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EFFECT OF MONSOONAL TRANSITION OF WIND FLOW PATTERN OF CAUVERY DELTA ZONE- A CASE STUDY

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ABSTRACT

The transition of monsoonal onset is often demarcated by distinct variation of different meteorological parameters, namely, wind-speed, wind direction, Relative humidity and Air Temperature. In fact, with the change in regional and global climate, the specific variation of these parameters can be used for monsoon-transitional diagnostic benchmark. The present research work is based on analysis of selected climatic parameters in the deltaic zone of Thanjavur to track their distinct variability to evaluate possible monsoonal transition, which plays a crucial role in updating agro-almanac to suit the contemporary climatic variations. The study involved use of IOT-based automated weather station located at PRIST University campus of Thanjavur, recorded at an hourly periodicity. The air temperature and humidity showed a distinct higher in morning hours and lower in afternoon hours during pre-monsoon phase (i.e., July-Aug), in comparison to monsoonal phase (i.e., Aug-Sept.), whereas the wind velocity showed just the opposite trend and the transitional time is found to be between 6:00 Hr to 10:00 Hr. Dominant wind direction has been observed to have a northern twist during noon hours and southern twist during afternoon and night hours during July-August, compared to August-September, although during both phase, it remained predominantly westerly.

Keywords: Wind Direction, Humidity, Air Temperature, Monsoon Transition

1. INTRODUCTION

The initiation of the atmospheric processes can be traced back to transitional weather conditions, as described by weather parameters, namely, temperature, winds, pressure, precipitation, humidity and so forth **[1]**. Wind energy is a well-known renewable energy source and has been used worldwide due to its advantages of clean, renewable, and large reserves **[2–4]**. Wind rose for a given region forms a standard graphical representation of percentage frequency distribution of different wind speeds and directions and often used in locating industry or industrial area, identification of measure impact area for development of master plan, optimizing the concept of industrial zoning, urban planning in respect of alignment of roads, location of parks and urban infrastructure, optimizing the vertical to horizontal expansion of the city and concreting to non - concreting surface area, determining the atmosphere stability, disaster management, and even in overall planning and development of social forestry and greenbelt development having regard to aero- dynamics and so forth **[5-7]**. Wind roses, being a reflection of the dominant transport direction of the winds for an area, is also influenced by local terrain, possible coastal effects, the exposure of the instruments, and the temporal variability of the wind and hence, may not always be representative of true transport for an area. Therefore recent trends in air temperatures ranging from regional to continental to global are also employed for better interpretability of wind-rose statistics **[8-10]**. The wind speed probability density distribution can be used to estimate wind power density **[11, 12]** and can also be applied to determine the most dominant wind direction **[13–15]**.

The objective of the paper is to utilize the wind-rose pattern augmented with selected other meteorological parameters (namely, air temperature-min & max, wind speed-min & max, wind direction & relative humidity) in order to detect the monsoonal transition.

2. MATERIAL AND METHODS

2.1. Climatic Data procurement and preparation:

The climatic data obtained through Ethernet and data logger by the wind sensors installed on the Automatic Weather Station (AWS) Tower, Centre for Research and Development, PRIST Deemed University, Thanjavur, Tamilnadu, India. The data was converted from csv-file to excel-file, and checked against the missing data and outliers, substituted by the average of the temporally adjacent data (i.e., before and after).

2.2. Preparation of Wind-Rose Diagram:

Hourly wind data (i.e., wind direction and wind speed) obtained from AWS, has been compiled for three months (July2019 to September 2019). Then using WR-PLOT (version. 8.02) the wind-rose was prepared separately for 12 July-11 Aug and for 12August-11 Sep. 2019, ***because of high consistent rainfall recorded during transition of these period***, indicating monsoonal transition.

3. RESULTS AND DISCUSSION

3.1. Distribution of Wind Speed

The wind rose **(Figure 1 and 2)** shows the distribution of wind speed and direction with regard to pre-monsoon (July-August) and during onset of monsoon phase (August-September). Most of the wind distribution is found in north western quadrant followed by south western quadrant thereby denoting the predominant wind direction to be westerly. Thus there is no drastic change in wind direction during onset of monsoon. However the highest wind speeds shows relative reductions during monsoon phase compared to pre monsoon phase.

The resultant vector combines the frequency of winds in each direction to get an "average" wind direction **(Figure 1and Figure 2)**. The direction of resultant vector is 308^o representing the mean resultant vector-59% on July to August and for the month of August- September, the resultant vector is 302^o representing the mean resultant vector-66%.

The frequency distribution plot displaying the normalized frequency of occurrences of winds in each direction sector and each wind speed class **(Figure 3)**.

3.2. Variation of Minimum and Maximum Air temperature

Table 1 illustrates the average maximum and minimum air temperature in study area for particular monthly series. (July – September 2019). According to Kendrew, deforestation leads to decrease the minimum temperature as in the case of desert. But where other factors, e.g. urbanization, industrialization etc. are more effective than deforestation, in those places minimum temperature trends to increase **[9]**. The average minimum temperature 31.16^{o}C on July - August 2019 and 30.22^{o}Con August –September and the calculated maximum temperature during July - August 2019 is 31.45^o and 30.49^{o}duirng August –September. The highest temperature is noted on August as 39.4^{o}C **(Figure 4)**.

3.3. Relative Humidity

Analysis of the monthly wise humidity data from July – September 2019 indicated that the highest humidity percentage at 96.8 during 2nd August, 2019. Monthly mean relative humidity have significant relations with temperature, elevation, and longitude in the study area. **Table 1** summarizes the monthly mean values of temperature and each humidity variable over the study area, based on the hourly data. The highest average percentage of the relative humidity is 73.0 on July 2019. Humidity variable is also the appropriate variable with which to quantify the effects of humidity on incoming longwave radiation (i.e., the greenhouse effect of water vapour) **[10, 11]**. The difference between the relative humidity higher than the September 2019.In the year of 2019 September noted that maximum relative humidity percentage is 78.0.

3.4 Wind speed and direction variation

The wind speed is divided in to two categories based on the monsoon which is July-August and August- September. The average wind speed on July 8.07 m/s which represents calms windy is percentage about 14.88. Further wind speed in average was calculated on August to September that is 7.88 m/s and calms windy percentage is 13.65.

3.5 Humidity variation

Humidity variable is also the appropriate variable with which to quantify the effects of humidity on incoming longwave radiation (i.e., the greenhouse effect of water vapour) (e.g., **[10, 11]**. The difference between the relative humidity higher than the September 2019.In the year of 2019 September noted that maximum relative humidity percentage is 78 **(Figure 7)**.

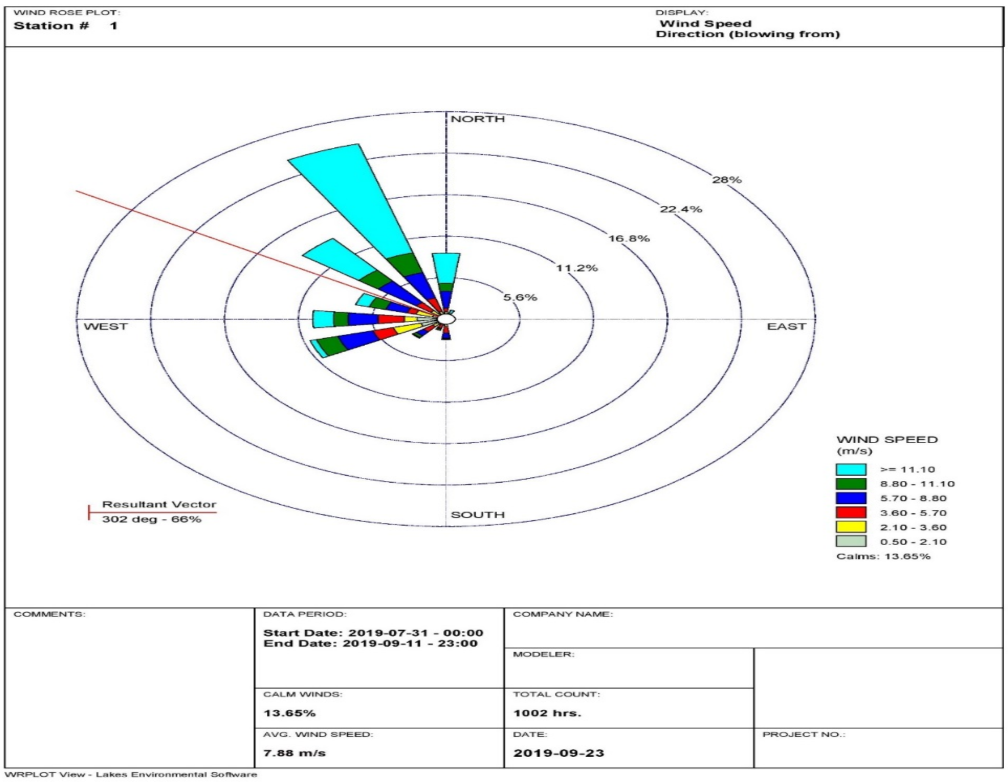

Figure 1: Wind Rose Plot for the data July to August 2019

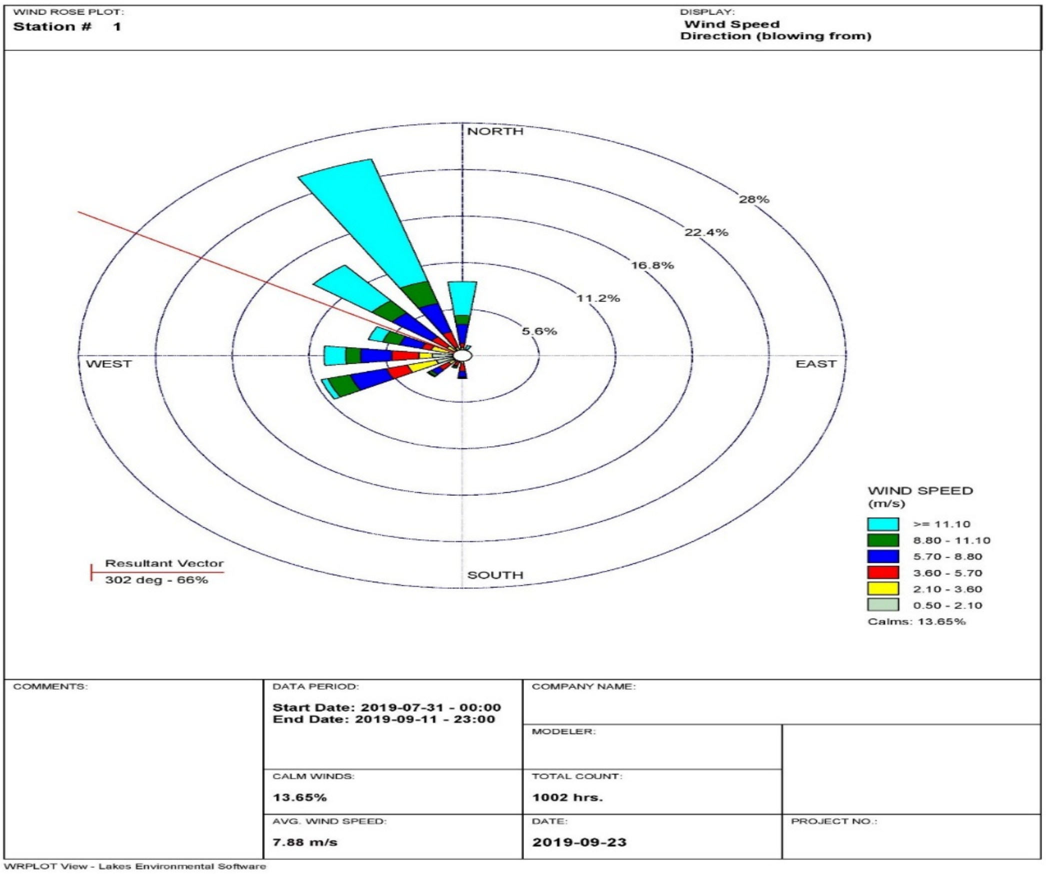

Figure 2: Wind Rose Plot for the data August to September 2019

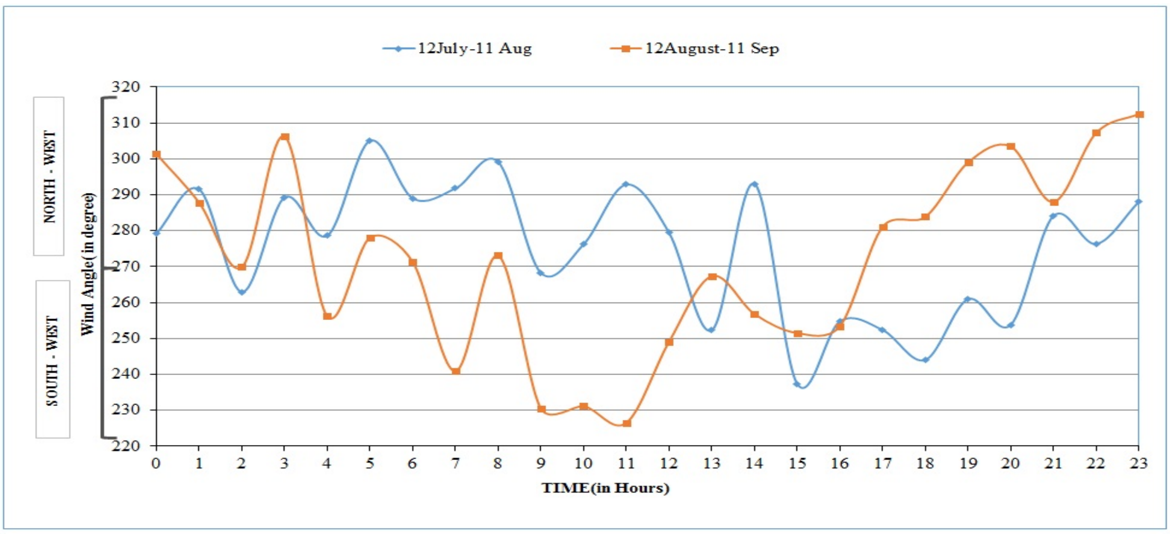

Figure 3: Wind Class Frequency Distribution

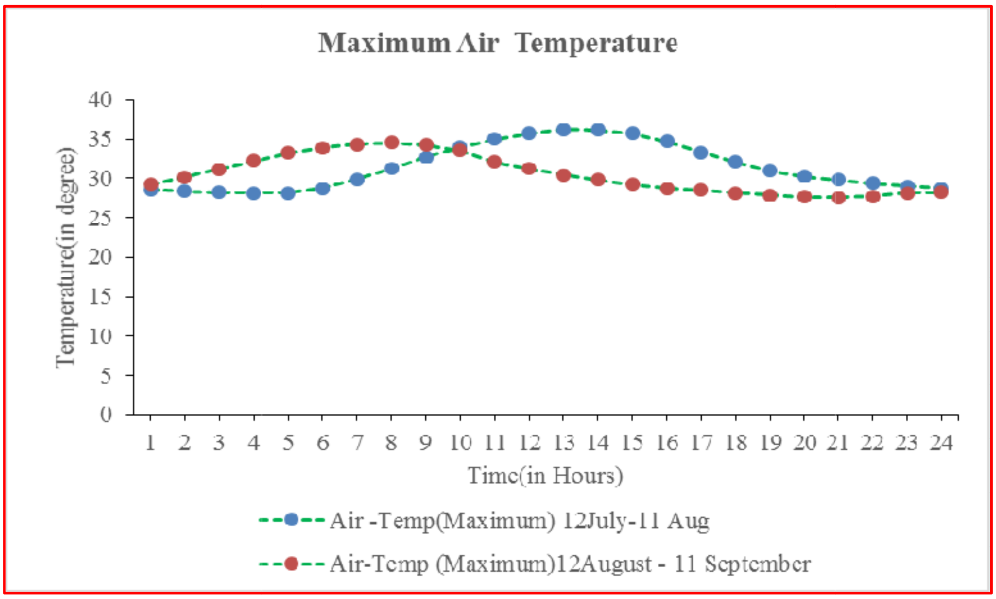

Figure 4: Minimum and Maximum Temperature variation during the study period

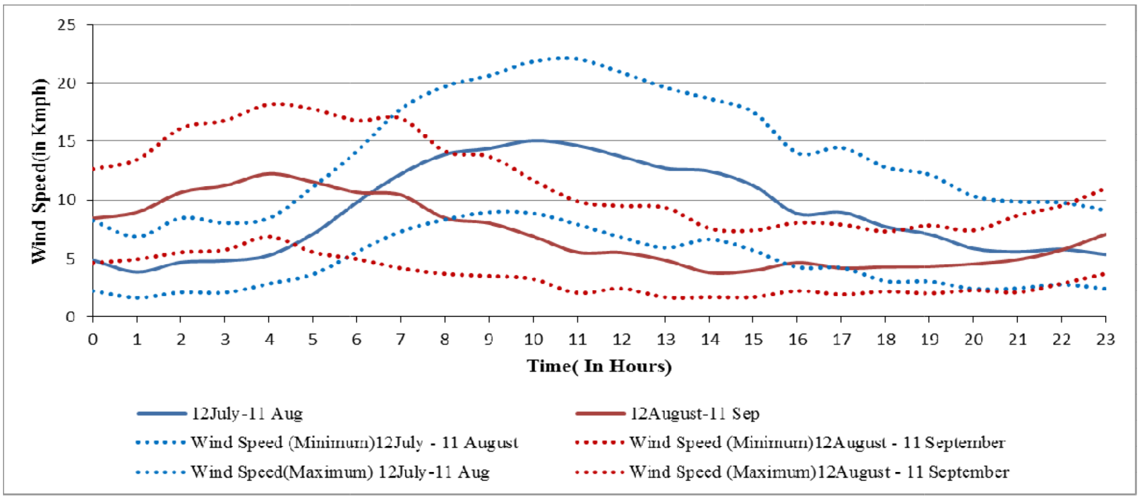

Figure 5: Wind speed variation during the study period

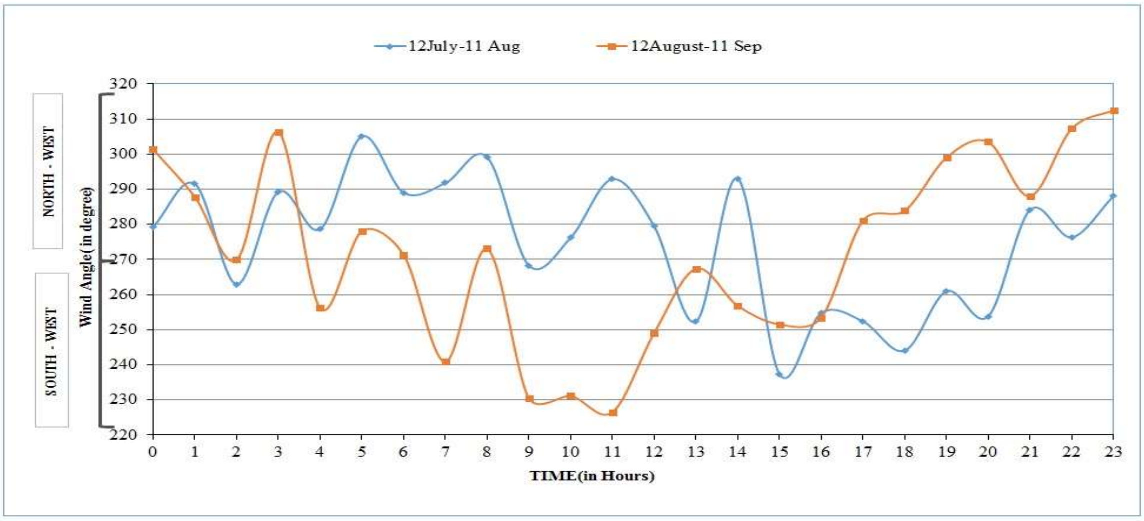

Figure 6: Wind direction variation during the study period

Table 1: Seasonal Variation of Selected Meteorological parameters at the study area

Hours	Wind speed (kmph)						Air Temp. (deg C)		Wind direction (degree)		Relative Humidity (%)	
	(12July- 11 Aug)		(12August- 11 Sep)		(12July- 11 Aug)		(12August- 11 Sep)		(12Aug- 11 Sep)	(12Aug- 11 Sep)	(12July- 11 Aug)	(12August- 11 Sep)
	Min	Max	Min	Max	Min	Max	Min	Max				
0	2.3	4.6	8.2	12.6	28.4	29.0	28.5	29.2	279.2	301.3	73.0	71.5
1	1.7	5.0	6.9	13.4	28.3	29.8	28.4	30.1	291.5	287.8	72.6	67.9
2	2.1	5.5	8.5	16.1	28.1	30.9	28.2	31.2	262.9	269.9	72.1	63.8
3	2.1	5.7	8.0	16.8	28.0	31.8	28.1	32.2	289.2	306.3	71.7	59.9
4	2.9	6.9	8.5	18.2	28.0	32.9	28.1	33.3	278.6	256.1	71.8	56.0
5	3.7	5.5	11.1	17.8	28.4	33.5	28.7	33.9	305.0	278.1	69.8	53.5
6	5.6	5.0	14.2	16.8	29.5	34.0	29.9	34.3	289.0	271.3	65.3	52.9
7	7.3	4.2	17.8	17.0	30.8	34.0	31.2	34.6	291.7	240.9	59.9	52.8
8	8.3	3.7	19.7	14.1	32.4	33.9	32.8	34.3	299.1	273.0	54.7	53.5
9	8.9	3.5	20.7	13.7	33.6	33.0	34.0	33.6	268.2	230.5	50.5	58.2
10	8.9	3.3	21.9	11.7	34.6	31.7	35.0	32.1	276.2	231.2	47.0	64.3
11	7.9	2.1	22.1	9.9	35.3	30.9	35.7	31.2	292.9	226.5	44.9	68.4
12	6.8	2.4	20.9	9.5	35.8	30.2	36.2	30.5	279.4	249.1	42.6	70.5
13	5.9	1.7	19.6	9.3	35.6	29.5	36.1	29.8	252.3	267.3	43.2	72.0
14	6.6	1.7	18.7	7.6	35.3	28.9	35.7	29.2	293.0	256.8	45.2	75.4
15	5.7	1.7	17.5	7.4	34.2	28.5	34.7	28.7	237.4	251.5	49.5	76.2
16	4.3	2.2	14.0	8.1	33.0	28.3	33.3	28.5	254.7	253.4	55.2	76.7
17	4.2	1.9	14.5	7.9	31.7	28.0	32.1	28.1	252.4	281.0	60.4	77.8
18	3.1	2.2	12.8	7.3	30.6	27.8	30.9	27.9	244.0	283.8	65.4	77.0
19	3.1	2.0	12.2	7.8	30.0	27.5	30.2	27.6	260.9	299.0	68.0	77.7
20	2.5	2.3	10.3	7.4	29.6	27.4	29.8	27.5	253.8	303.4	69.2	78.0
21	2.5	2.1	9.9	8.7	29.3	27.5	29.4	27.7	284.1	288.0	70.5	77.8
22	2.8	2.9	9.8	9.5	28.9	27.9	29.0	28.1	276.3	307.2	71.4	76.0
23	2.5	3.7	9.1	11.0	28.6	28.4	28.7	28.2	279.2	301.3	71.5	75.8

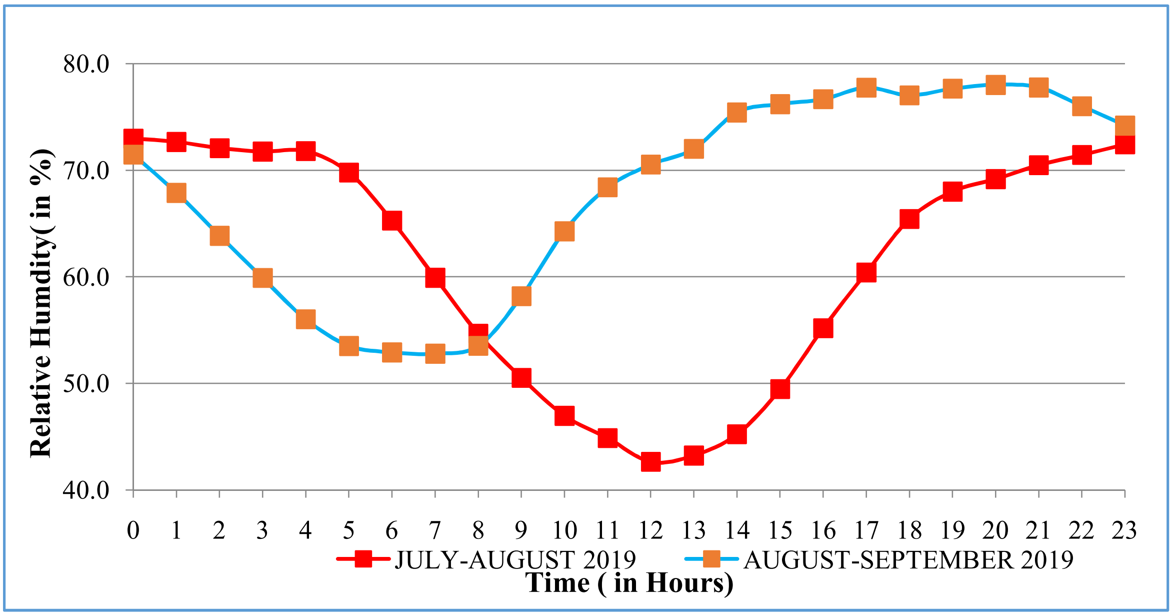

Figure 7: Relative humidity variation during the study period

4. CONCLUSION

The study revealed a distinct variation of wind rose during July-Aug and Aug-Nov pattern, the former being with higher wind speed pattern (amplitude and duration) than the latter, although the predominant direction had been mostly westerly (i.e., mostly NW and to a less degree SW). Interestingly, the dominant wind class in all the duration under study are mostly greater than 11.1m/s, which is almost double of the second-highest wind classes (i.e., 5.7 to 8.8 m/s and calms or lesser than 0.5 m/s). The minimum and maximum air-temperature are found to follow the similar profile, yet characteristically air temperature is found to be cooler during morning hours (0:00 hr to 10:00 hr) and higher during afternoon (10:00 hr to 0:00 hr) during Pre-monsoon phase (July-August) compared to during monsoon-phase (August-September). The similar trend is observed with respect to wind speed, i.e., higher in morning hours and lower in afternoon hours during July-Aug, in comparison to Aug-Sept., though the transitional time is 6:00 Hr to 7:00 Hr, instead of 10:00 Hr. However, in relation to relative humidity, the trend is reversed, i.e., lower in morning hours and higher in afternoon hours during July-Aug, in comparison to Aug-Sept., though the transitional time is about 8:00 Hr. Although the wind direction has been unsteady, yet overall show northern twist during noon hours and overall southern twist during afternoon and night hours during July-August, compared to Aug.-Sept. Thus, the variability of the seasonal and diurnal pattern of wind, temperature and humidity can be used as demarcation of monsoonal transition, thereby utilize the classification for various logistic and developmental activities.

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