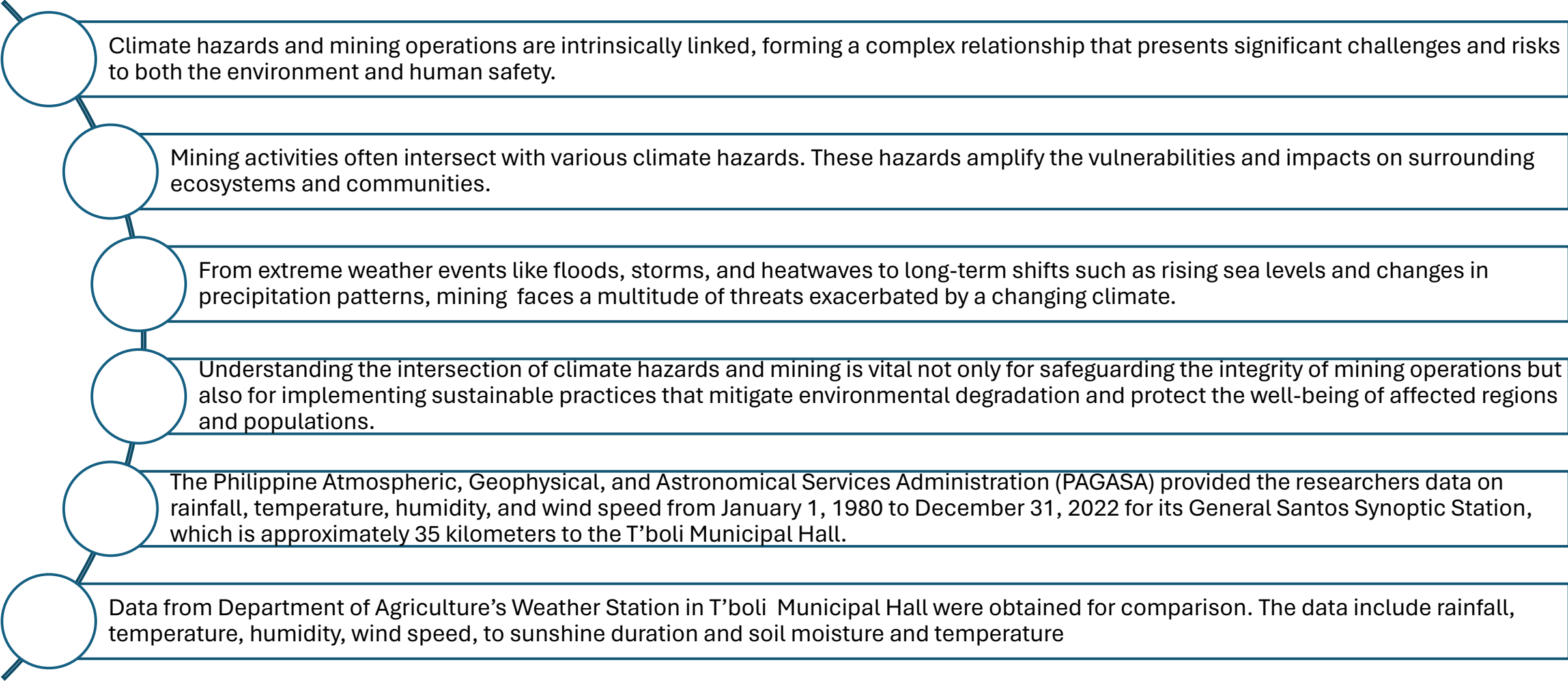


Climate Hazards in Tboli, South Cotabato

**Project under the-
National Institutes of Health, University of the Philippines Manila**

**Program Leader- Dr Jinky leilanie LU
Project Leader- Hon. Secretary Teodoro J. Herbosa**

Introduction



Climate hazards and mining operations are intrinsically linked, forming a complex relationship that presents significant challenges and risks to both the environment and human safety.

Mining activities often intersect with various climate hazards. These hazards amplify the vulnerabilities and impacts on surrounding ecosystems and communities.

From extreme weather events like floods, storms, and heatwaves to long-term shifts such as rising sea levels and changes in precipitation patterns, mining faces a multitude of threats exacerbated by a changing climate.

Understanding the intersection of climate hazards and mining is vital not only for safeguarding the integrity of mining operations but also for implementing sustainable practices that mitigate environmental degradation and protect the well-being of affected regions and populations.

The Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA) provided the researchers data on rainfall, temperature, humidity, and wind speed from January 1, 1980 to December 31, 2022 for its General Santos Synoptic Station, which is approximately 35 kilometers to the T'boli Municipal Hall.

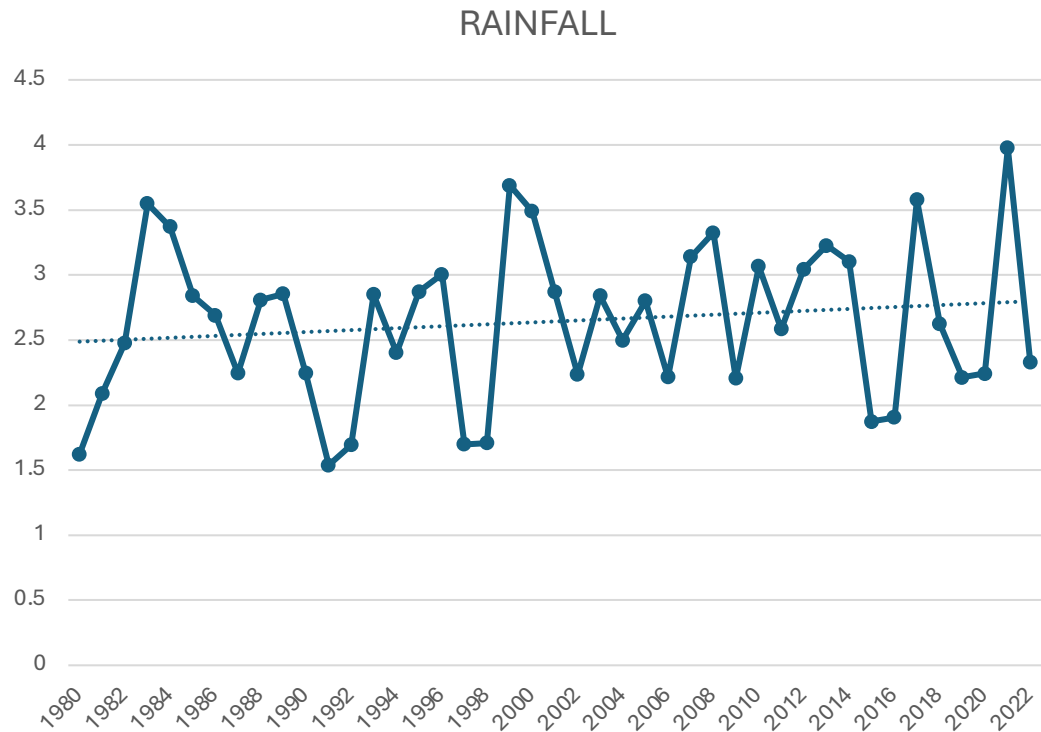
Data from Department of Agriculture's Weather Station in T'boli Municipal Hall were obtained for comparison. The data include rainfall, temperature, humidity, wind speed, to sunshine duration and soil moisture and temperature

Climate Trends

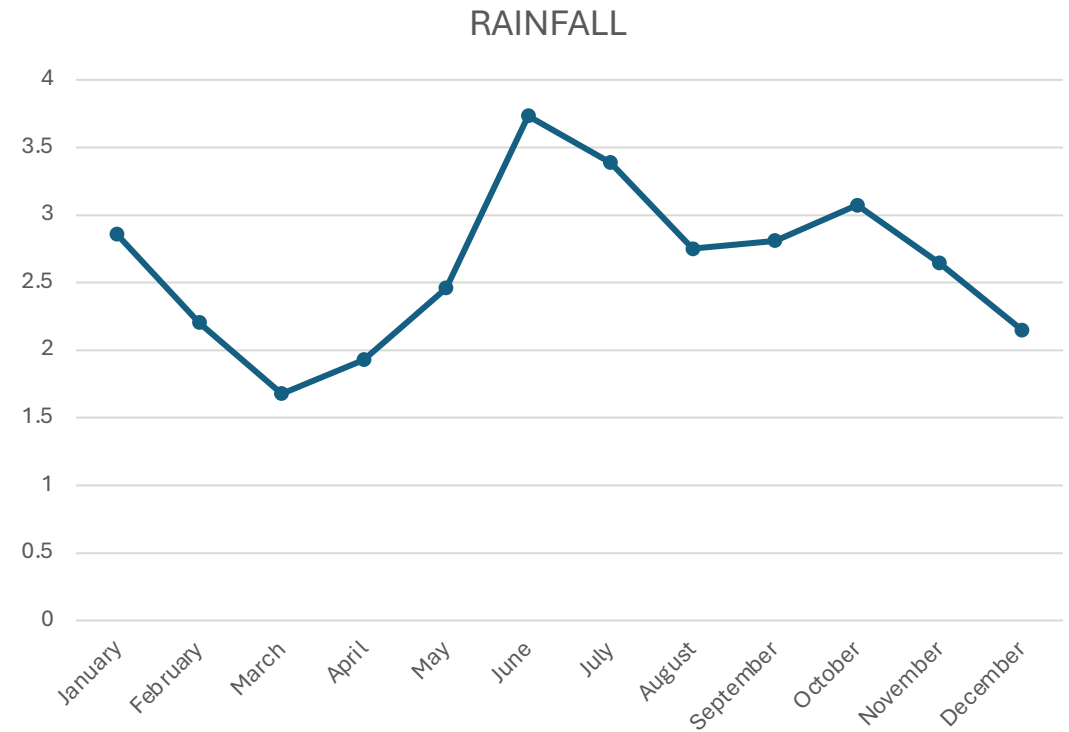
PAGASA General Santos Synoptic Station

Rainfall

- The average rainfall from 1980 to 2022 is 2.641mm with a standard deviation of 7.681.
- The trend seems to be increasing over the years with 2021 having the highest average rainfall at 3.976mm.

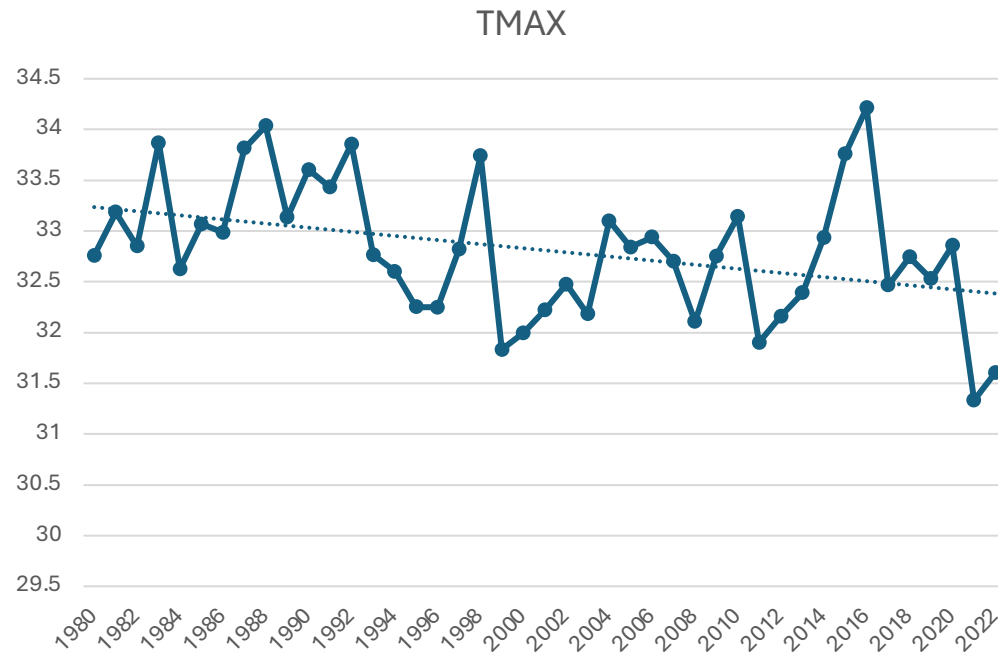


- Rainfall measured in the General Santos Synoptic Station seems to be peaking during the month of June, while the month of March appears to be the driest month of the year on the average.

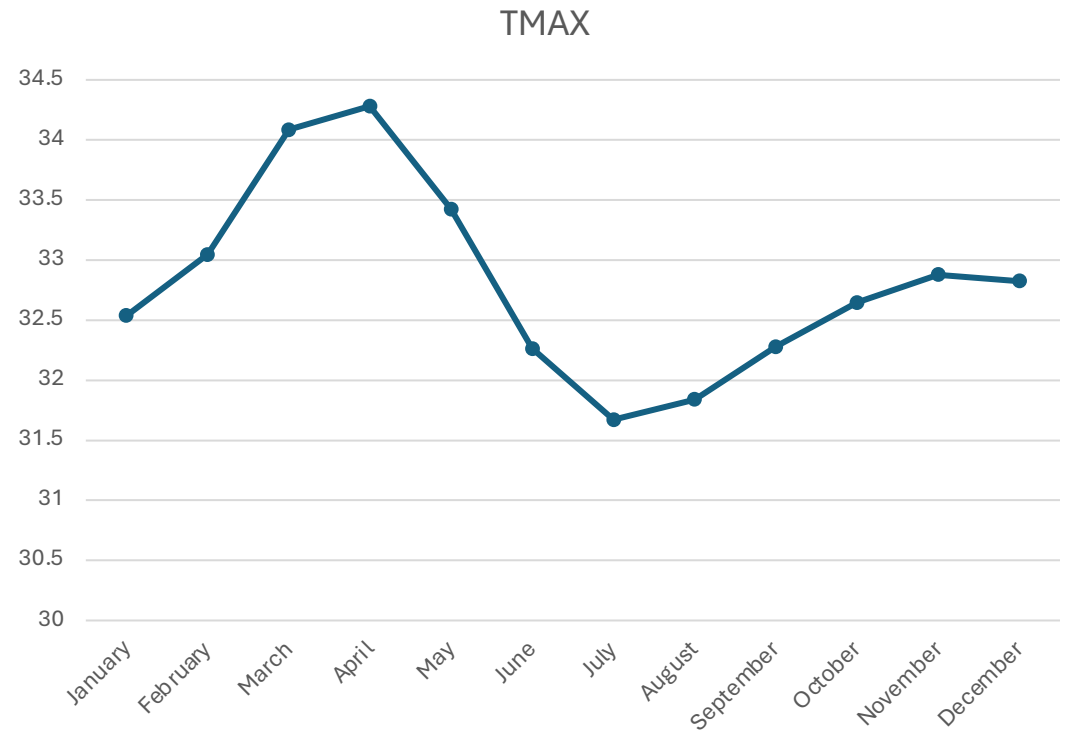


Maximum Temperature

- The average daily maximum temperature recorded from 1980 to 2022 is 32.811 celsius with a standard deviation of 2.025.
- The trend seems to be decreasing through the years as shown in the regression trendline, however, the highest daily maximum temperature average was reported in 2016 at 34.212 celsius.

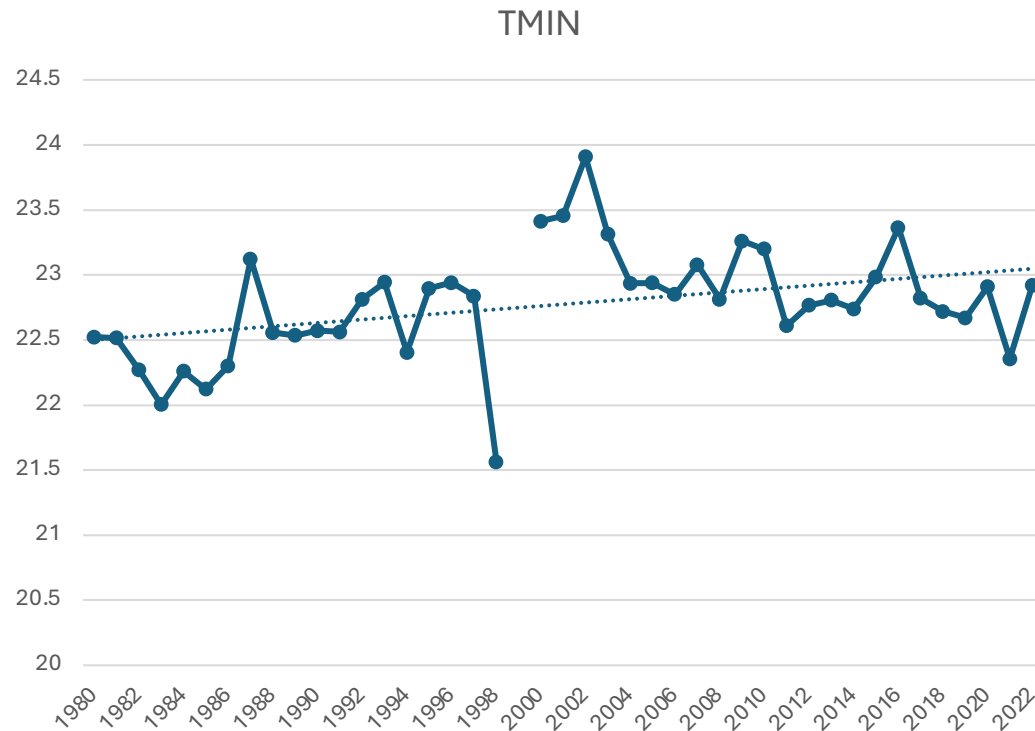


- The hottest months of the year based on average daily maximum temperatures are March and April, while the months with the lowest average daily maximum temperatures fall in June, July, and August.

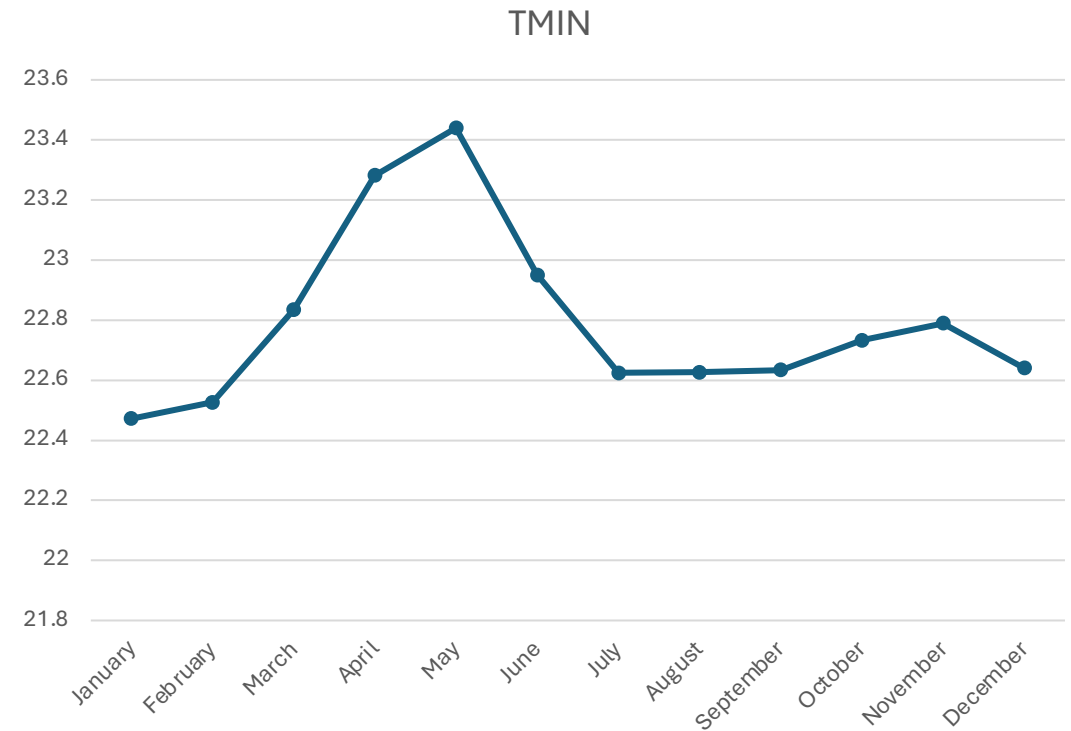


Minimum Temperature

- The average daily minimum temperature recorded from 1980 to 2022 is 22.794 celsius with a standard deviation of 0.9807.
- Unlike the maximum temperature averages, minimum temperature averages through the years seem to be on an increasing trend.

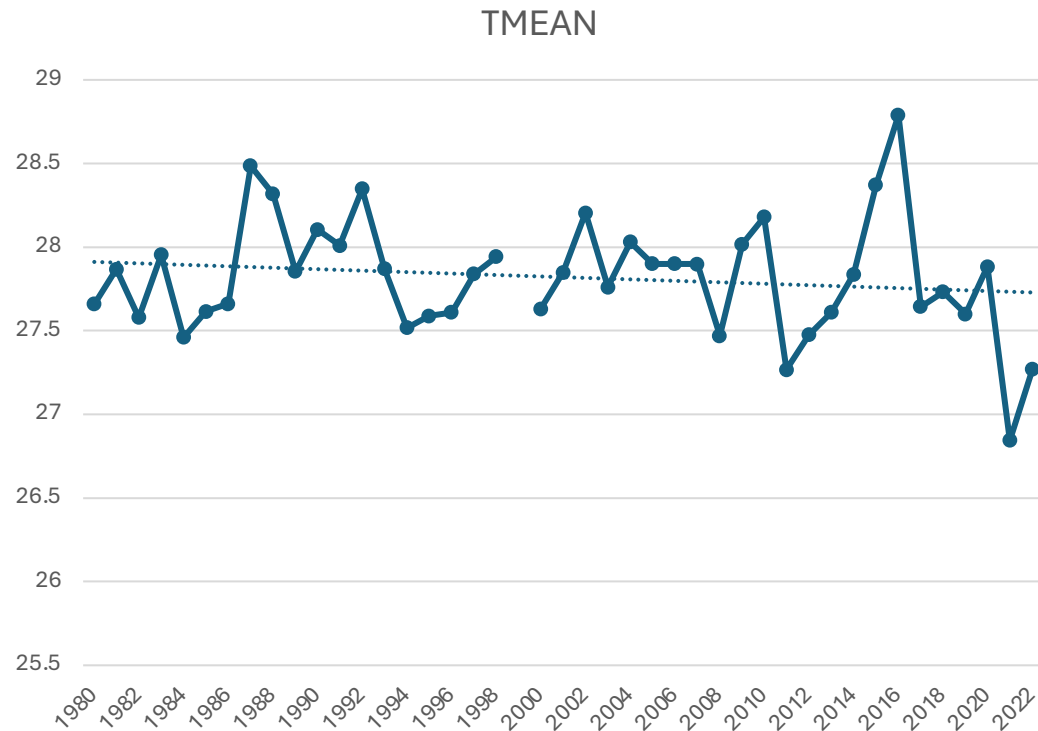


- The hottest months of the year based on average daily minimum temperatures are April and May, while the coldest months according to lowest average daily maximum temperatures span from July to February.

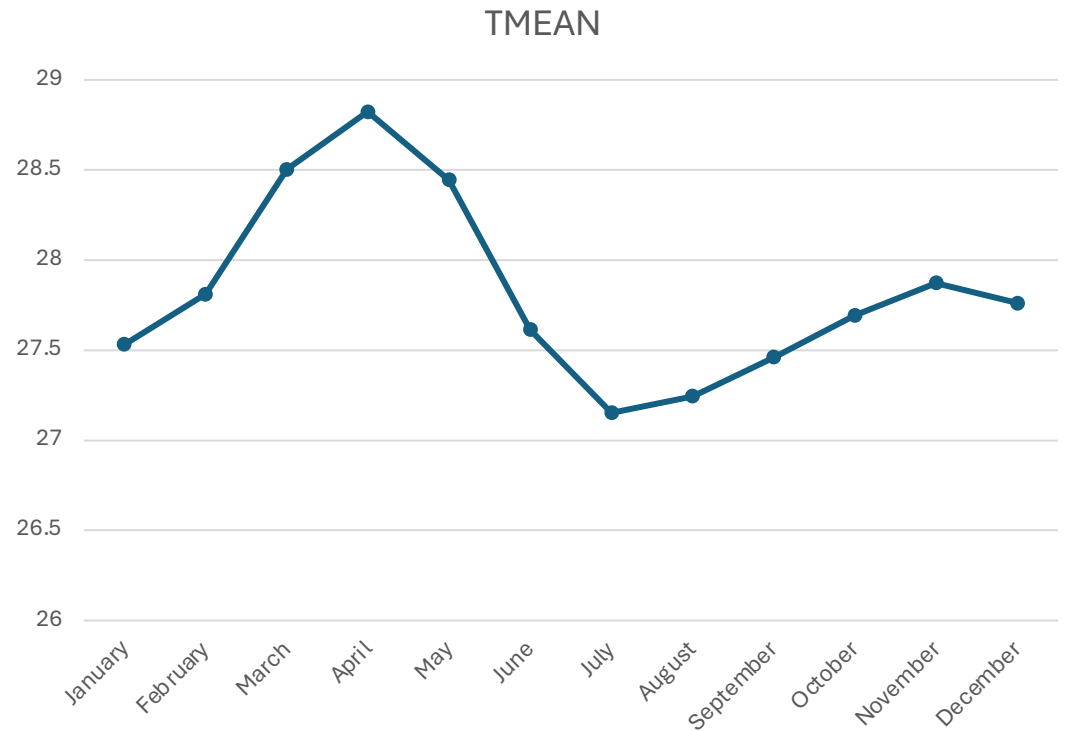


Average Temperature

- The average daily temperature recorded from 1980 to 2022 is 27.820 celsius with a standard deviation of 1.1961.
- The trend seems to be decreasing through the years as shown in the regression trendline, however the highest daily temperature average was reported in 2016 at 28.788 celsius.

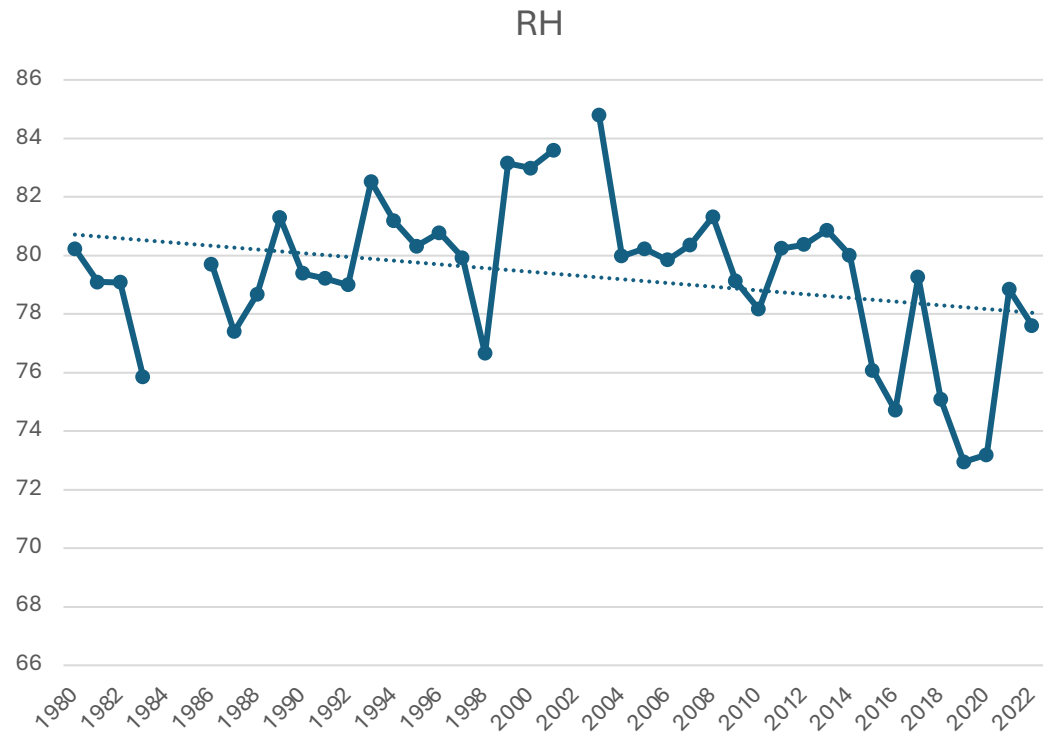


- Based on average daily temperatures, the hottest months of the year from 1980 to 2022 are March, April, and May, with April as the peak.
- While the coldest months of the year are July and August.

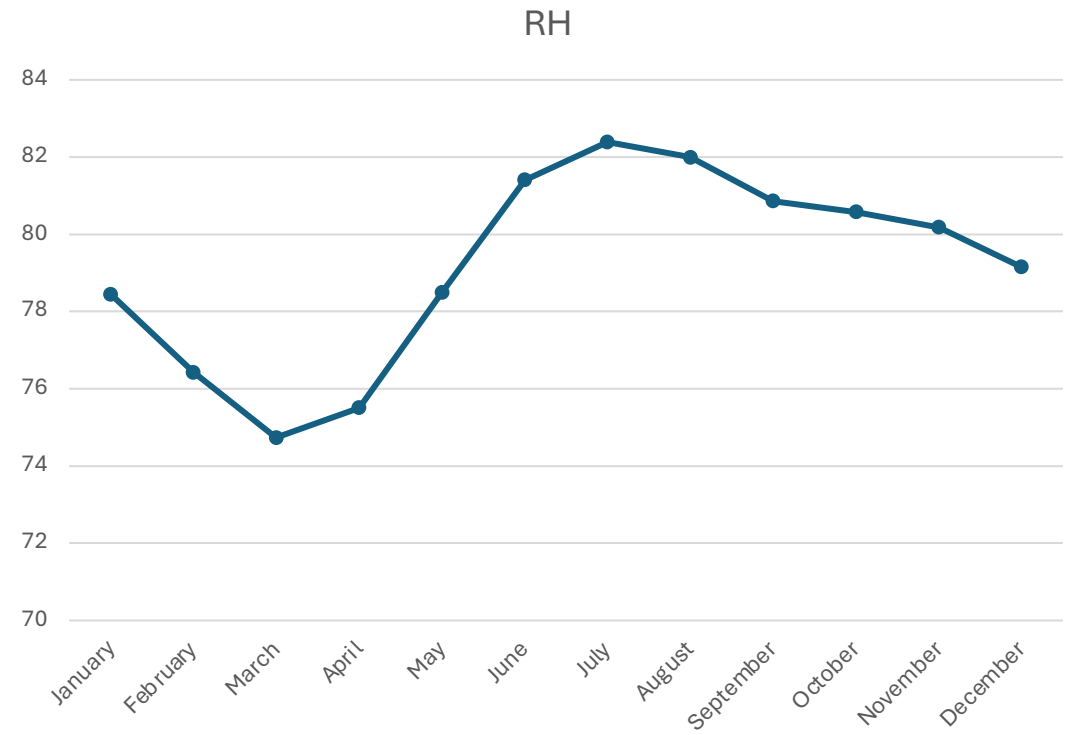


Relative Humidity

- The average daily relative humidity recorded from 1980 to 2022 is 79.24% with a standard deviation of 6.25.
- The trend seems to be decreasing through the years as shown in the regression trendline, with the peak relative humidity average measured in 2003 at 84.81%

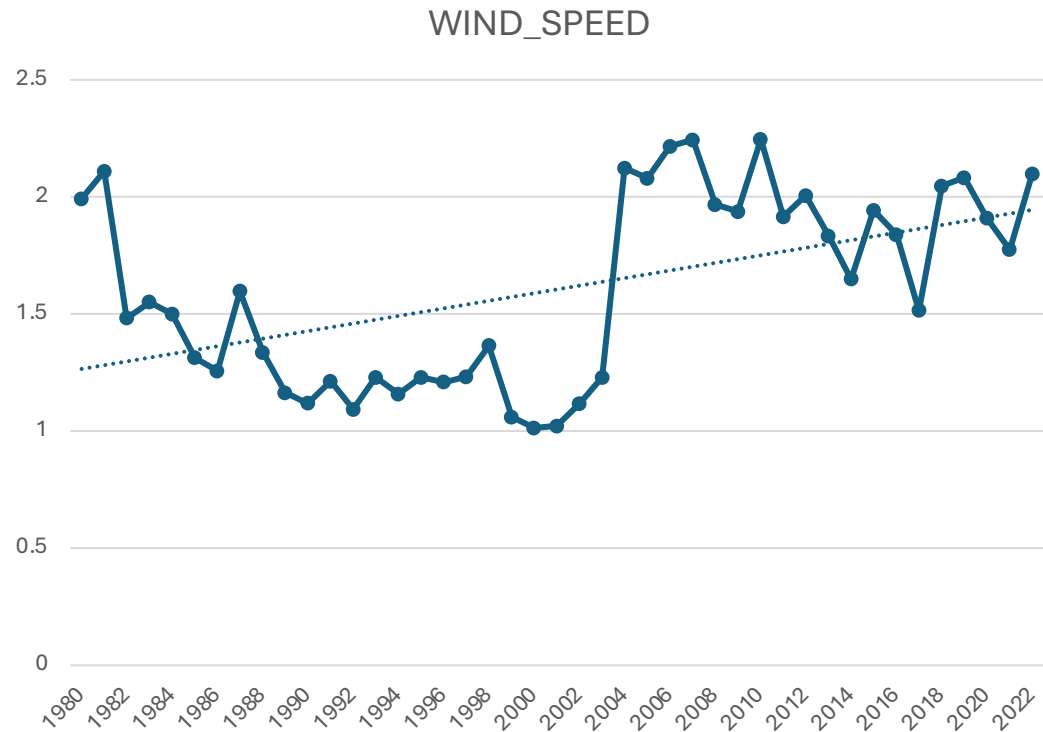


- The months from June to November have a relatively higher humidity of above 80% compared to the months of December to May which have an average relative humidity of 74% to 80%.

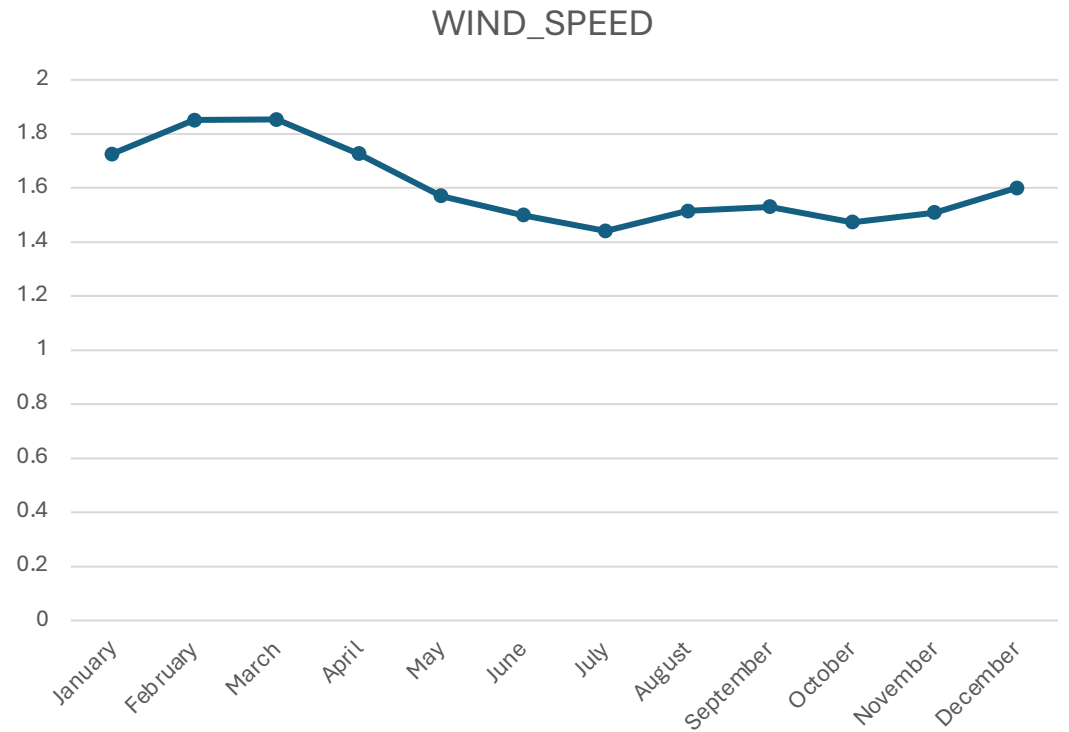


Wind Speed

- The average daily wind speed recorded from 1980 to 2022 is 1.61m/s with a standard deviation of 0.756.
- The trend seems to be increasing, with a very noticeable jump from 2003 with an average of 1.23m/s to 2.12m/s in 2004.



- Wind speed is generally similar in the General Santos Synoptics Station at around 1.4m/s to 1.85m/s. The windiest months are during January to April.



Statistics of Climate Measurements from 1980 to 2022

- The average daily rainfall from 1980 to 2022 is 2.641mm.
- The average daily maximum temperature is 31.811 degrees Celsius, while the average daily minimum temperature is 22.794 degrees Celsius.
- The average daily temperature is 27.82 degrees Celsius. The average daily humidity is 79.24% and the average wind speed is 1.607m/s.

	Mean	Median	Std. Deviation	N (days)	Missing
Rainfall (mm)	2.641	0.000	7.681	15612	94
Maximum Temperature (Degree Celsius)	32.811	32.800	2.025	15597	109
Minimum Temperature (Degree Celsius)	22.794	22.900	0.981	14800	906
Mean Temperature (Degree Celsius)	27.820	27.800	1.196	14800	906
Relative Humidity (%)	79.241	80.000	6.253	14085	1621
Wind Speed (m/s)	1.607	1.000	0.756	15567	139

Climate Trends

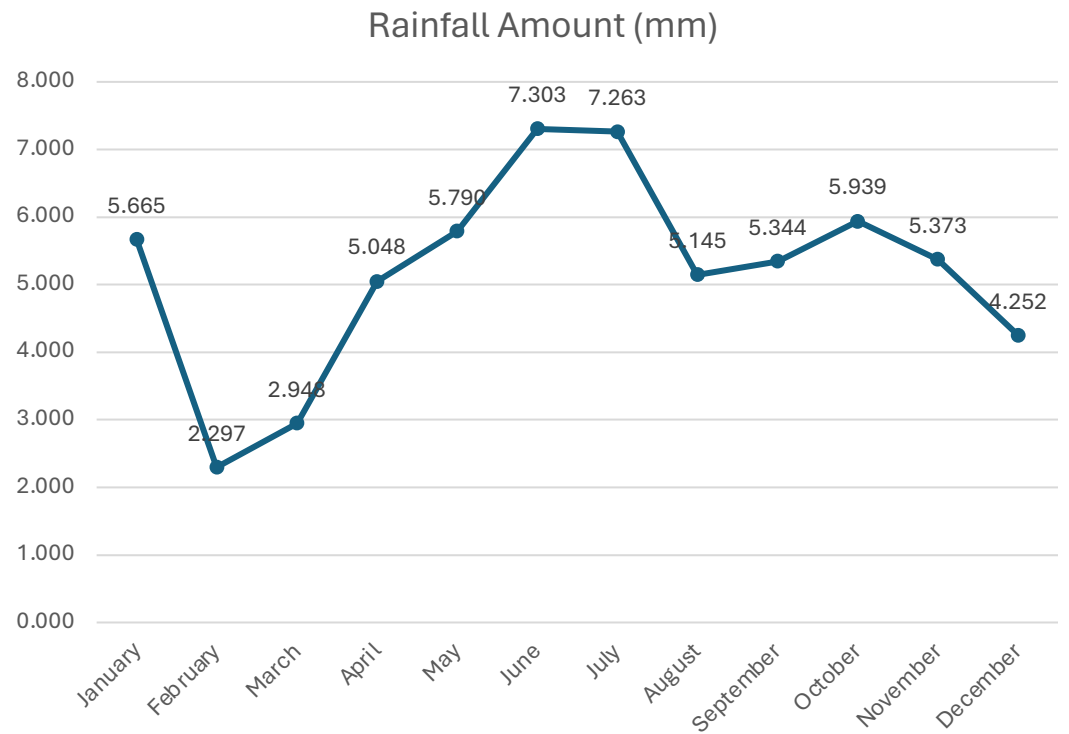
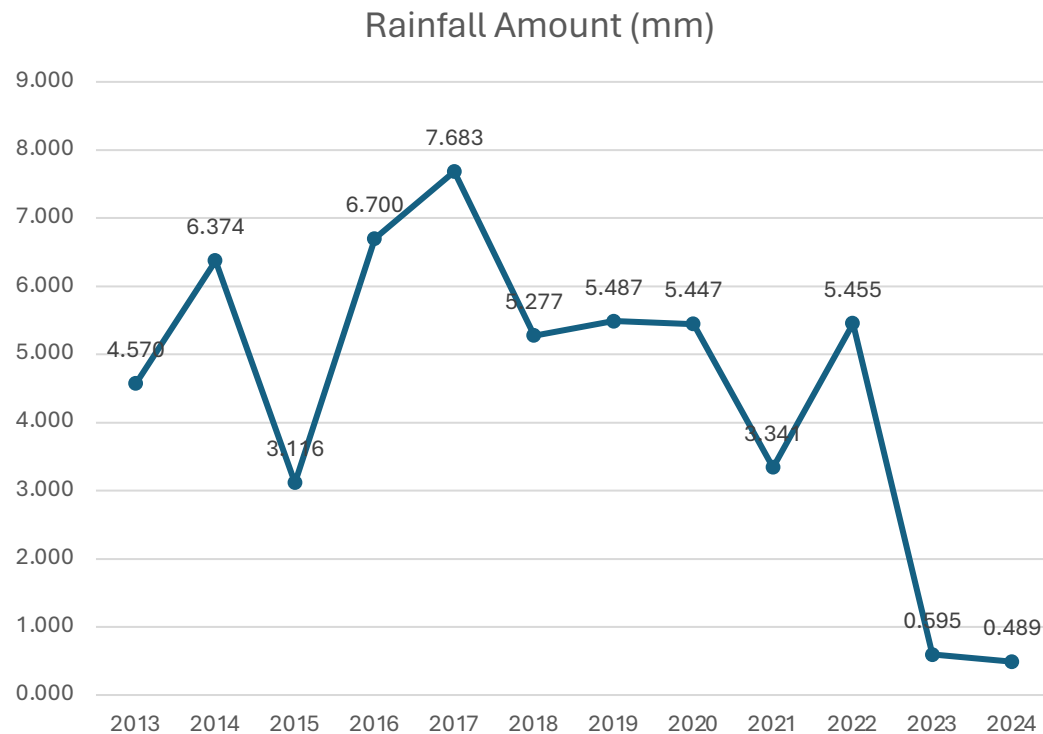
Department of Agriculture

T'boli Municipal Hall Weather Station

Rainfall

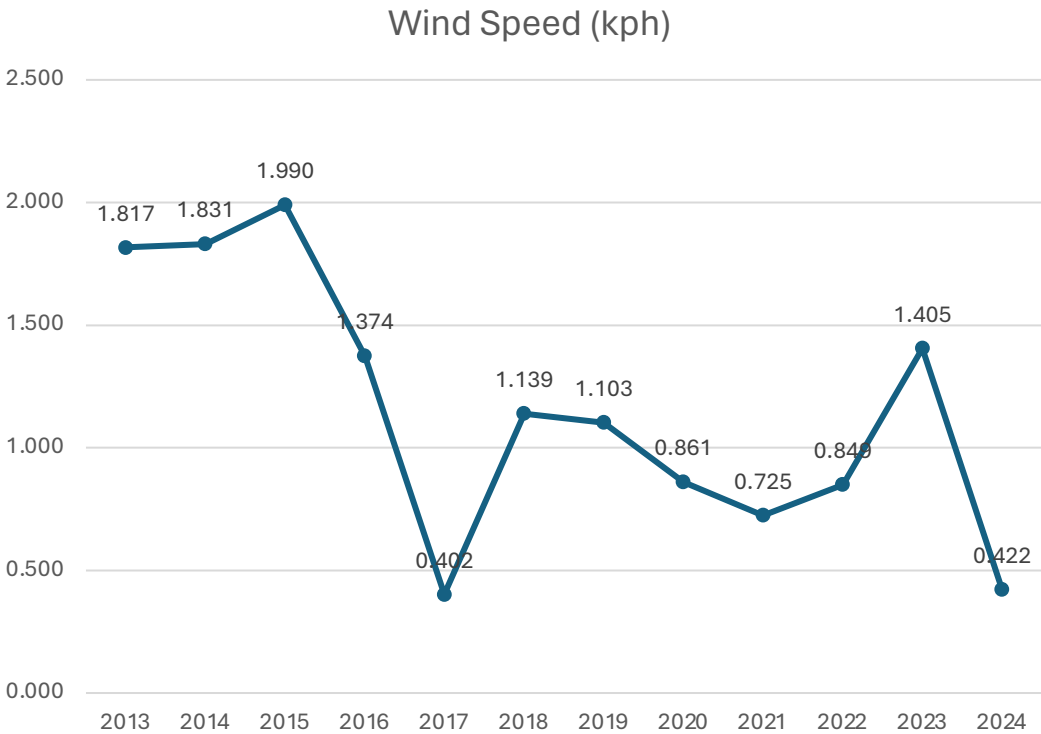
Highest peak of rainfall was recorded in 2017.

- Peak rainfall is observed in T'boli during the months of June and July.
- The driest months are during February and March.

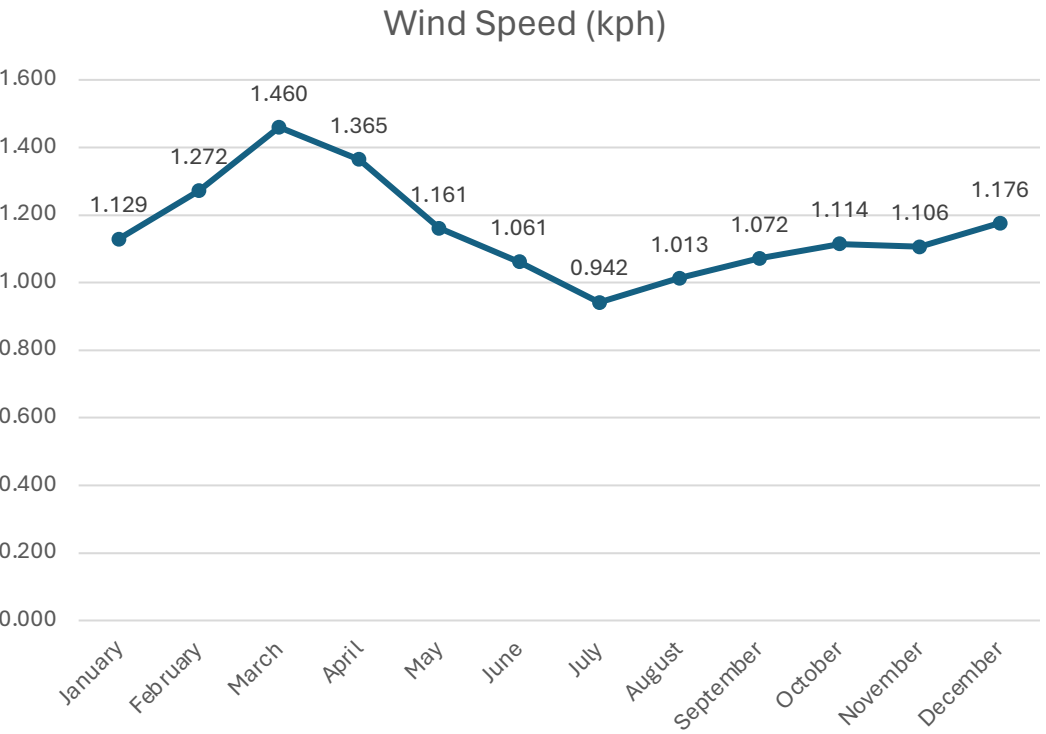


Wind Speed

- Yearly trend shows the peak of wind speed in 2015, and another peak in 2023.

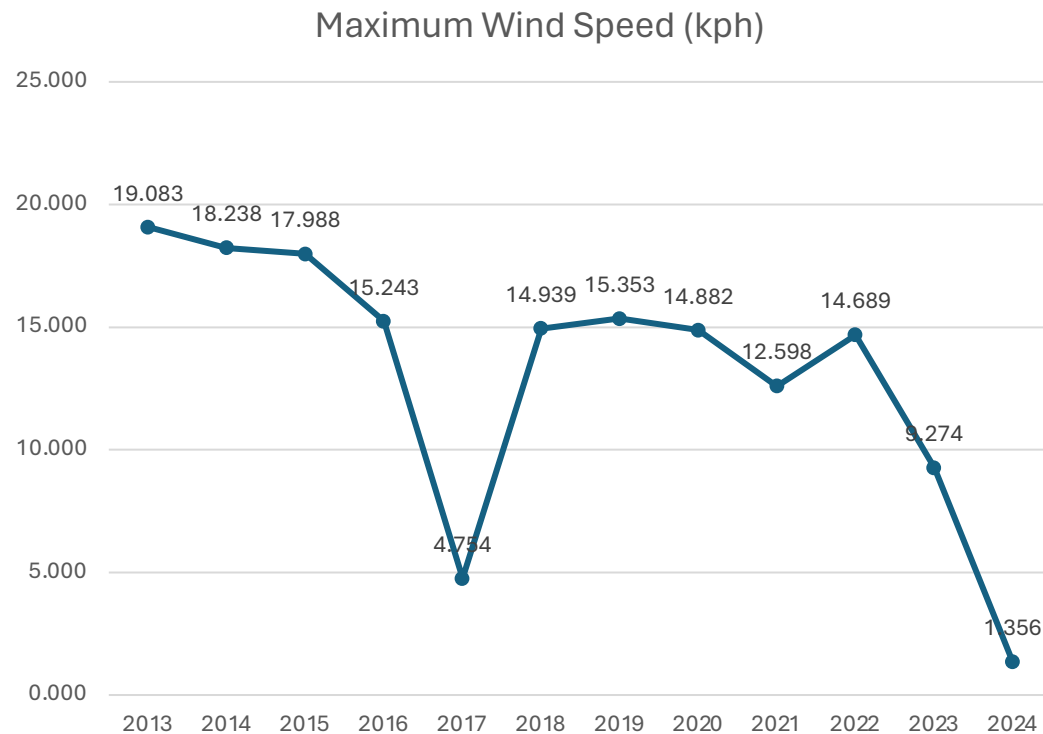


- Wind Speed is generally lower than what is observed in General Santos City (PAGASA)
- Wind speed in General Santos ranges from 1.4m/s to 1.85m/s, while in T'boli, wind speed range from 0.95m/s to 1.46m/s

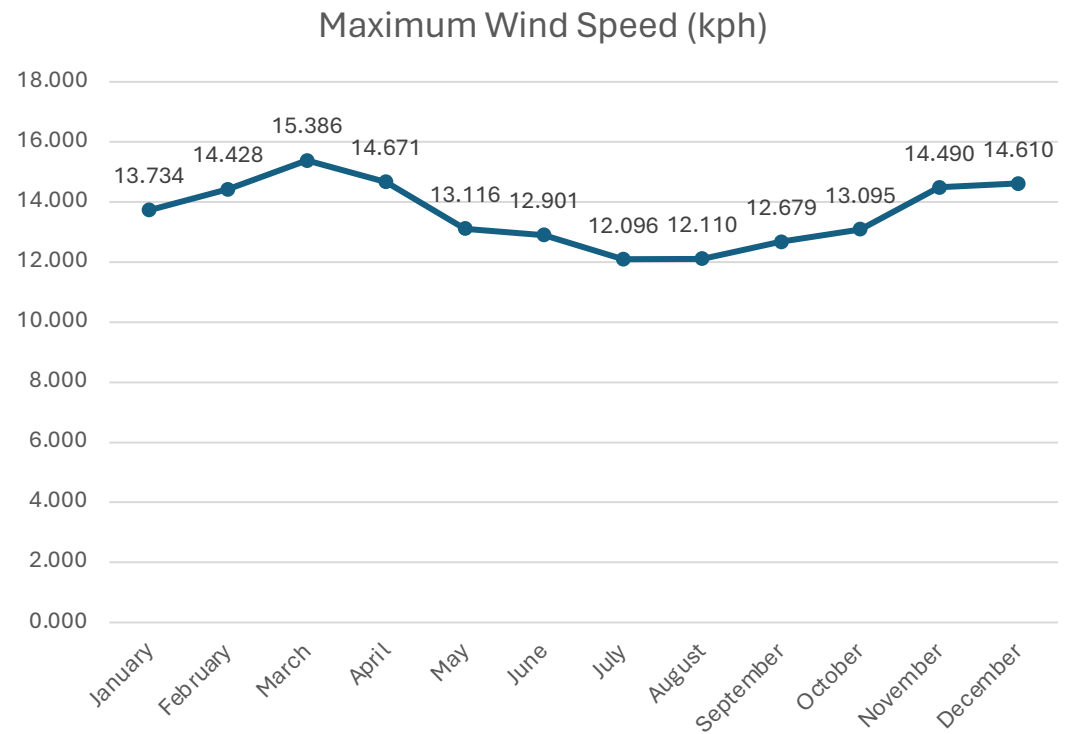


Maximum Wind Speed

- Yearly trend of maximum wind speed shows highest readings in 2013 to 2016.

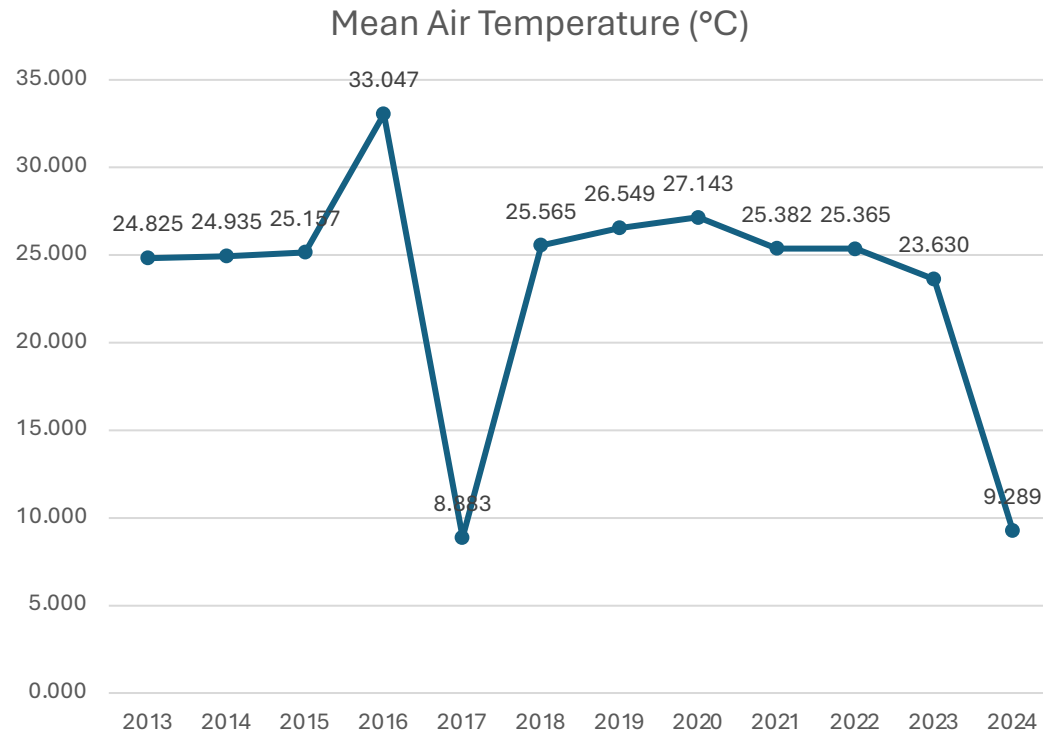


- The strongest winds in T'boli are observed during the months of November to April, peaking in March.

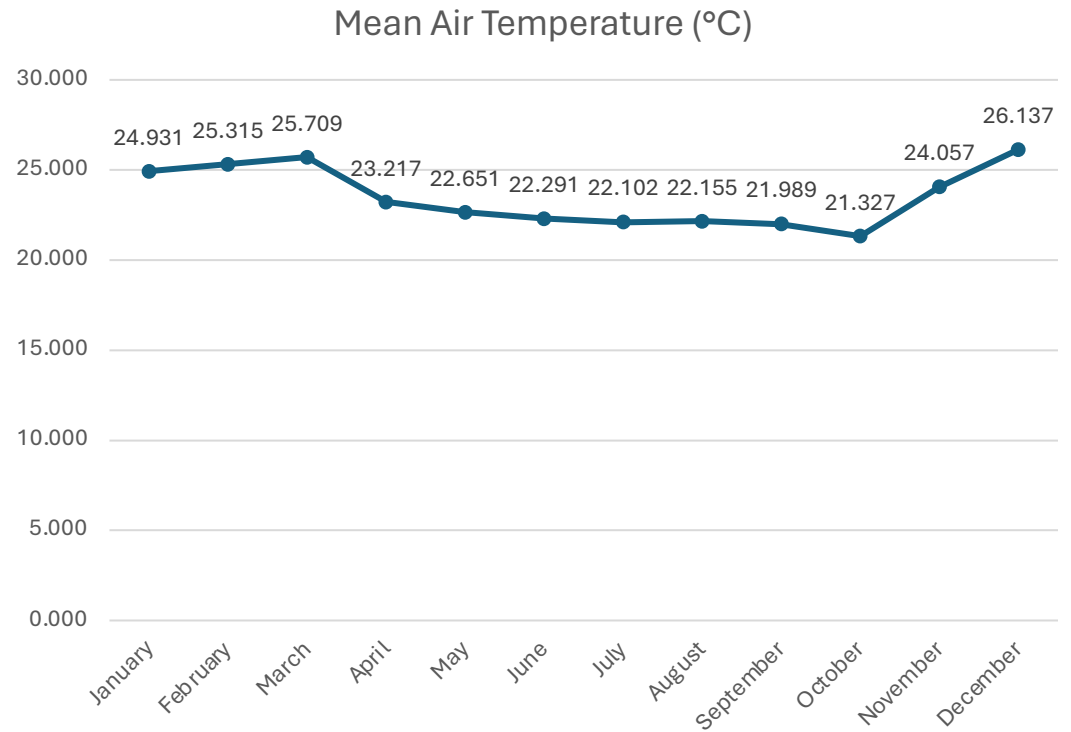


Mean Air Temperature

- Yearly trend shows that the peak of mean air temperature was in 2016.

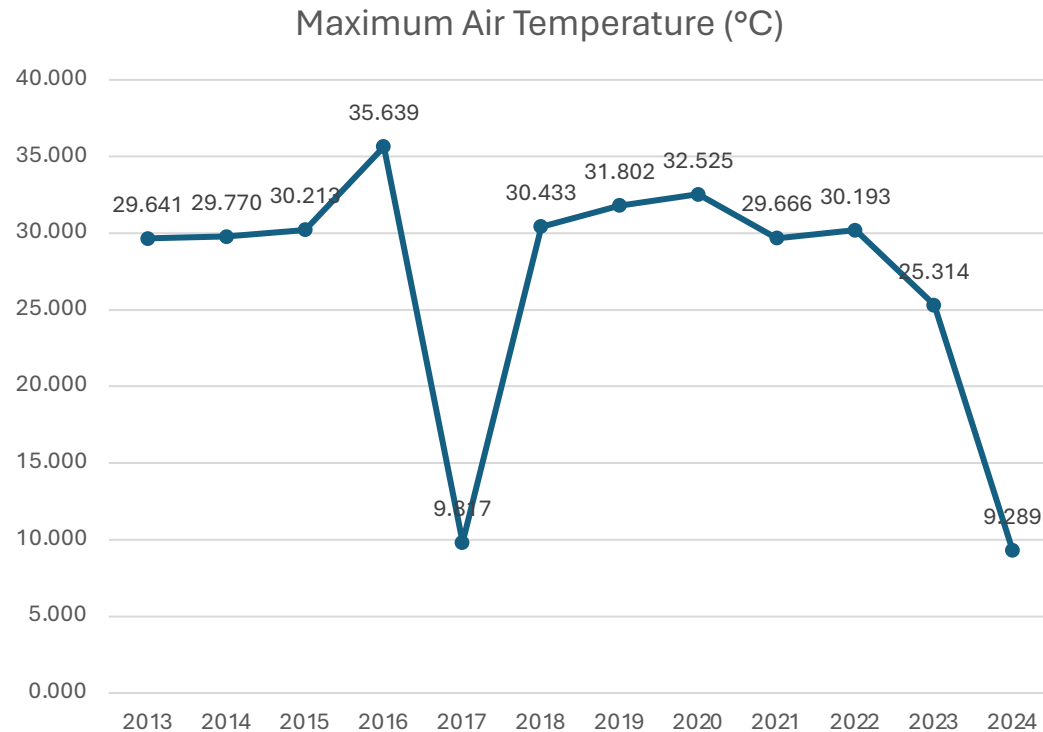


- The hot months in T'boli are recorded from November to March.
- The cold months are April to October.

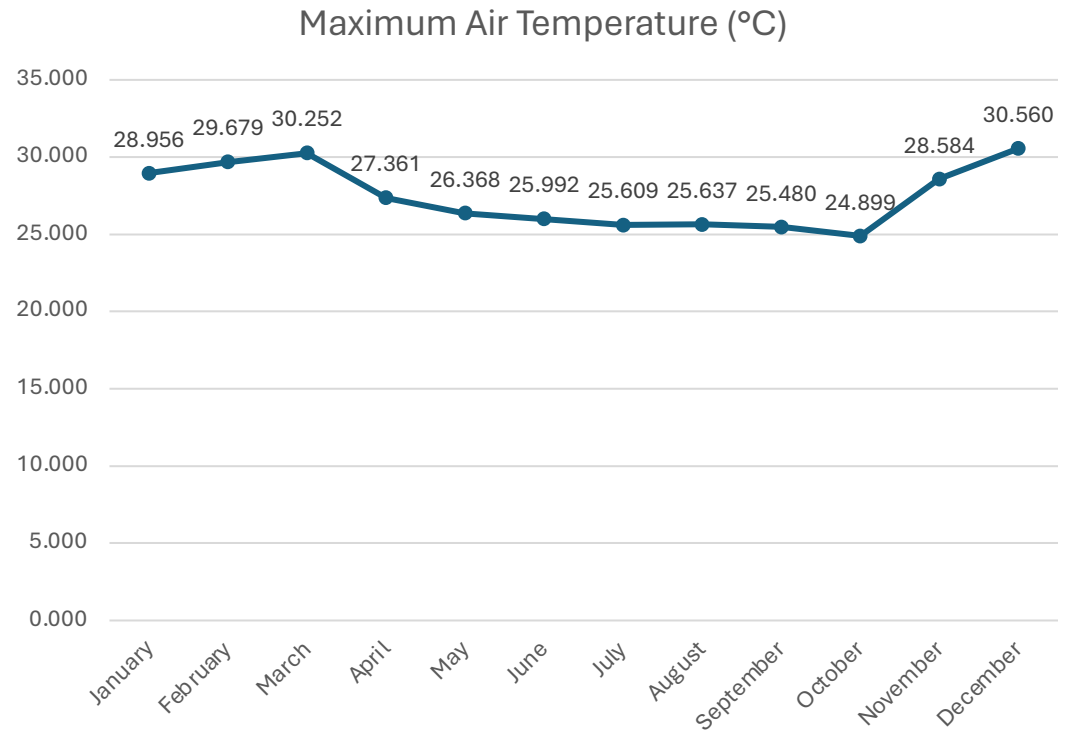


Maximum Air Temperature

- Yearly trend shows the peak again of maximum air temperature in 2016.

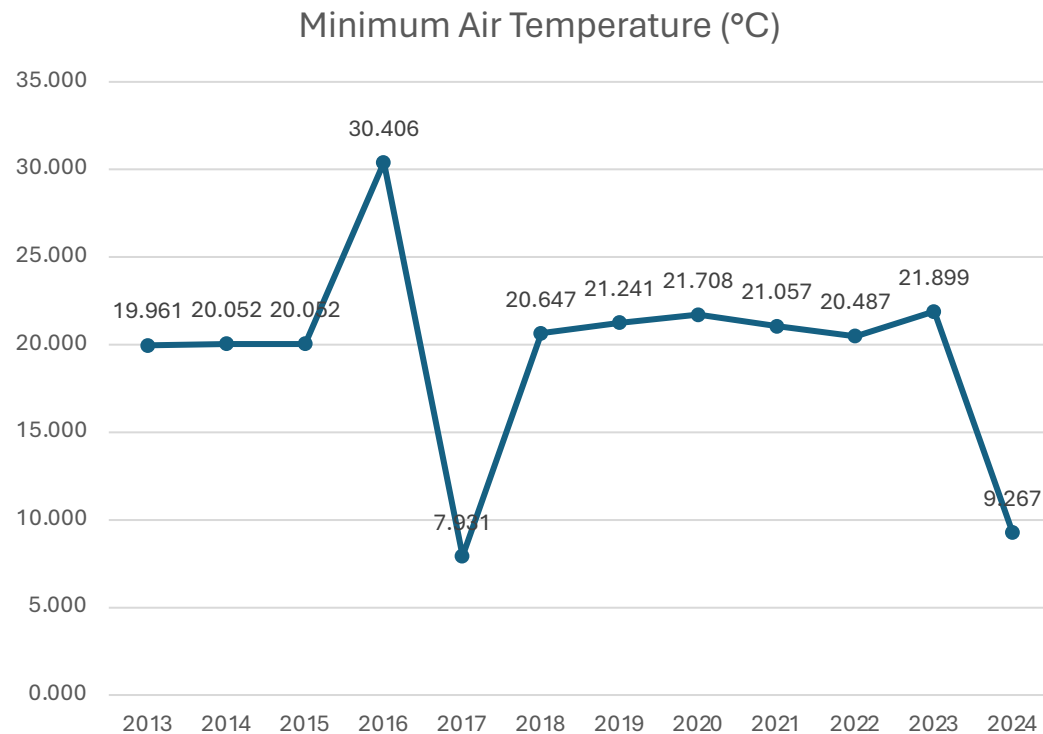


- Maximum air temperature trend is similar to the mean air temperature trend

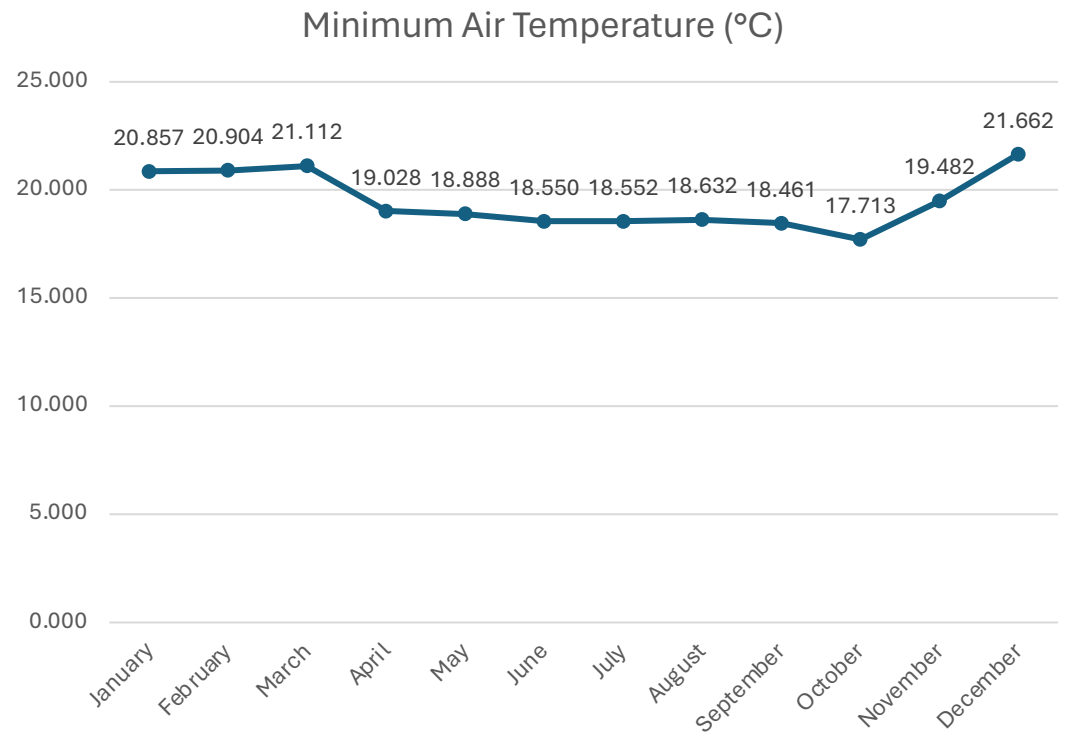


Minimum Air Temperature

- Yearly trend shows the peak of minimum air temperature in 2016

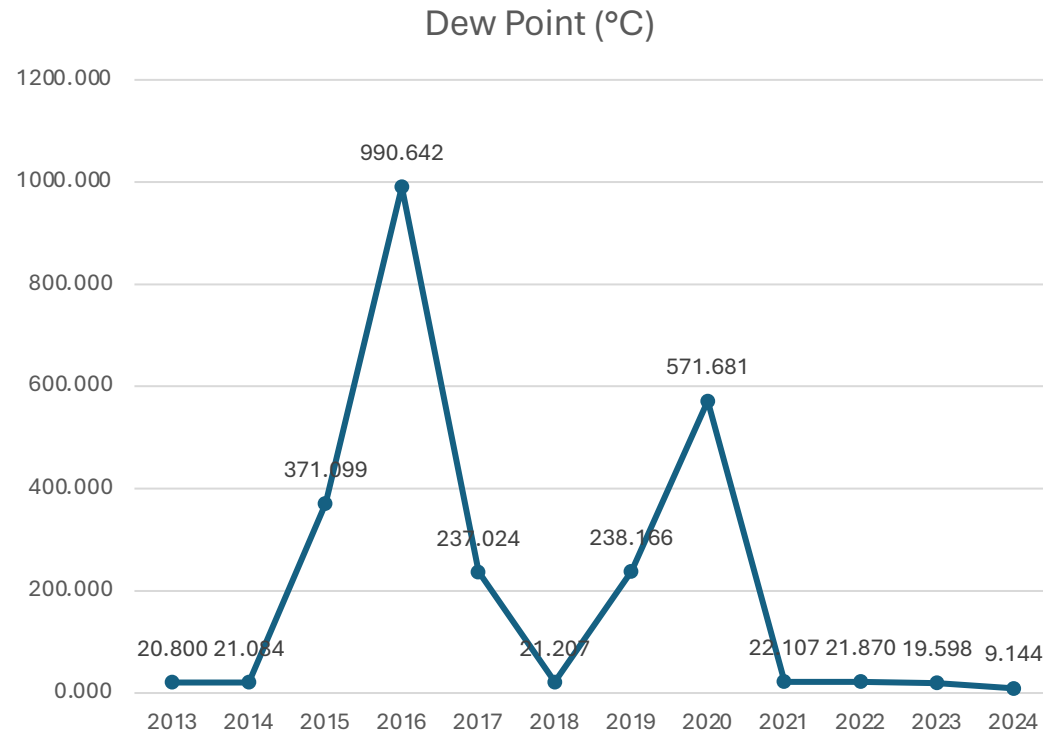


- Minimum air temperature trend is similar to the mean air temperature trend

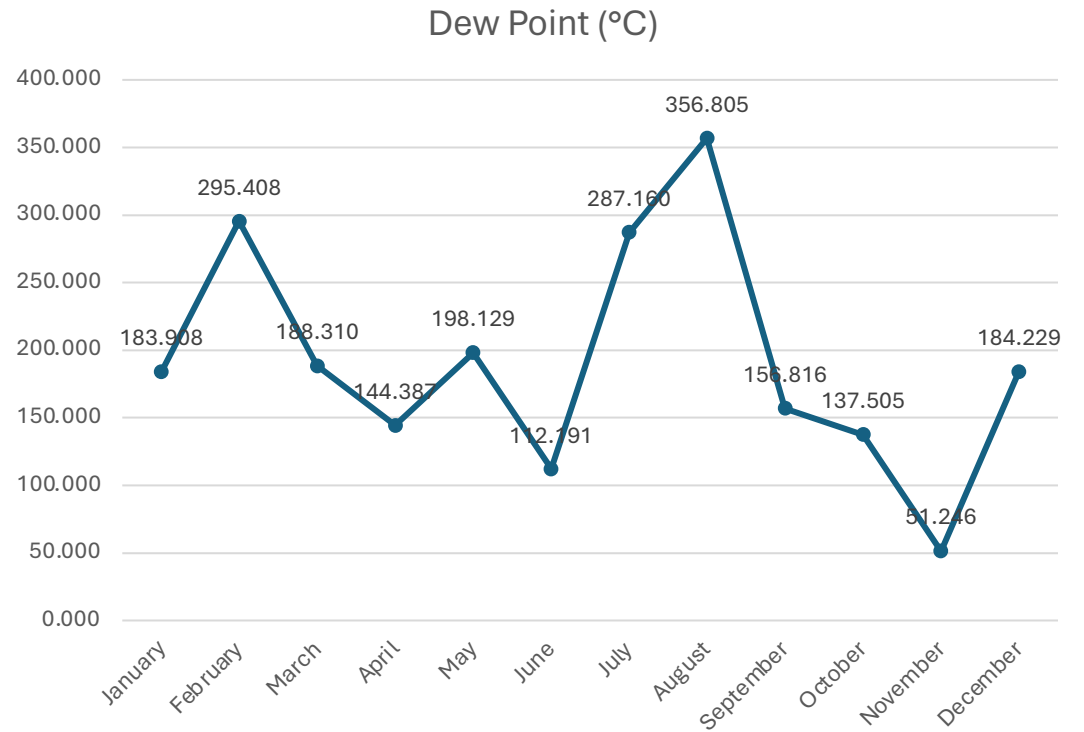


Dew Point Temperature

- Yearly trend shows the peak of dew point temperature in 2016.

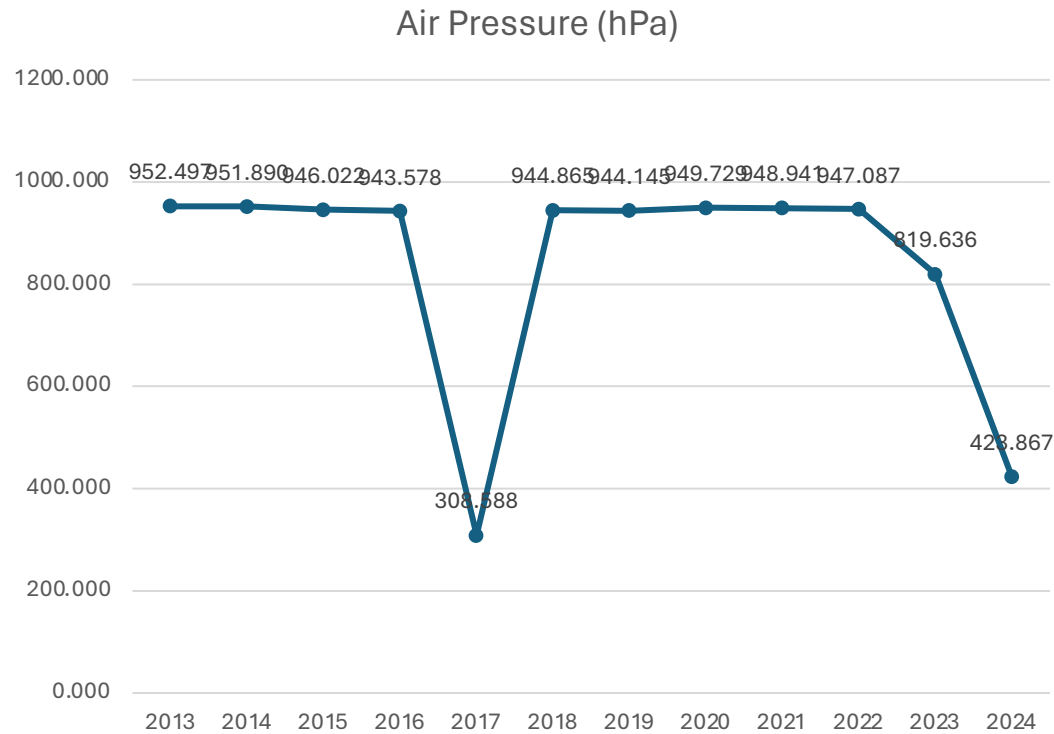


- Dew point temperature is highest during August and February.

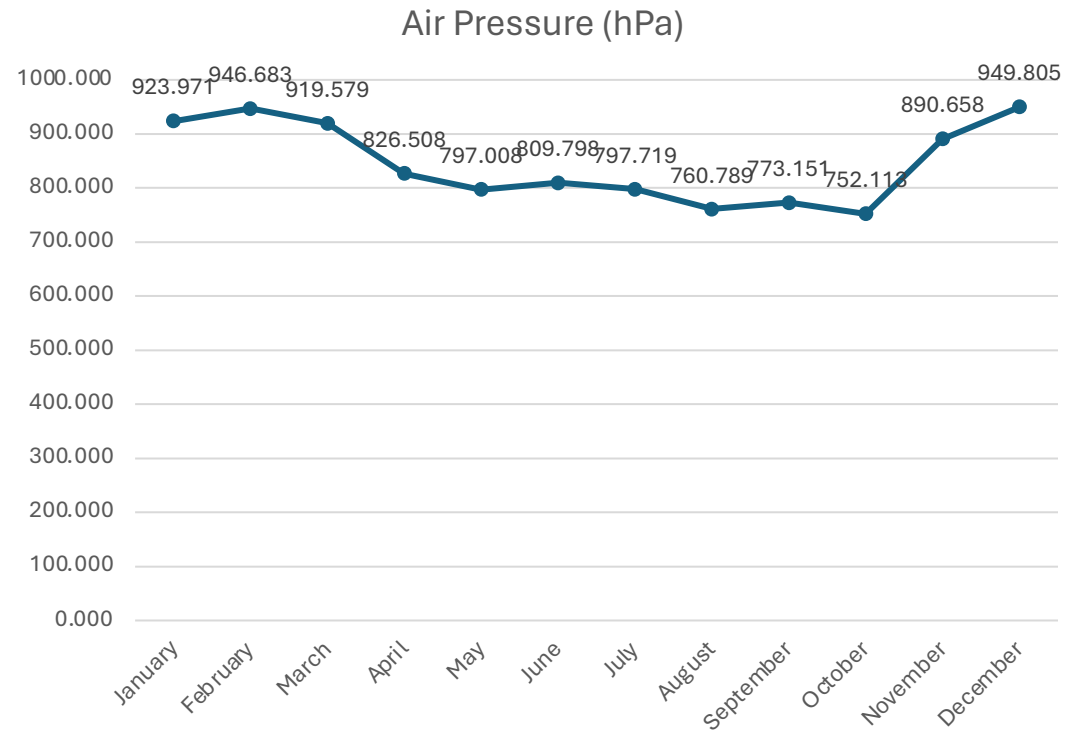


Air Pressure

- Yearly trend shows a steady air pressure from 2013 to 2016, and then a sudden dip in 2017, and a sharp increase in 2018 to 2022.



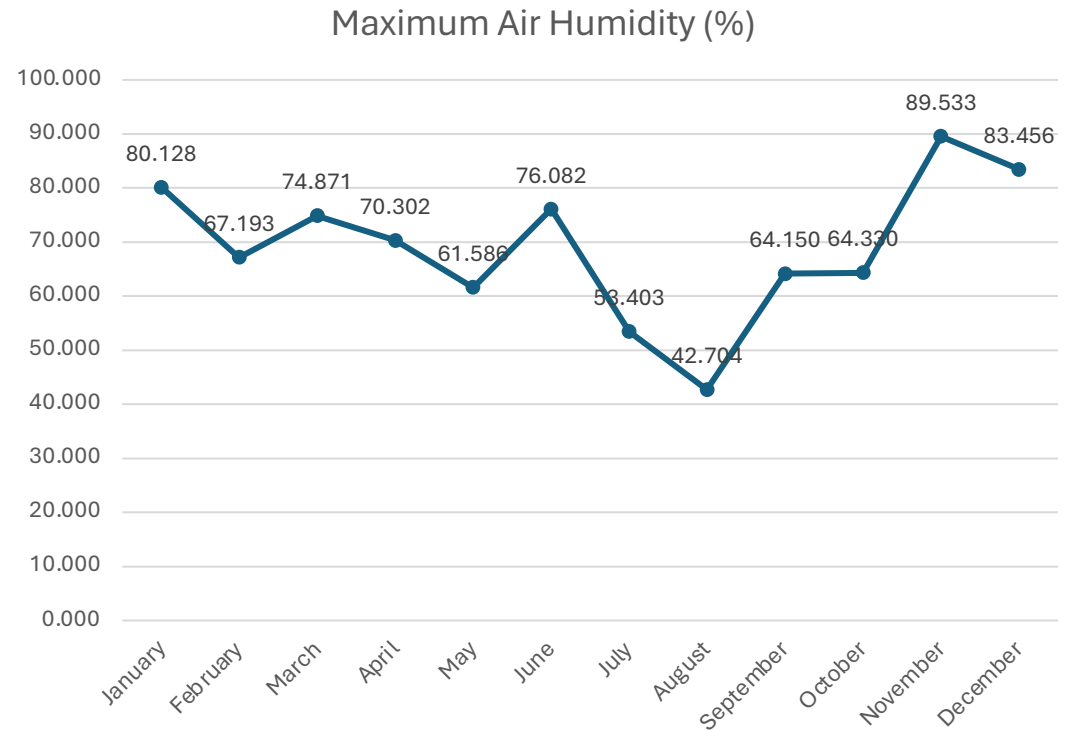
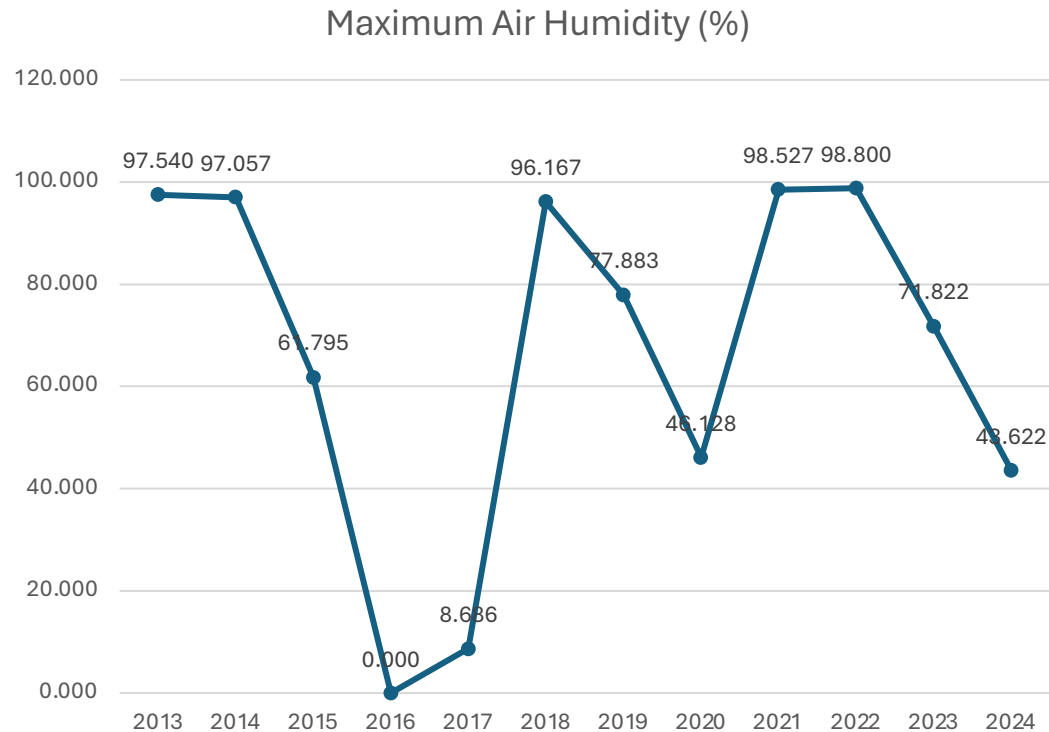
- Average Air pressure in T'boli is less than 1Atm (1,013.25 hPa) throughout the year
- This is due to T'boli being located in high altitude



Maximum Air Humidity

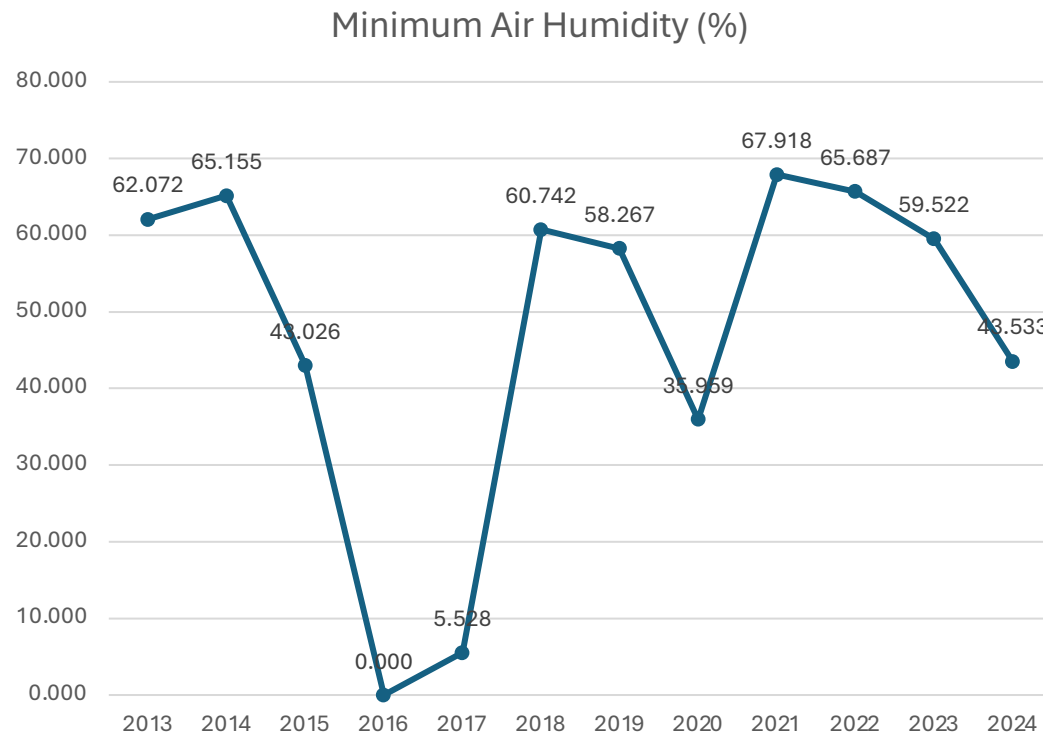
- Yearly trend shows highest maximum air humidity in 2013-2015, 2018 and 2021-mid 2022. \

- It is most humid in T'boli during the months of November, December, and January.
- There is a peak in air humidity during June .

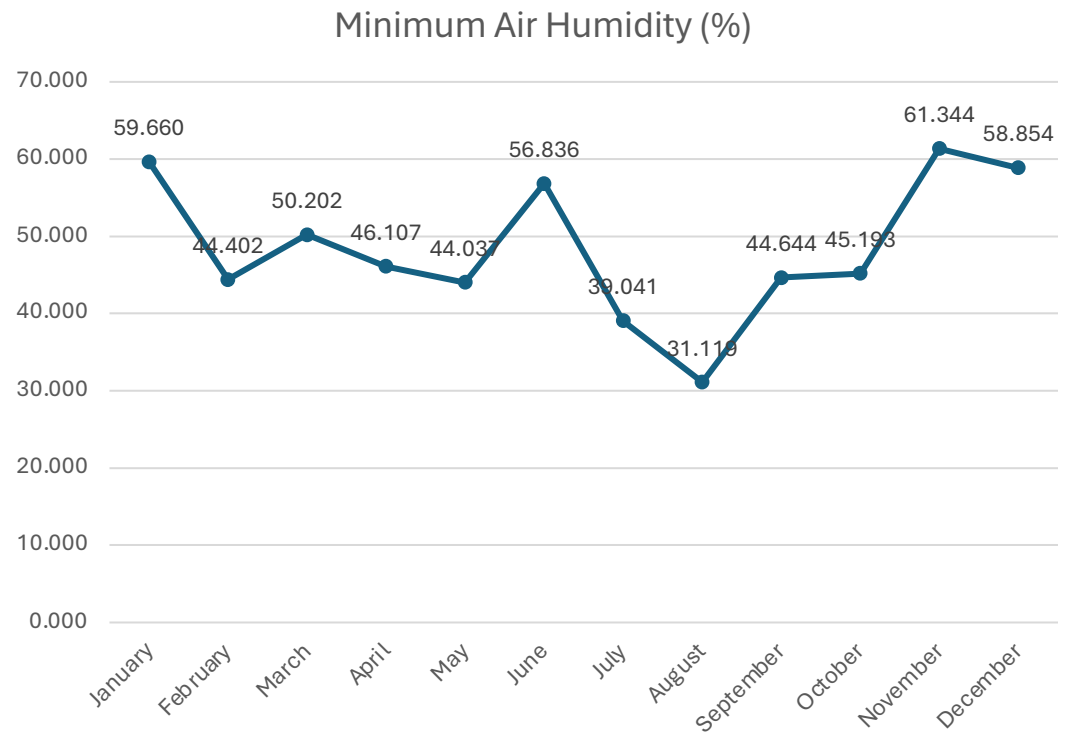


Minimum Air Humidity

- Yearly trend shows peak minimum air humidity in 2014, 2018, and 2021

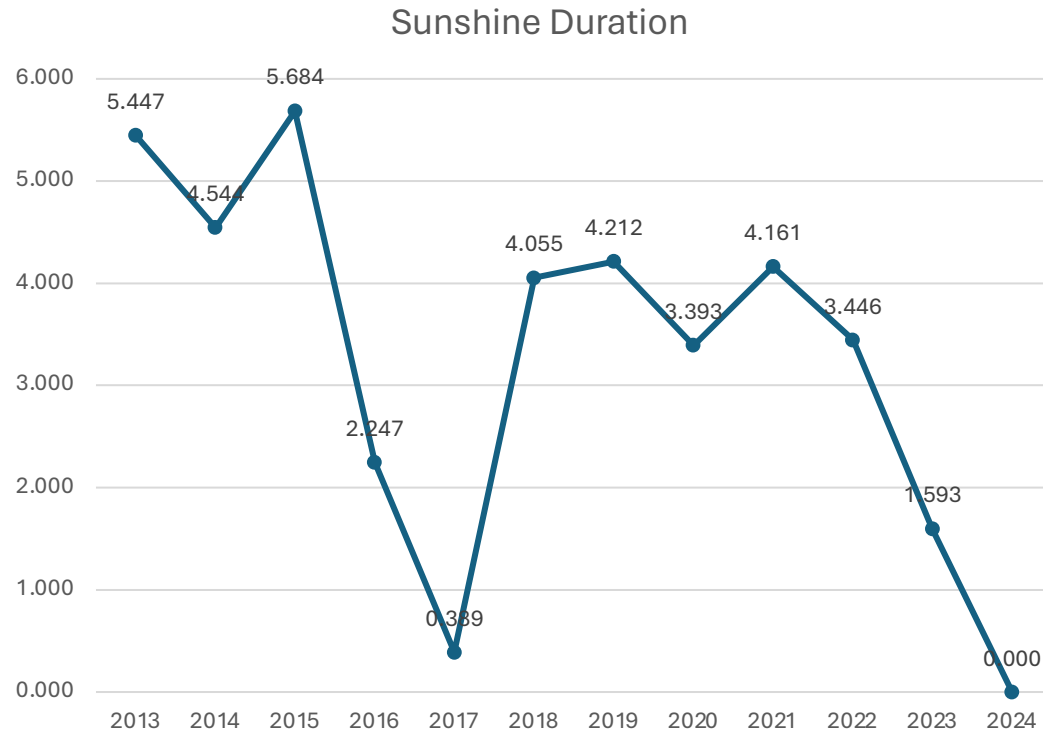


- The trend of minimum air humidity is similar to the maximum air humidity

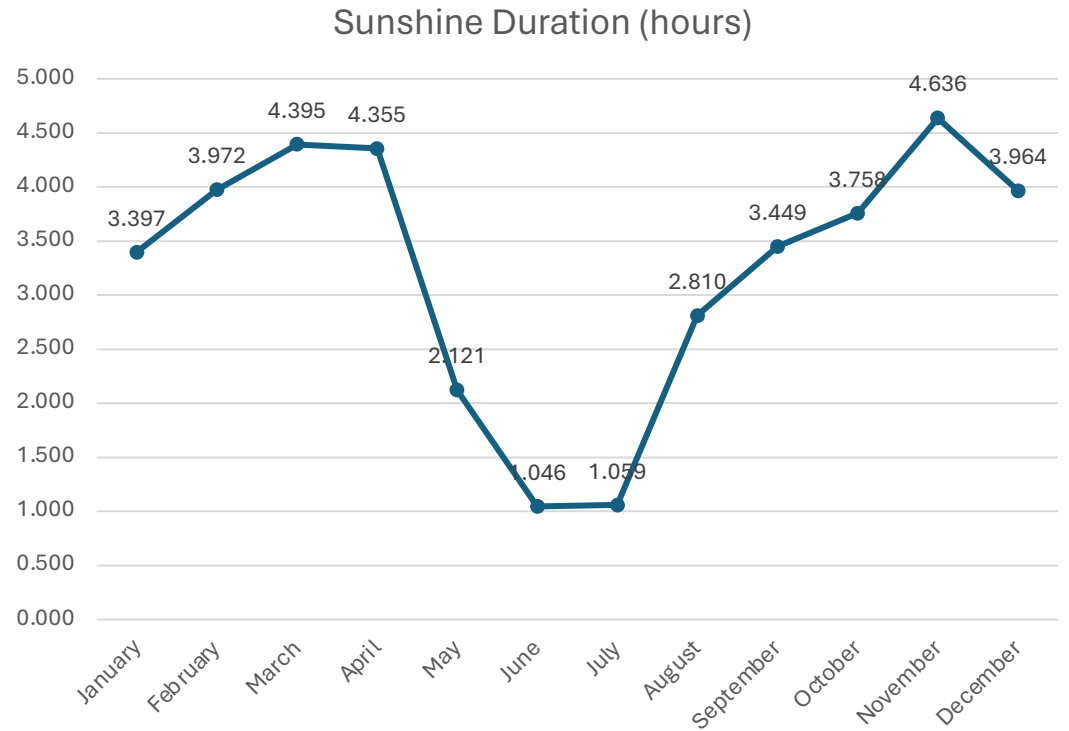


Sunshine Duration

- Yearly trend shows sunshine duration is longest in 2013, 2016, 2018, 2019, and 2021.

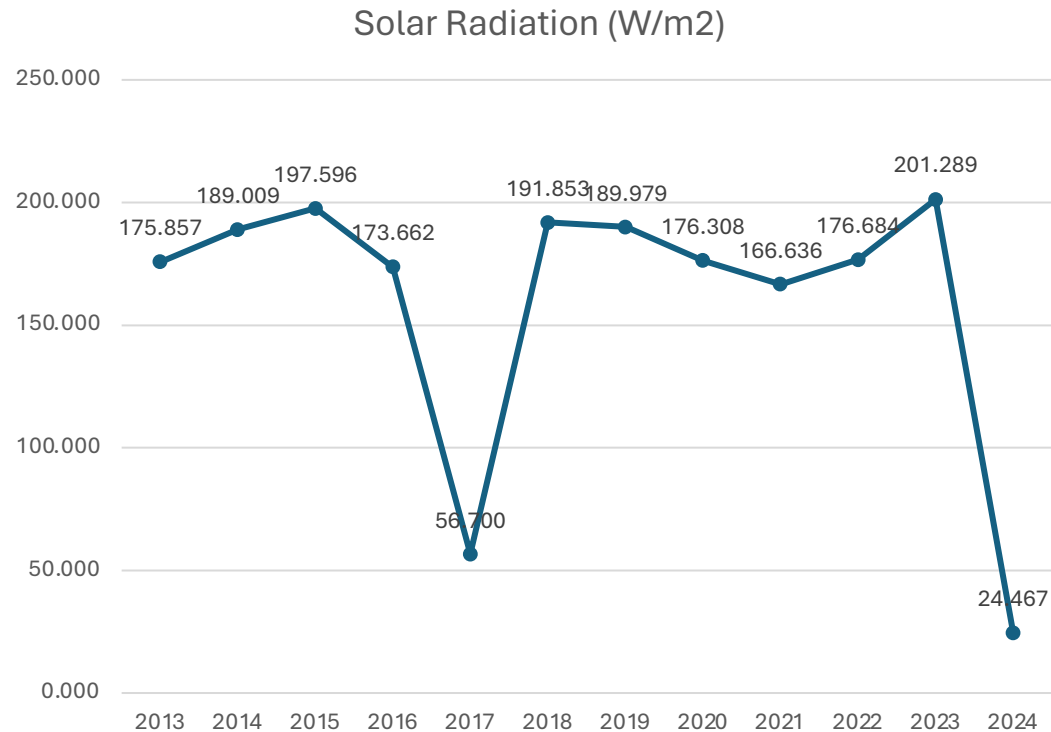


- Sunshine Duration peaks during the months of November to April.
- The lowest sunshine duration is during the months of April to August.

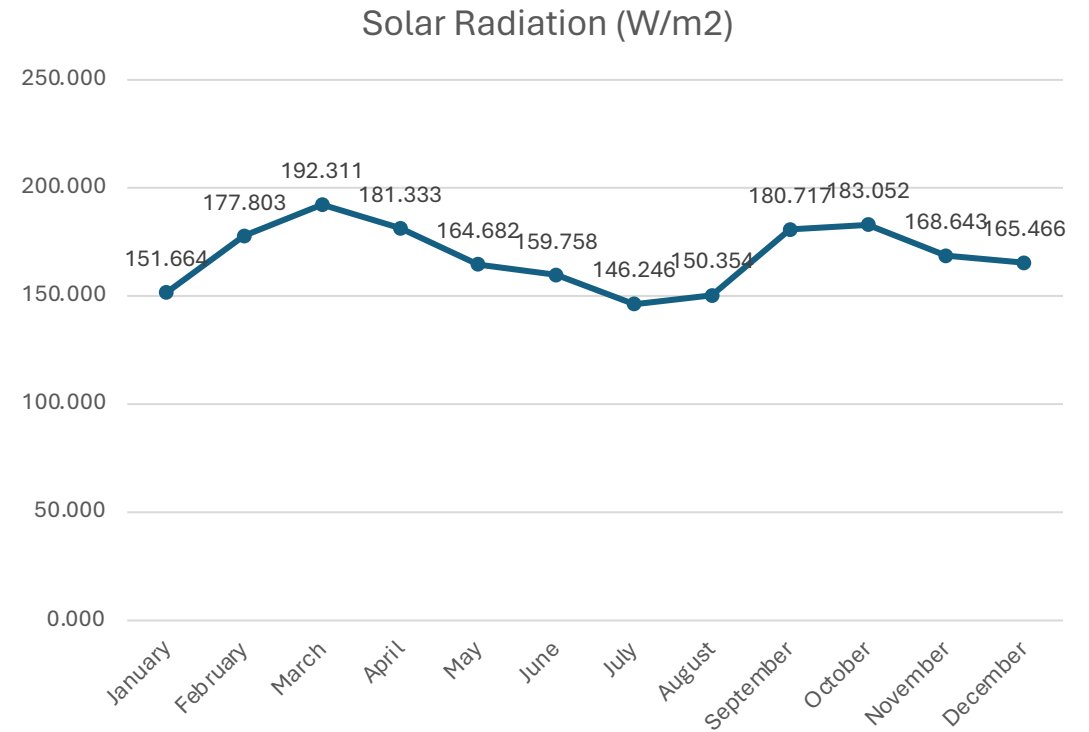


Solar Radiation

- Yearly trend shows solar radiation strongest in 2015 and throughout 2018 until 2023.

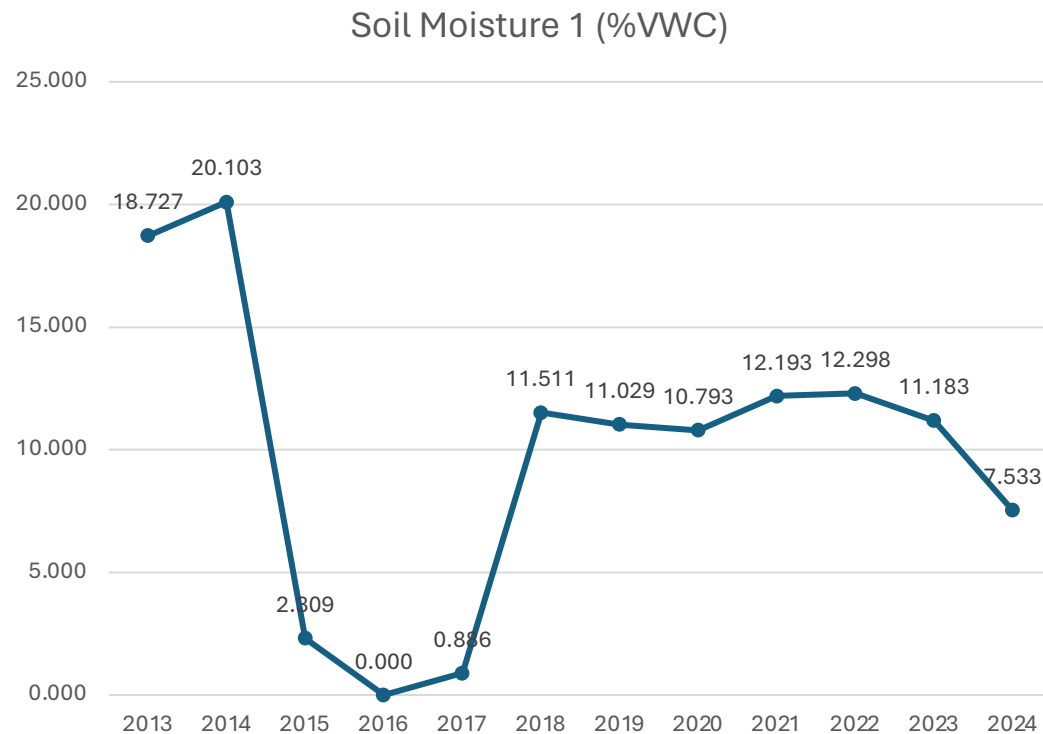


- Solar radiation on the other hand peaks during the month of March.
- Generally, there is high solar radiation recorded during the months of February to April, then September and October where solar radiation are above 175 W/m².

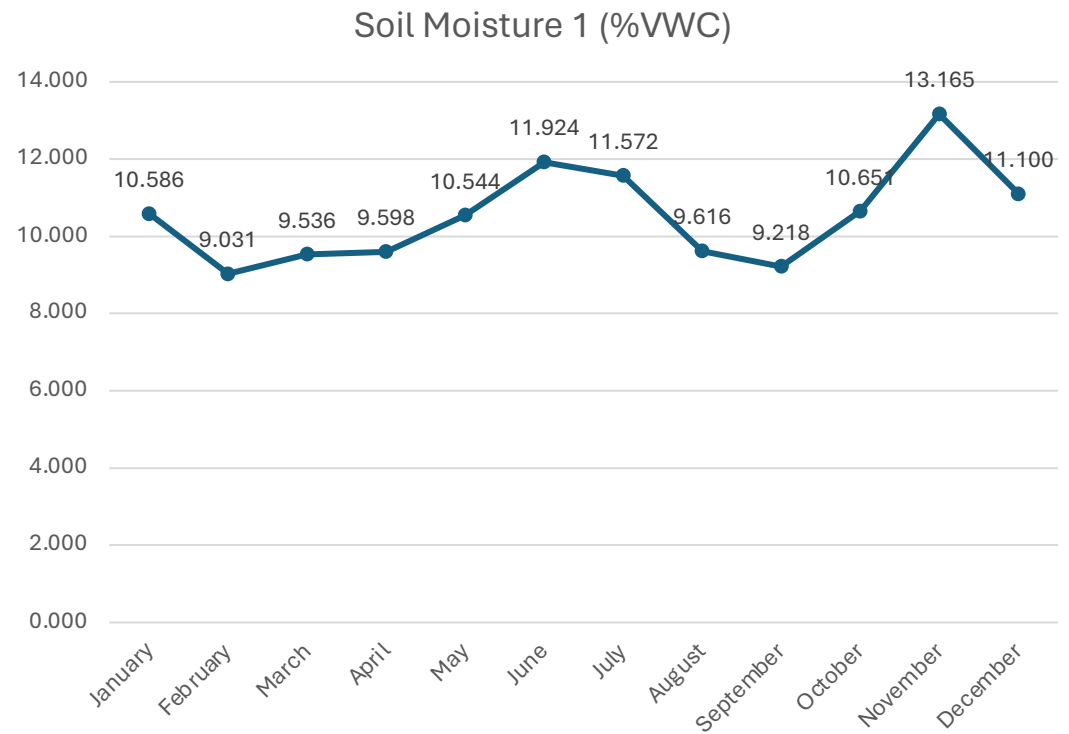


Soil Moisture (15cm)

- Yearly trend shows highest moisture in soil in 2014.

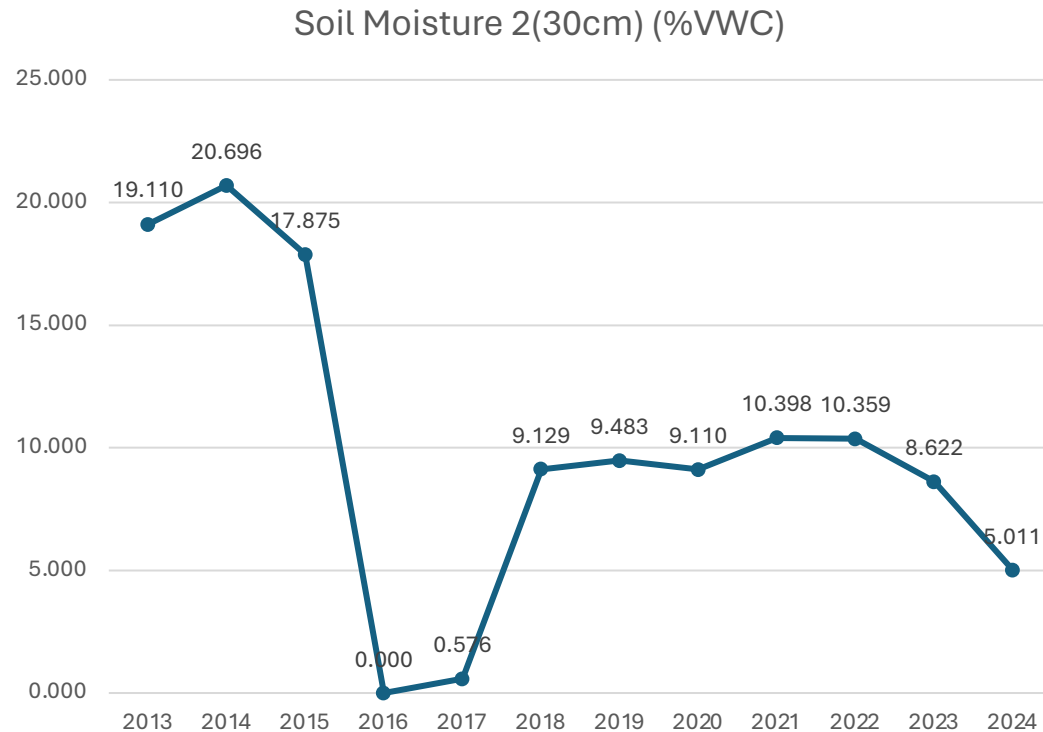


- Soil is most wet during the months of June, July, and November

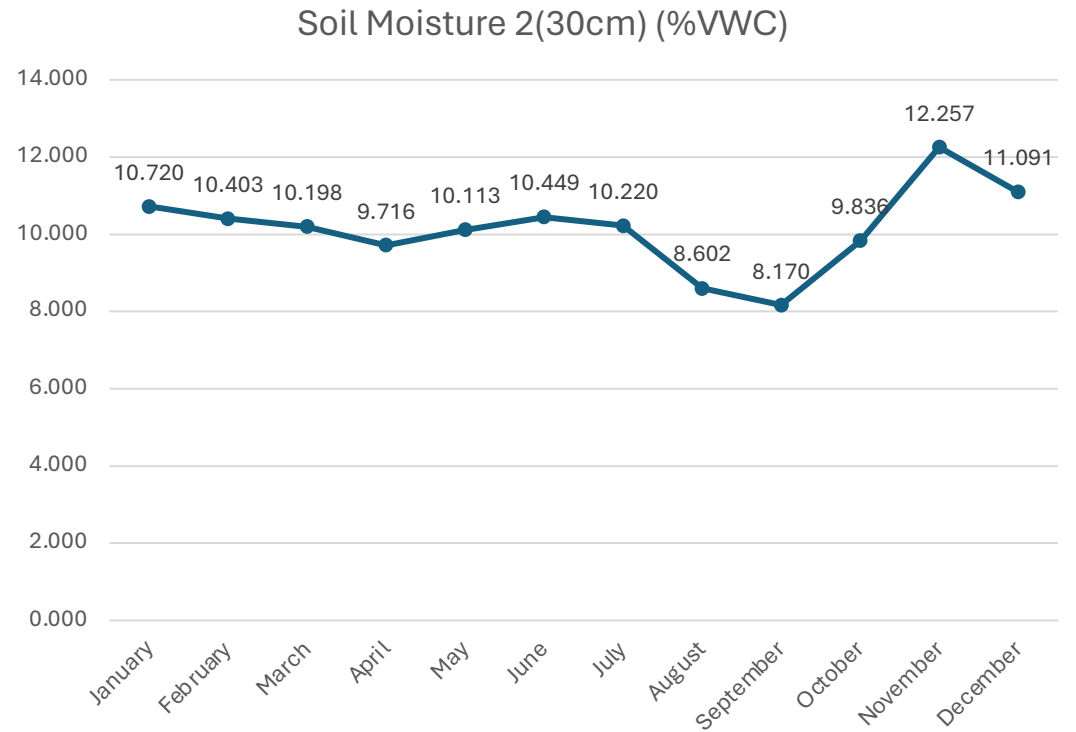


Soil Moisture (30cm)

- Yearly trend shows peak soil moisture at 30 cm in 2014

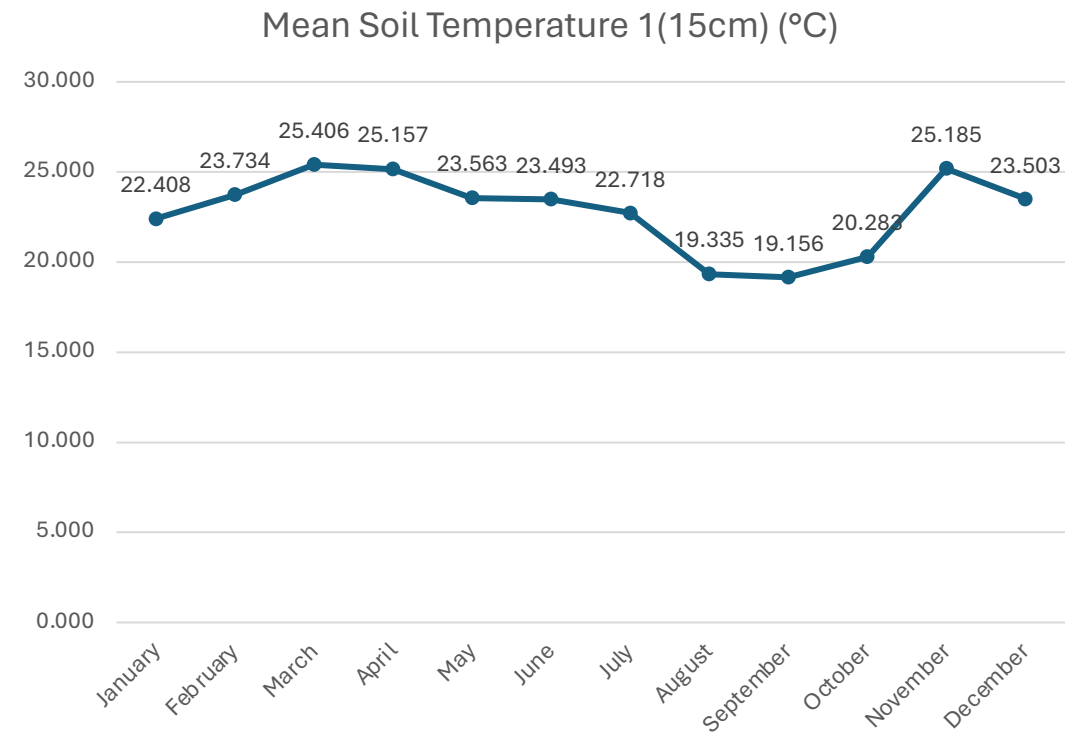
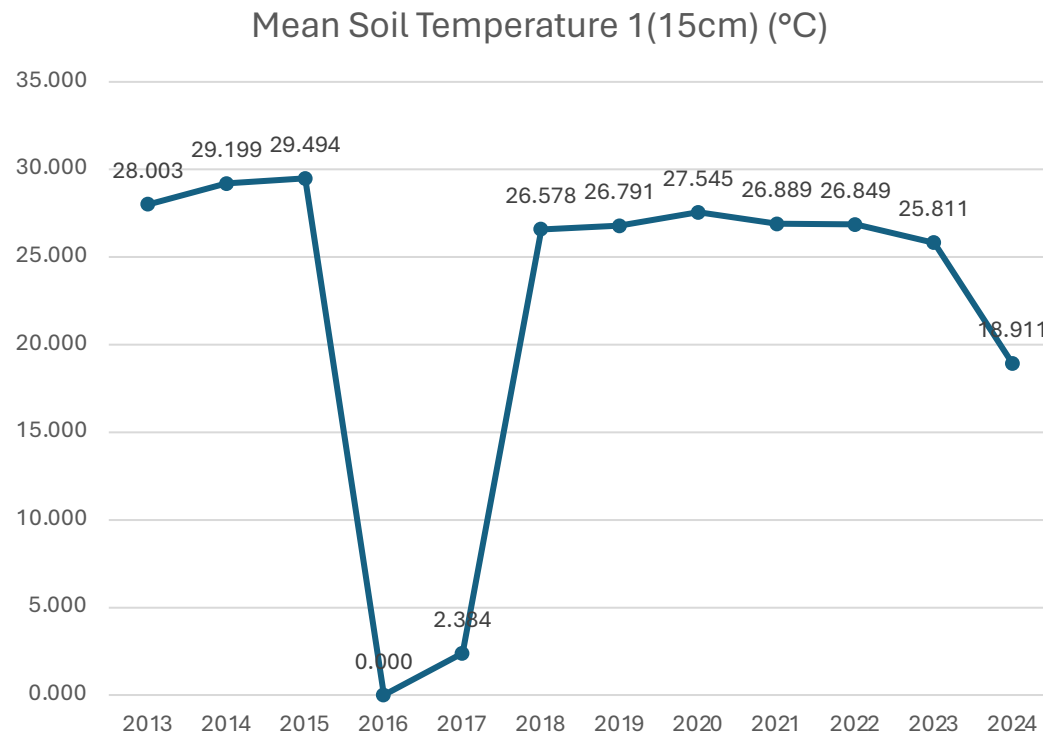


- For deeper measurements, soil is most moist during the month of November .



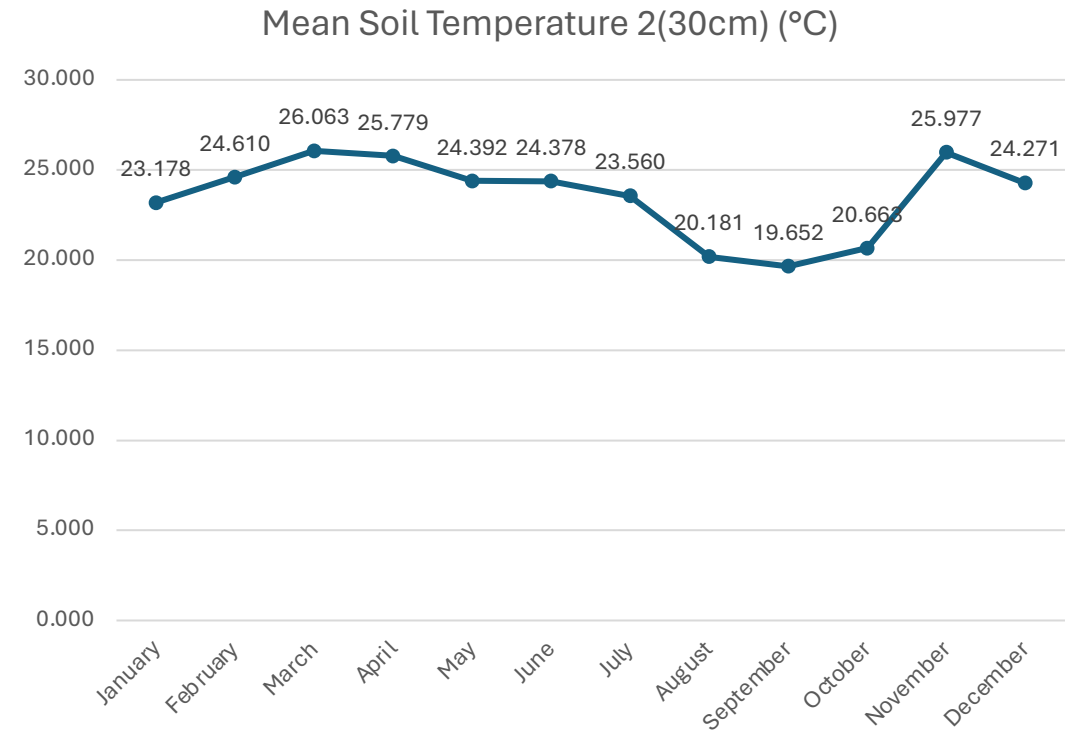
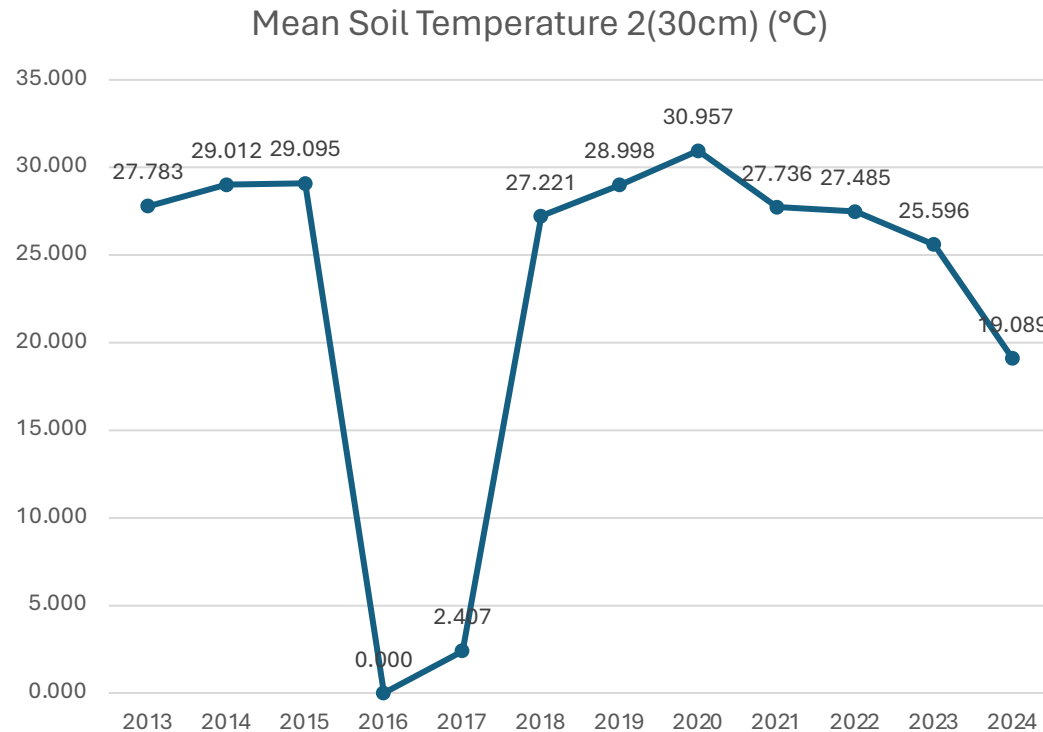
Mean Soil Temperature (15cm)

- Yearly trend shows a relatively high soil moisture at 15 cm., but with a sudden dip in 2016 to 2017.
- Soil is generally above 22 degrees Celsius, except for the months of August to October where the soil is generally colder.



Mean Soil Temperature (30cm)

- Yearly trends show that the mean soil temperature at 30 cm is also generally high except for a dip in 2016-2017.
- Similarly for deeper layers of soil, the temperature is generally above 23 degrees Celsius, except for the months of August to October where the soil is generally colder.

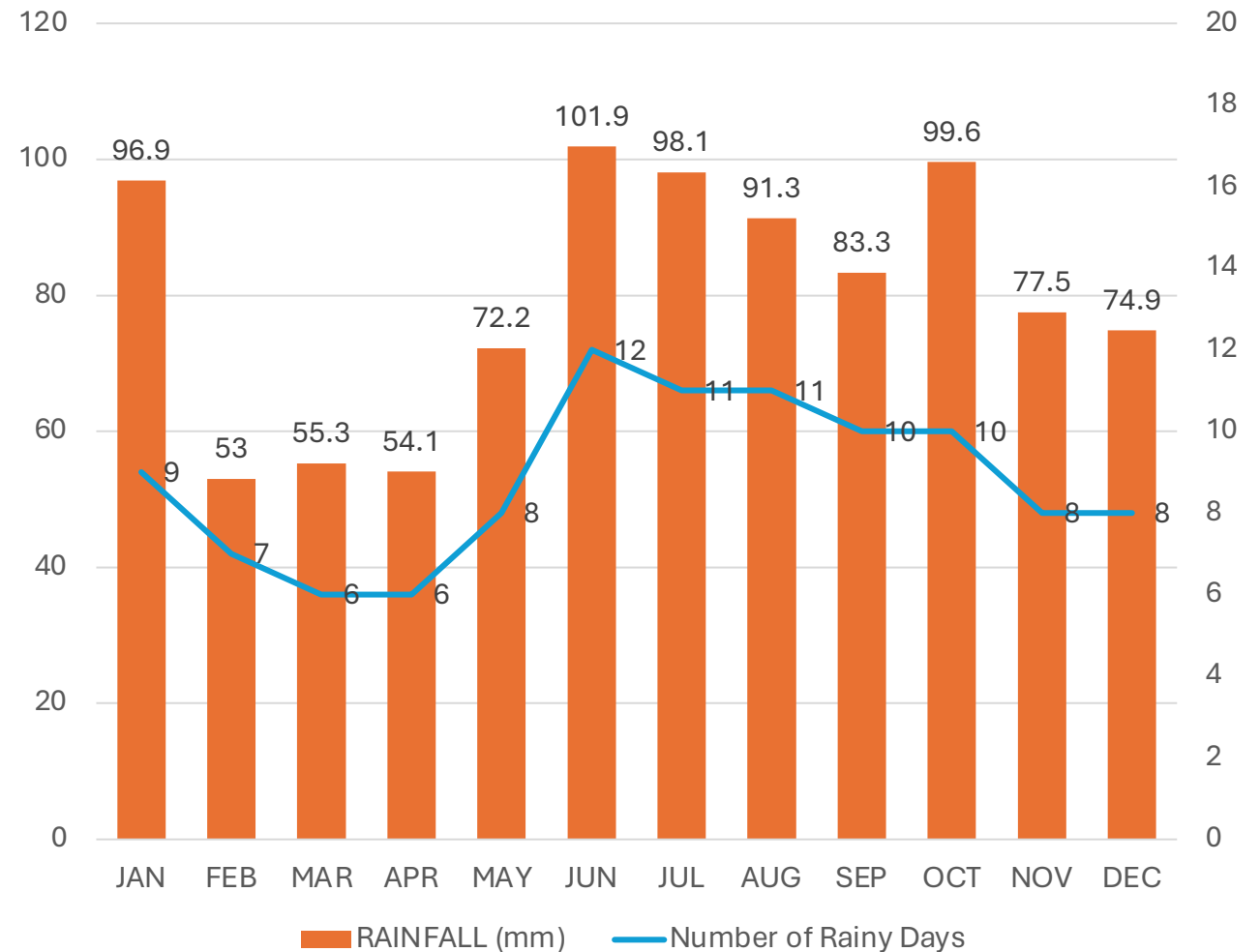


Climate Normals

PAGASA General Santos Synoptic Station

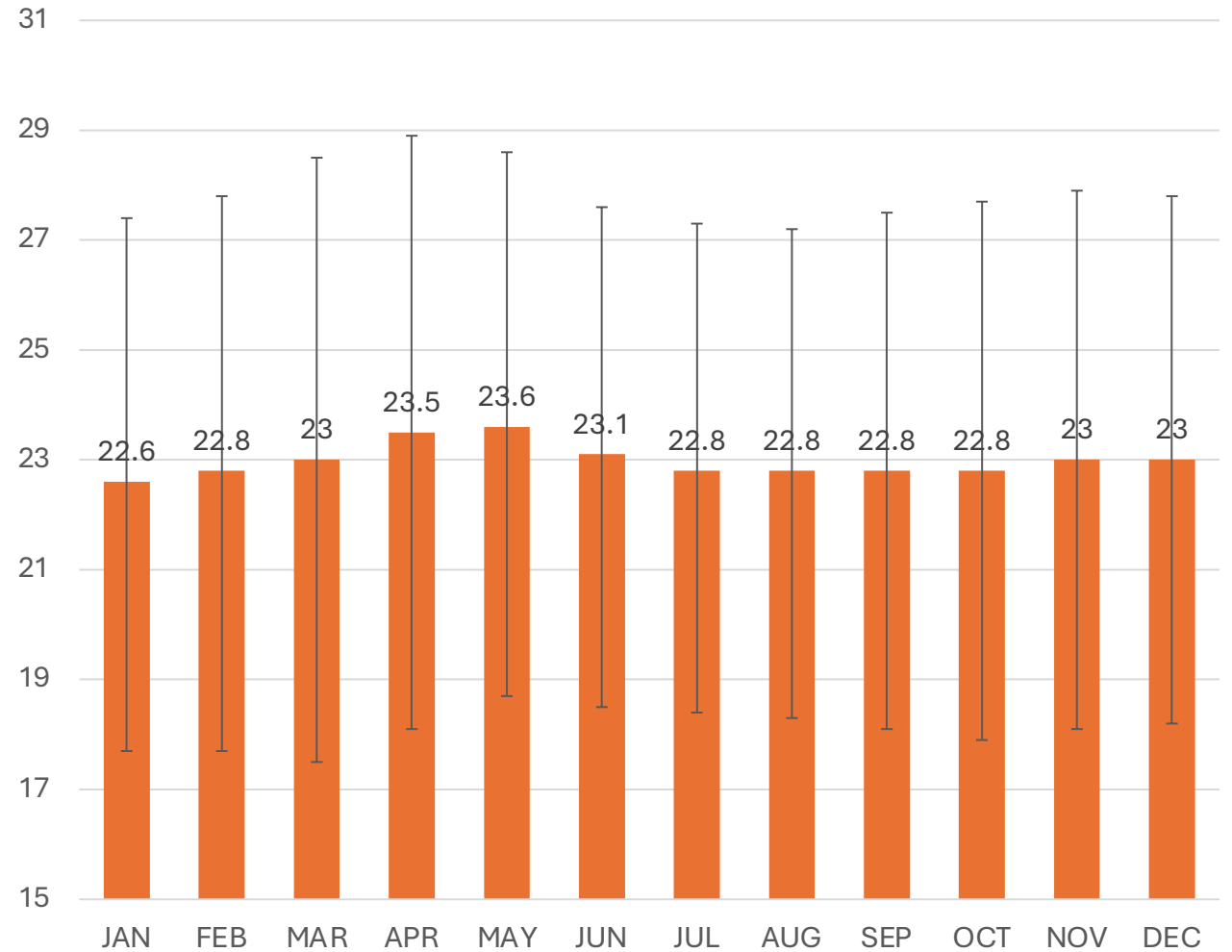
Rainfall

- June is the most wet month during the year with an average rainfall of 101.9mm, and 12 rainy days.
- The driest months are March and April with only 6 rainy days and 54mm to 55mm of rainfall.



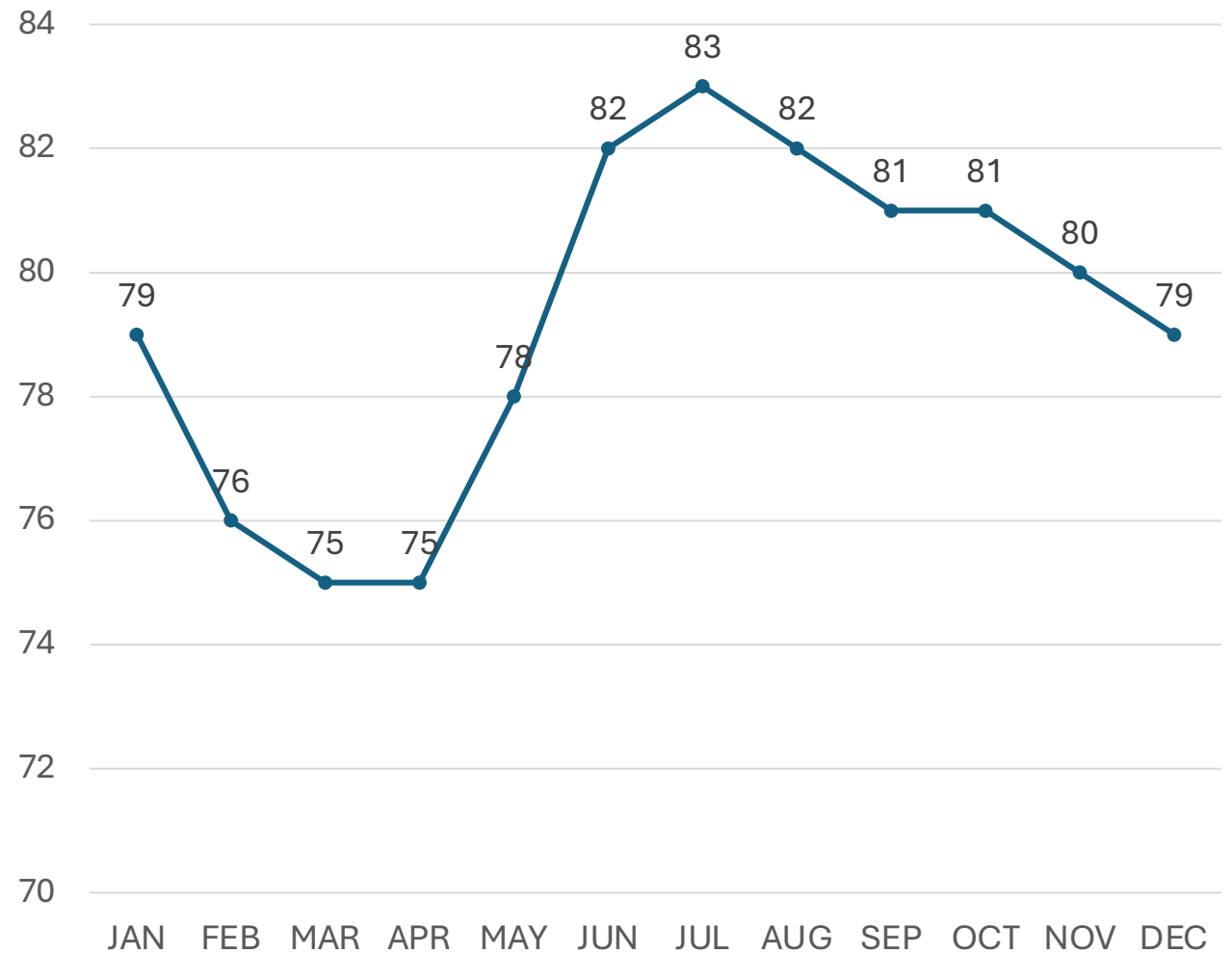
Temperature

- The hottest months are March to May with an average temperature of above 28 degrees Celsius, with April having an average maximum temperature of above 34 degrees Celsius.



Relative Humidity

- The months of June to November are relatively more humid than the months of December to May, with the average humidity of June to November being above 80%.
- February to April are the least humid months with the average humidity of 75% to 76%.



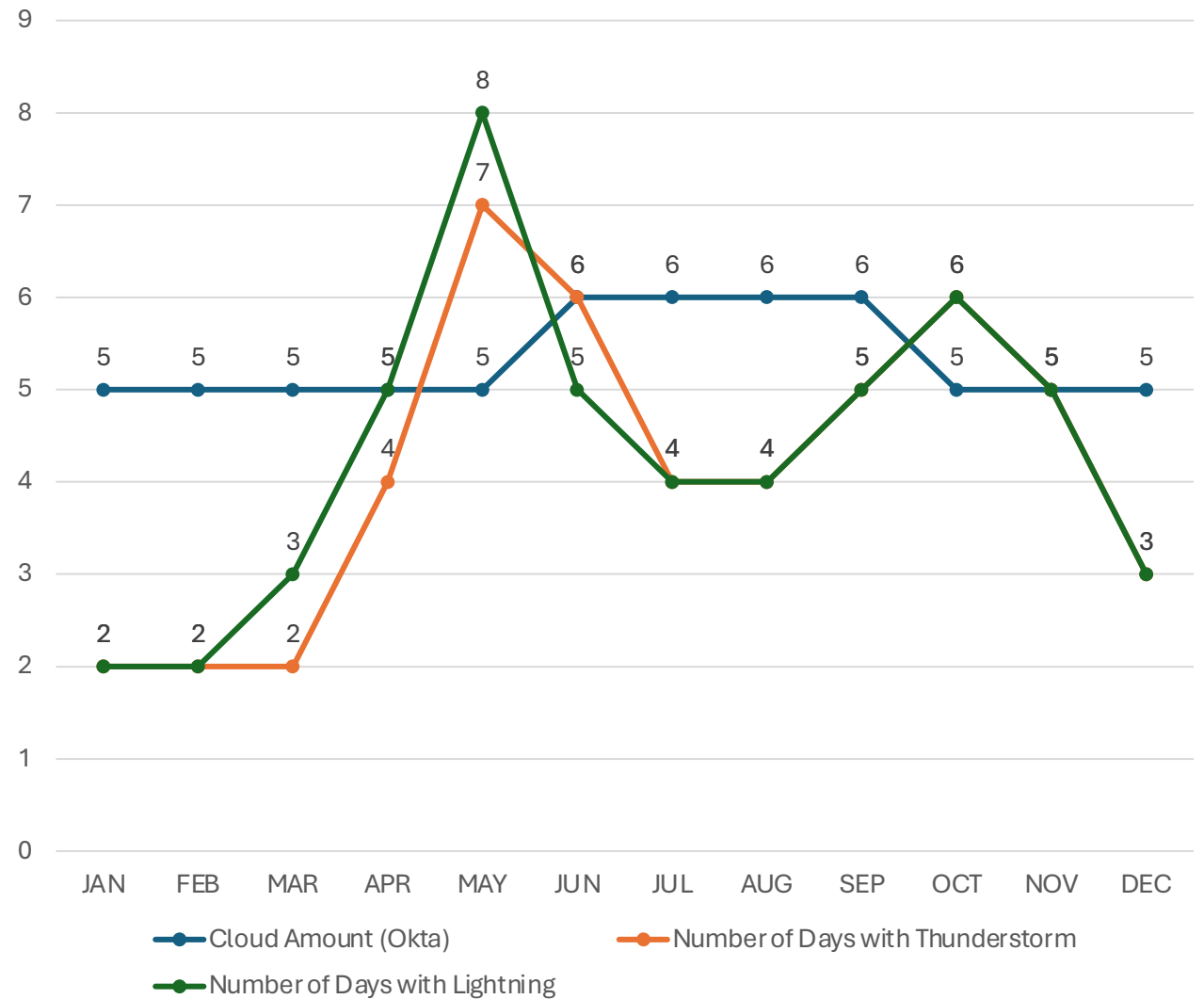
Wind Speed

- Wind speed in the area is relatively slow at only 1 to 2m/s.
- From April to November, the winds blow South, while from January to February, the winds blow Northeast.

MONTH	Wind SPD (m/s)	Wind DIR
JAN	2	NE
FEB	2	NE
MAR	2	NE
APR	2	S
MAY	2	S
JUN	1	S
JUL	1	S
AUG	1	S
SEP	1	S
OCT	1	S
NOV	2	S
DEC	2	W
ANNUAL	2	

Clouds

- Thunderstorm season is in May with an average of 7 days with thunderstorm and 8 days with lightning.



Climate Extremes

PAGASA General Santos Synoptic Station

Rainfall

- The greatest rainfall that the PAGASA General Santos Synoptic Station has observed was in September 8, 1977 at 189.5mm of rain.
- The most recent climate extreme was recorded in March 28, 2017, at 60.8mm of rain.
 - This was especially extreme considering that March is generally a dry month in the area around General Santos City, including T'boli.

MONTH	GREATEST DAILY RAINFALL (mm)	
	AMOUNT	DATE
JANUARY	105.9	January 17, 1966
FEBRUARY	96.5	February 22, 2000
MARCH	60.8	March 28, 2017
APRIL	109	April 17, 2004
MAY	151.8	May 18, 2021
JUNE	142	June 22, 1983
JULY	109.4	July 12, 2007
AUGUST	126	August 28, 1959
SEPTEMBER	189.5	September 8, 1977
OCTOBER	101	October 18, 1970
NOVEMBER	102.1	November 9, 1962
DECEMBER	78.6	December 10, 2007
ANNUAL	189.5	September 8, 1977
Period of Record	1949-2022	

Temperature

- The highest temperature extreme was recorded on April 16, 2016 at 39.4 degrees Celsius.
- On the other hand, the lowest temperature extreme was recorded on March 9, 1963.
- There are multiple record breaking extreme temperature highs observed in 2016, particularly for the months of February, April, July, and August.
- On the other hand, multiple extreme temperature lows were recorded in 1985, particularly for the months of July, August, and September.

MONTH	TEMPERATURE (Degrees Celsius)			
	HIGH	DATE	LOW	DATE
JAN	37.5	January 24, 1988	17.1	January 24, 1965
FEB	38	February 18, 1992	17.2	February 4, 1958
	38	February 4, 2016		
MAR	38.9	March 28, 1991	16.9	March 9, 1963
APR	39.4	April 16, 2016	18.3	April 11, 1963
MAY	38.5	May 5, 1998	18.7	May 14, 1951
JUNE	37	June 6, 1991	17.9	June 10, 1961
	37	June 2, 2014		
JULY	37	July 16, 2016	17.2	July 9, 1985
AUG	36.5	August 29, 2016	17.5	August 16, 1985
SEP	37	September 23, 1992	18	September 5, 1985
OCT	37	October 16, 1980	18.2	October 8, 1961
NOV	37	November 1, 1994	18.3	November 28, 1951
DEC	37.5	December 4, 1987	18	December 30, 1950
ANNUAL	39.4	April 16, 2016	16.9	March 9, 1963
Period of Record	1949 - 2022			

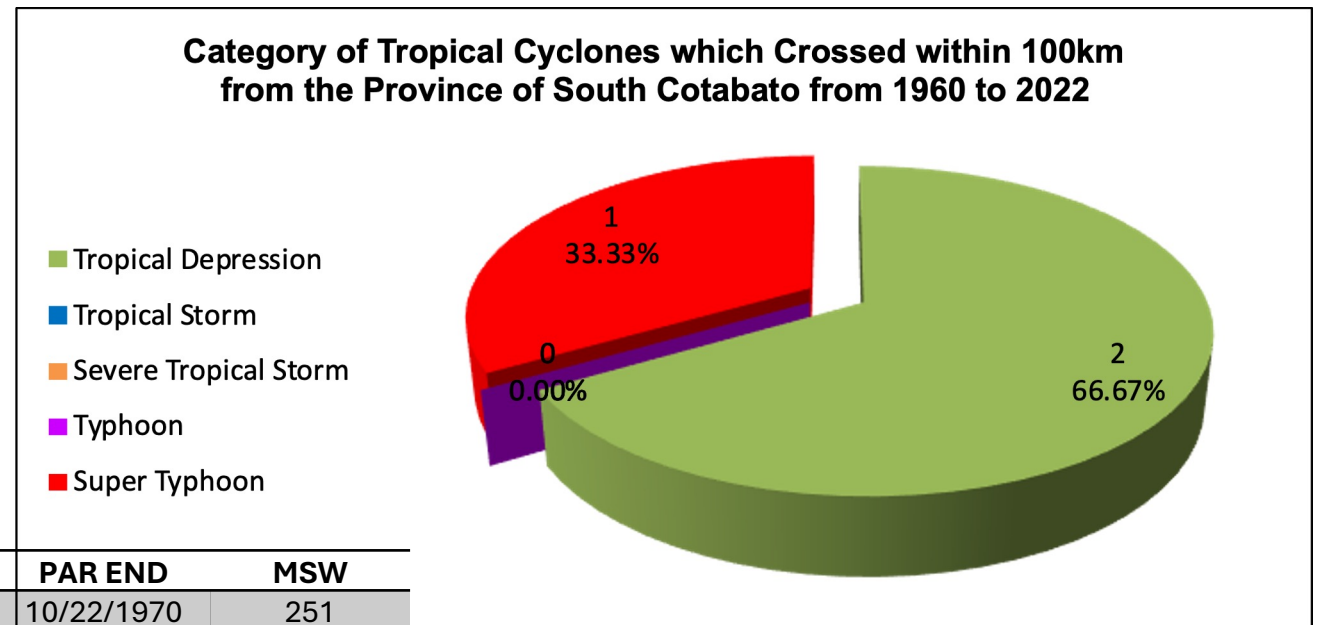
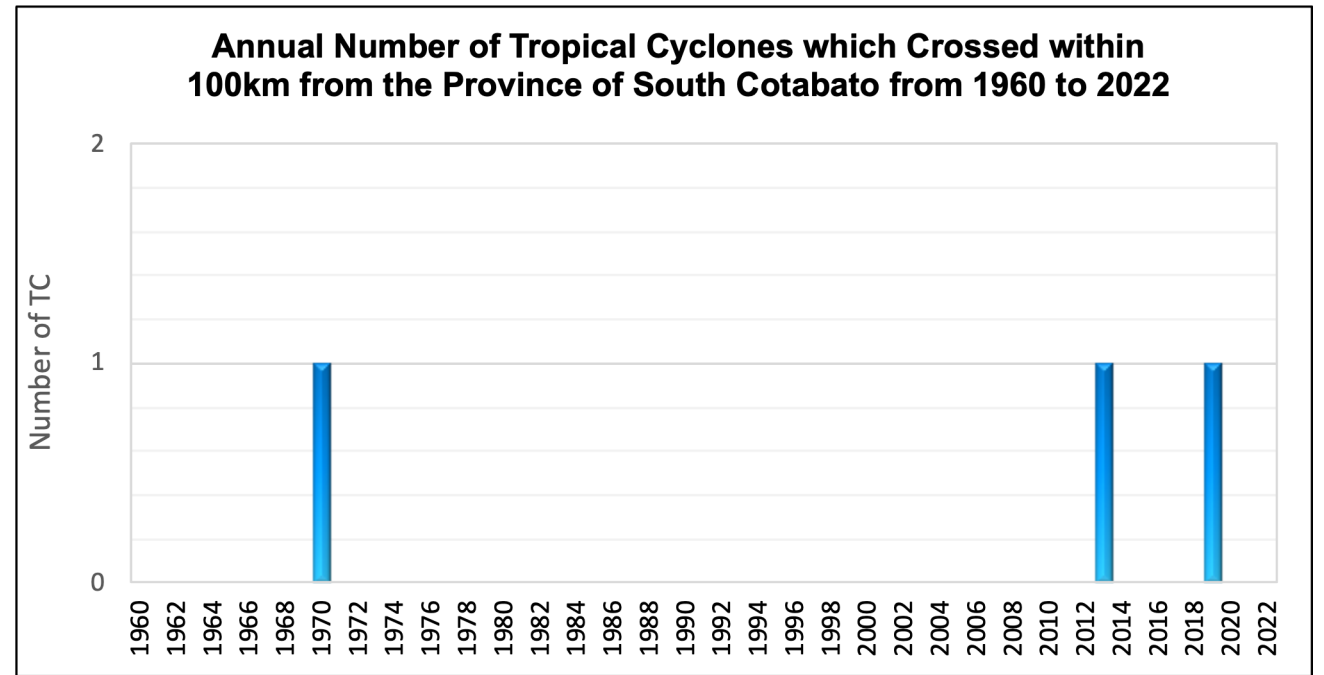
Wind

- The strongest winds were recorded on November 6, 2007 with a wind speed of 25m/s.

MONTH	STRONGEST WINDS (m/s)		
	SPD	DATE	DIR
JANUARY	20	January 9, 1982	S
FEBRUARY	16	February 3, 1975	NNE
MARCH	18	March 22, 1983	SW
APRIL	19	April 19, 1971	S
MAY	16	May 19, 2007	NNE
JUNE	16	May 7, 2021	ENE
JULY	17	June 24, 1972	S
AUGUST	17	July 24, 1972	SSE
SEPTEMBER	18	August 23, 2000	NW
OCTOBER	18	September 14, 1972	SSE
NOVEMBER	17	October 12, 1972	S
DECEMBER	25	November 6, 2007	SE
JANUARY	15	December 5, 1997	NE
ANNUAL	25	November 6, 2007	SE
Period of Record	1966 - 2022		

Tropical Cyclones

- Only three tropical cyclones are reported to have crossed within 100km of the province of South Cotabato.
- Of the three tropical cyclones, one is a supertyphoon, and two are tropical depressions.
- The strongest tropical cyclone that crossed the province of South Cotabato was in October 1970, with a maximum sustained wind of 251km/h.
- The most recent tropical cyclone which crossed the province of South Cotabato was in March\ 2019.

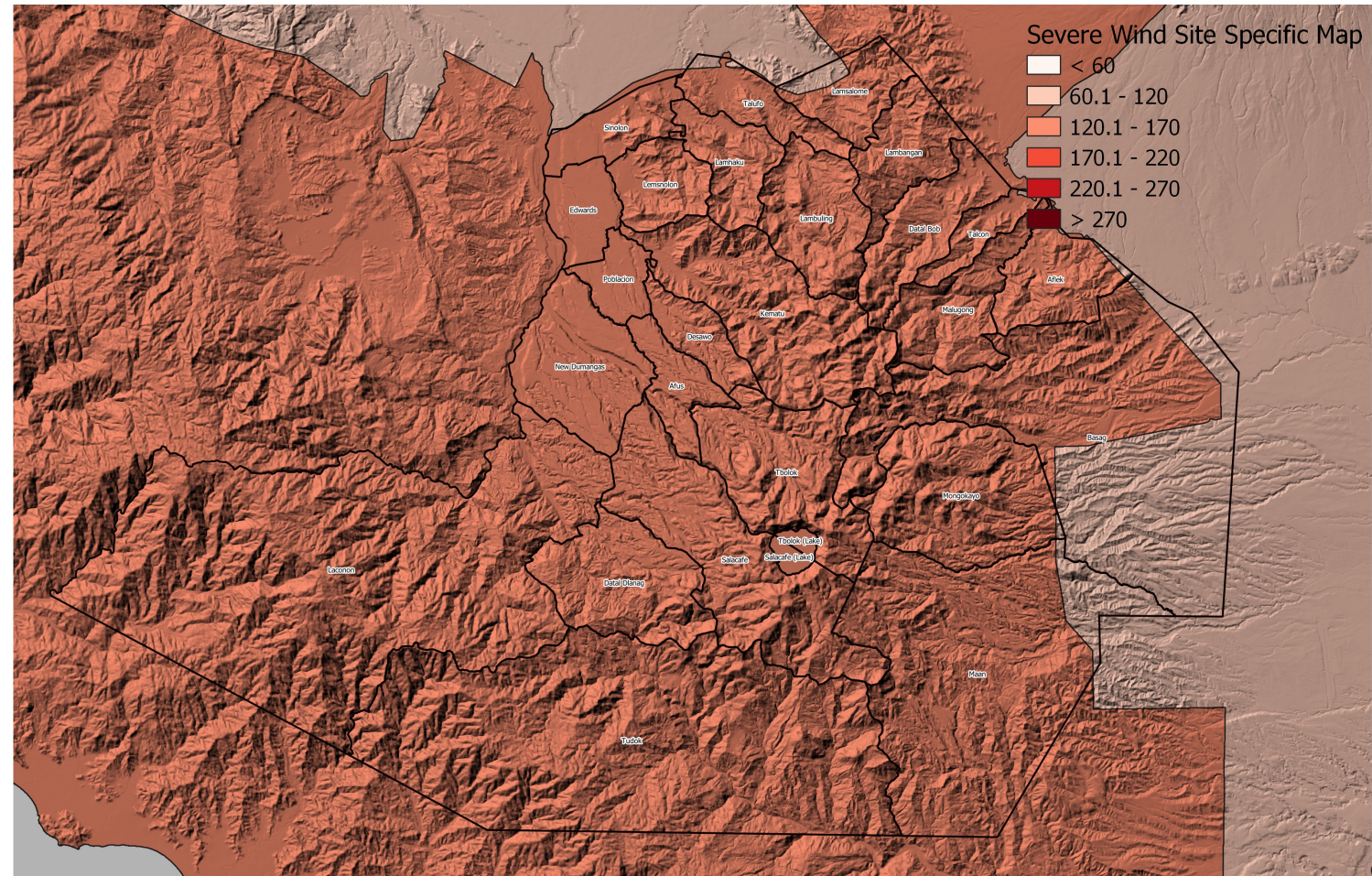


YEAR	MONTH	TYPE	TC NAME	PAR BEG	PAR END	MSW
1970	10	STY	TITANG	10/16/1970	10/22/1970	251
2013	2	TD	CRISING	2/18/2013	2/21/2013	45
2019	3	TD	CHEDENG	3/17/2019	3/19/2019	45

Climap Severe Wind Hazard Data

Site Specific Severe Wind Hazard Map (20- year Return Period)

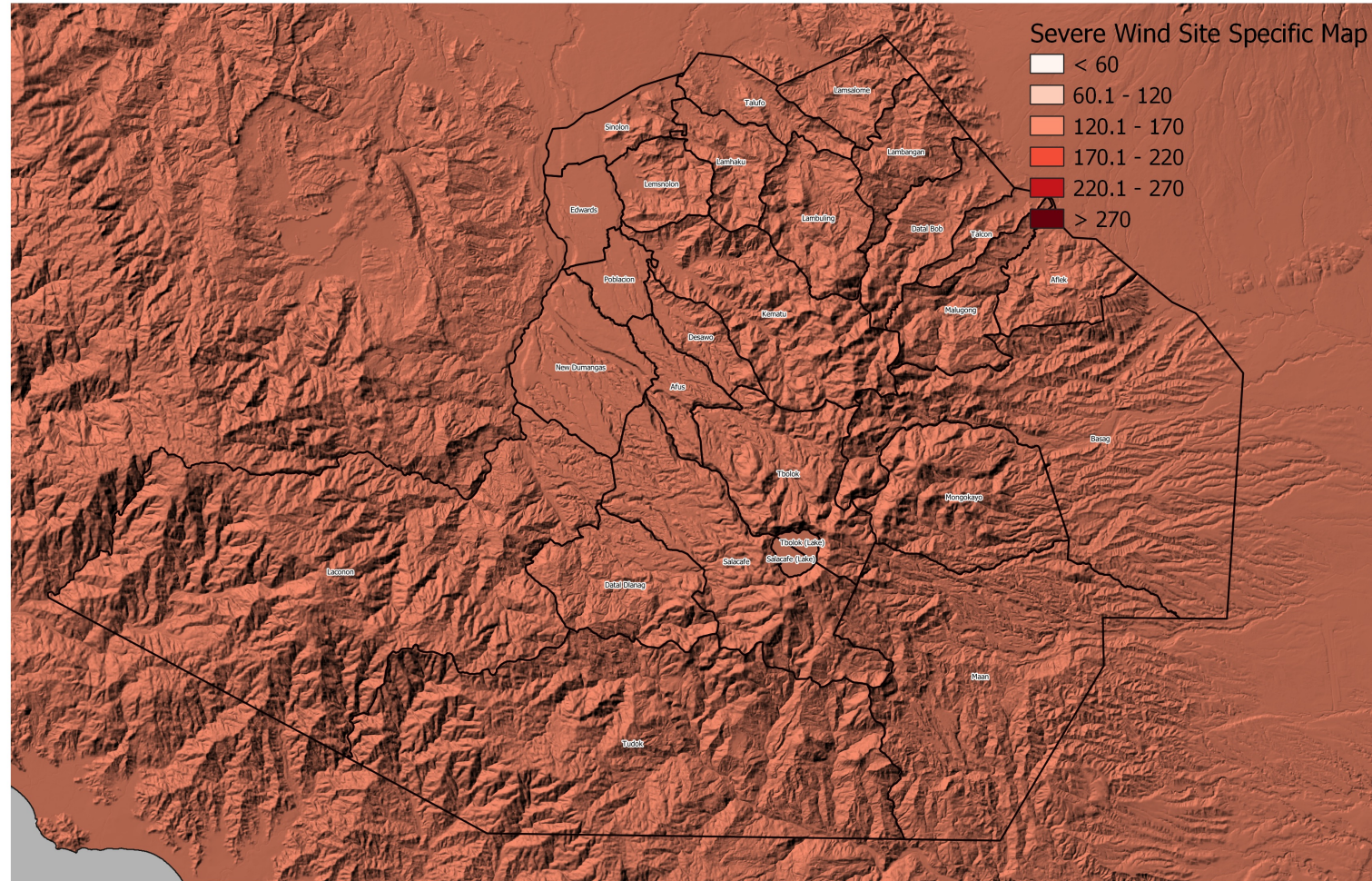
- A huge part of T'boli has a 5% chance in any given year, or at least once in every 20 years, that a severe wind reaching 120kph to 170kph could occur.



Severe Wind Site Specific Hazard Map (20-year Return Period)

Site Specific Severe Wind Hazard Map (50- year Return Period)

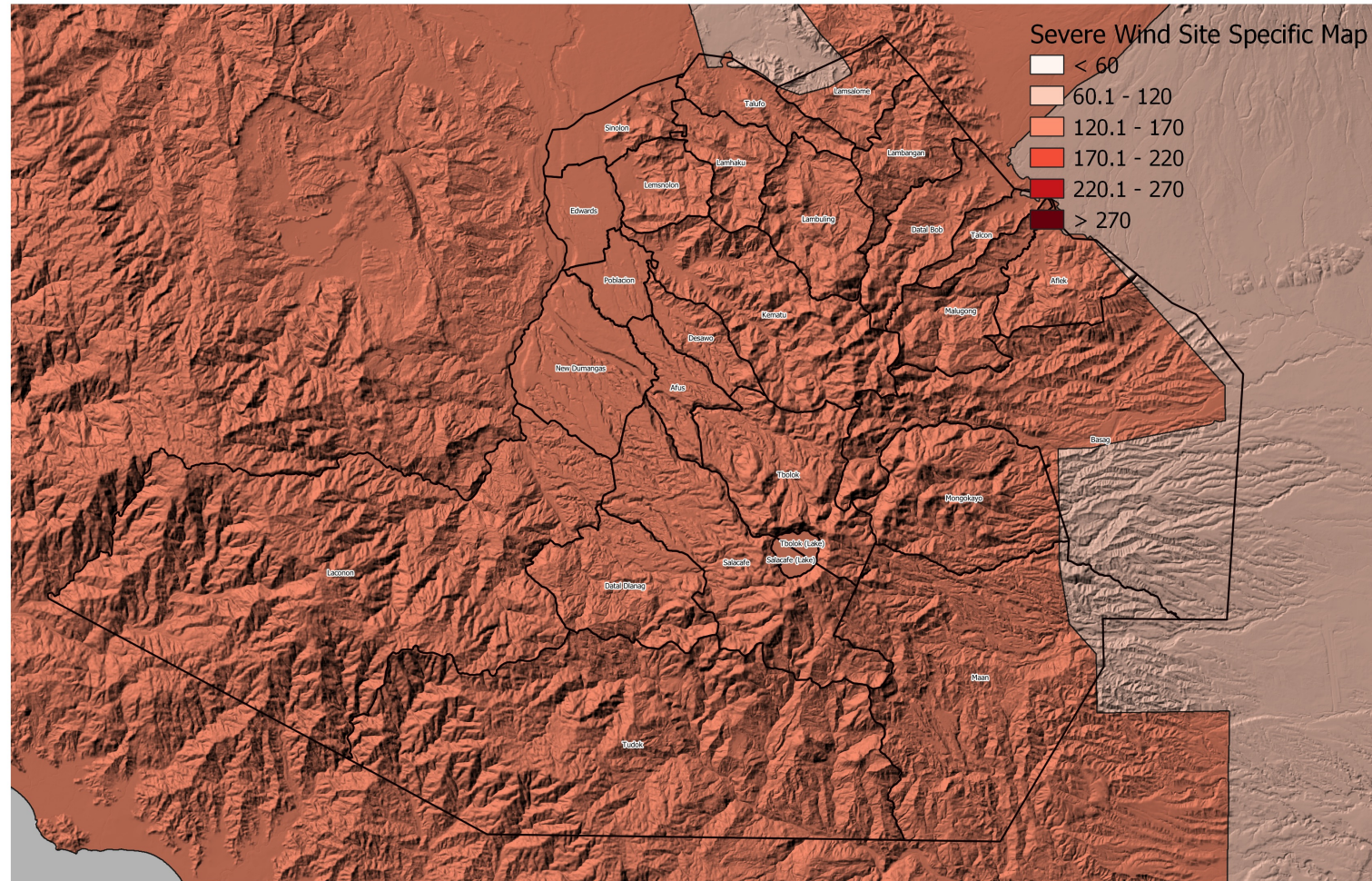
- The whole municipality of T'boli has a 2% chance in any given year, or at least once in every 50 years, that a severe wind reaching 120kph to 170Kph could occur.



Severe Wind Site Specific Hazard Map (50-year Return Period)

Site Specific Severe Wind Hazard Map(100- year Return Period)

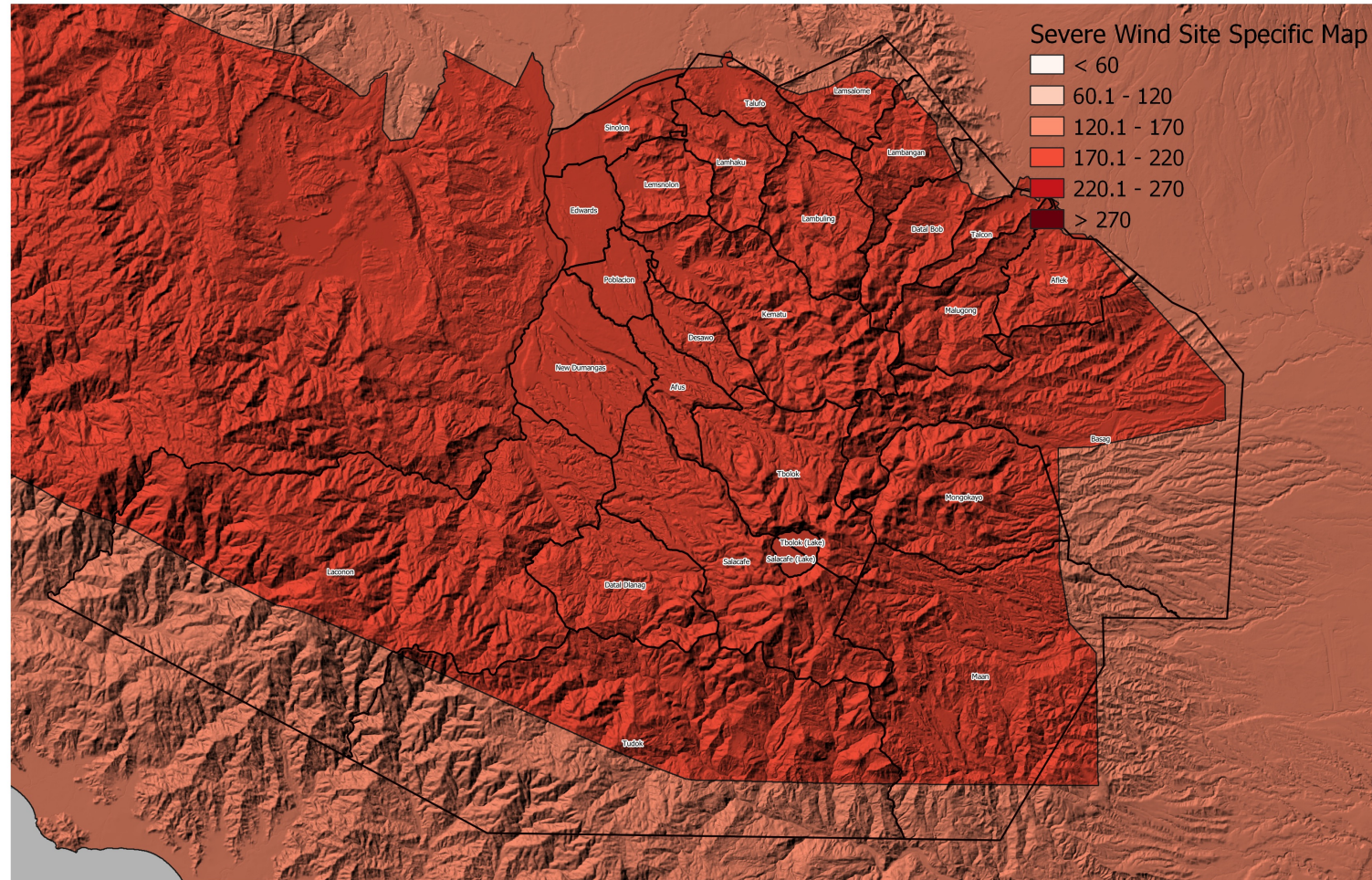
- A huge part of T'boli has a 1% chance in every given year that a wind with a speed of 120kph to 170kph would occur.



Severe Wind Site Specific Hazard Map (100-year Return Period)

Site Specific Severe Wind Hazard Map (200- year Return Period)

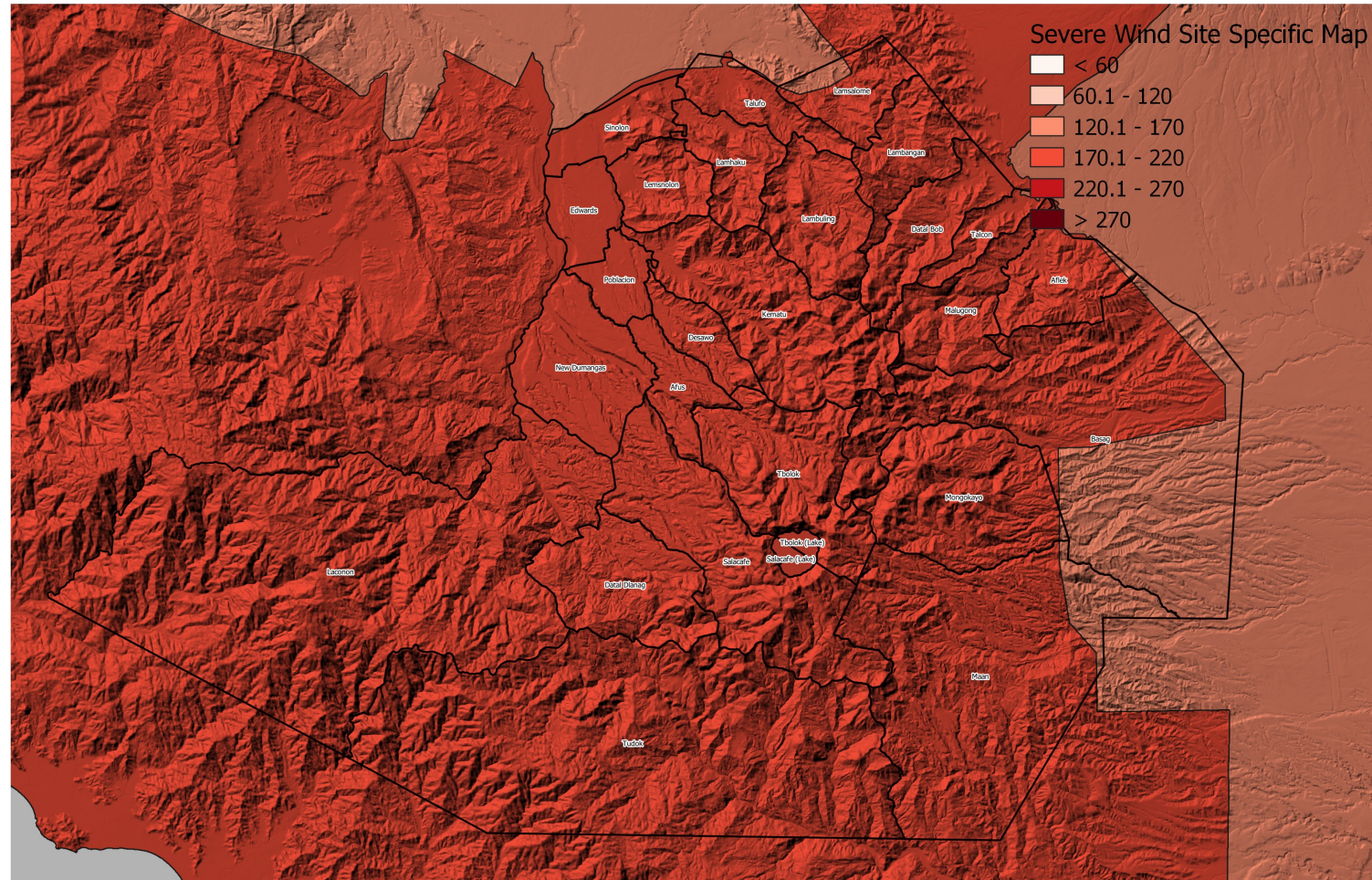
- There is a 0.5% chance in any given year or once in every 200 years that a severe wind with a speed of 170kph to 220kph would occur over a huge part of T'boli.



Severe Wind Site Specific Hazard Map (200-year Return Period)

Site Specific Severe Wind Hazard Map (500- year Return Period)

- There is a 0.2% chance in any given year or once in every 500 years that a severe wind with a speed of 170kph to 220kph would occur over a huge part of T'boli.



Severe Wind Site Specific Hazard Map (500-year Return Period)