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Development of wind rose diagrams for Kadapa region of Rayalaseema

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Abstract: An air quality management is of paramount importance to protect man, domestic animals, crops and materials from damaging exposure to air pollution and requires reliable information on air quality to be collected, analyzed and evaluated. Further, it is necessary to know the trends in air quality for effective regulation. Air pollution processes vary in time and space according to their transport, dispersion, Development of wind rose diagrams for coal used thermal power plant Kadapa removal, etc. based on meteorological aspects. Wind Rose diagrams represent two-way joint distribution of wind direction and wind speed.
This paper presents the development of wind rose diagrams for different environmental applications and to understand the distribution pattern of air pollutants discharged from Rayalaseema Thermal Power Project (scope of 14°42'52"N and longitude of 78°27'29"E) VV Reddy Nagar, Kadapa, and Andhra Pradesh, India.
Keywords: Ambient Air quality; contaminants; Meteorology; Power plant; Wind speed; Wind direction.

1. Introduction:

A wind rose depicts the frequency of incidence of winds in each of the particular wind direction sectors and wind speed modules for a predetermined site and time period[1]. The most regular structure comprises of a circle from which eight or sixteen lines come out, one for each direction. The length of each line is similar to the occurrence of wind from that direction and the occurrence of calm conditions is entered in the centre. Wind roses may be depicted in several ways. Some point out the range of wind speeds from each direction, and some indicate wind direction with other meteorological conditions.

Wind rose are widely used and has applications in the fields such as environmental impact assessment, industrial emissions measurements, oceanography, wind energy, agriculture engineering, ambient air monitoring, air quality measurements, indoor air quality testing, air dispersion modeling [3], noise impact modeling and soil impact modeling (India Meteorological Department). Development of wind rose diagrams are essential to know the distribution pattern of wind direction and wind speed and are used in this project to study dispersion of criteria air pollutants emitted from Rayalaseema Thermal Power Project.

2. Methodology

Wind rose may be constructed from the data obtained over a given time period such as a particular month or season or a year. In constructing or interpreting wind roses, wind direction[7] refers to the direction from which wind is blowing. A line or bar extending to the north on the wind rose indicates the frequency of

winds blowing from the north. Wind rose diagram is prepared using an appropriate scale to represent percentage frequencies of wind directions and appropriate index shades, lines, and so on to represent different wind speeds.

Wind roses provide concise and meticulous data of wind velocity and direction at a site. Obtainable in a circular design, the wind rose shows the occurrence of winds blowing from meticulous directions[5]. The extent of each "spoke" around the circle is associated to the occurrence of period that the wind blows from a meticulous direction. Every concentric circle represents a dissimilar frequency, excluding from zero at the centre to developing frequencies at the external circles. Wind roses provide extra information (data), in that each spine is broken down into separate frequency categories that explain the percentage of time that winds blow from that direction and at definite speed ranges. Wind roses generally use 16 basic directions, such as north (N), (NNE), (NE), and so on[5].

Wind roses were constructed for Kadapa station for all the months using *Lakes Environmental Software* said to be WR-PLOT.

Main features

- Rapid and simple visualization of the given meteorological data. this is an outstanding method to precisely express huge amounts of wind data and performs excellent.
- Evaluate rapidly the given meteorological data to a) Wind rose plots b) Frequency distribution tables c) Wind Class frequency distribution graphs
- General file formats are supported; and for those that are not, an Import from Excel utility allows simple importing.
- Permits for simple export of wind roses to Google Earth, and have complete control of:

  a) Colours b) opacity c) maximum radius d) height

Working

Wind Rose can read the data from files consisting data in columns in accepted format. A minimum of five columns of data are essential to run the program: wind velocity, wind direction, hour, day, month, and year. With hour, day, month, and year many formats are accepted[7]. if cloud cover, precipitation, cloud height, stability class, temperature, pressure and relative humidity are recorded, suitable analysis is performed (www.symmetron.gr).

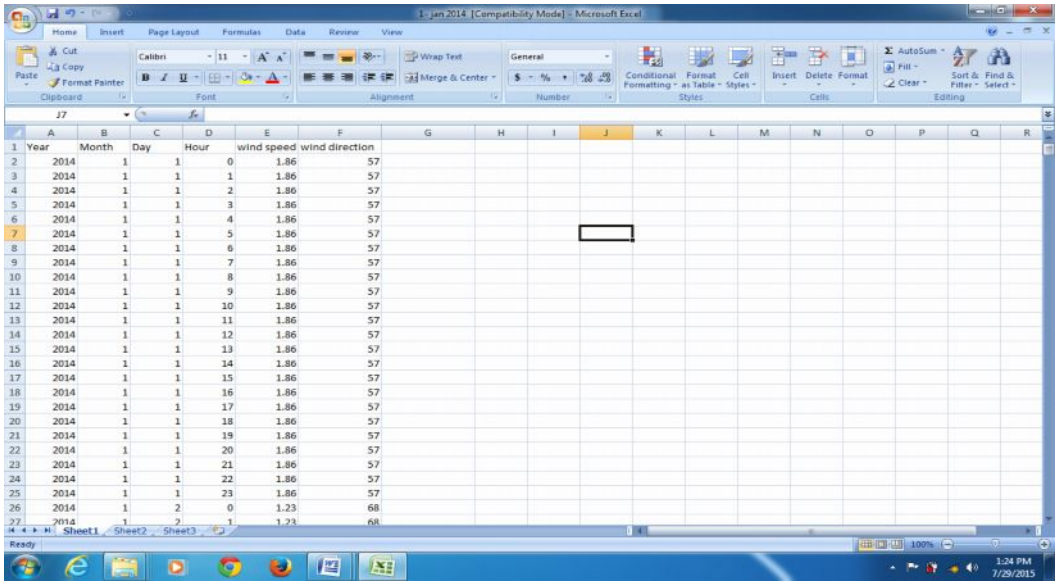
Input data

The essential parameters used by WR-PLOT View comprise the following (faculty.washington.education):

- Surface Station Id: The five digit number/name identifying the surface observation station.
- Year, Month, Day and time of Record: identifies the year, month, day and time for the period of which the meteorological data (Nasa.gov.in) were recorded. Only the last two digits of the year are reported. Time is on the basis of 24- hour clock and is recorded as 00 through 23.
- Wind Direction: from which direction the wind is blowing, based on the 360 point compass, e.g. 090=East, 180=South, 270=West, 360=North, 000=Calm.
- Wind Speed: the wind speed measured in knots (00=Calm).[3]

3. Meteorological data

The data required for the evolution of wind roses for Kadapa station is obtained from NASA Meteorological Department from January 2014 to December 2014(India solar radiation Department). Using monthly data of one year, wind roses are developed for every month.



Year	Month	Day	Hour	wind speed	wind direction
2014	1	1	0	1.86	57
2014	1	1	1	1.86	57
2014	1	1	2	1.86	57
2014	1	1	3	1.86	57
2014	1	1	4	1.86	57
2014	1	1	5	1.86	57
2014	1	1	6	1.86	57
2014	1	1	7	1.86	57
2014	1	1	8	1.86	57
2014	1	1	9	1.86	57
2014	1	1	10	1.86	57
2014	1	1	11	1.86	57
2014	1	1	12	1.86	57
2014	1	1	13	1.86	57
2014	1	1	14	1.86	57
2014	1	1	15	1.86	57
2014	1	1	16	1.86	57
2014	1	1	17	1.86	57
2014	1	1	18	1.86	57
2014	1	1	19	1.86	57
2014	1	1	20	1.86	57
2014	1	1	21	1.86	57
2014	1	1	22	1.86	57
2014	1	1	23	1.86	57
2014	1	2	0	1.23	68
2014	1	2	1	1.23	68

Fig 4.2. Meteorological data as input data in Microsoft excel

4. Output

Monthly wind rose diagrams generated for RTPP, Kadapa from January 2014 to December 2014 are shown below:

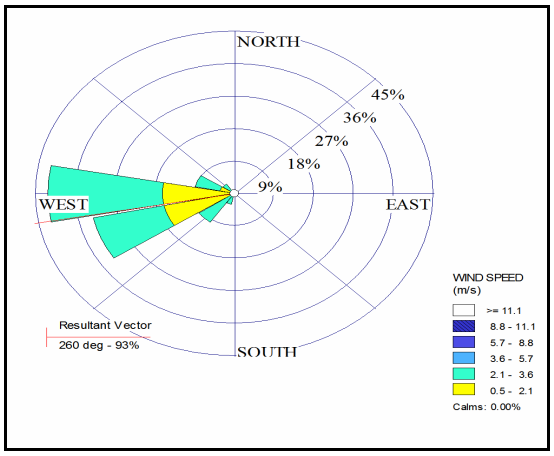


Figure 4.3 Wind Rose-January 2014

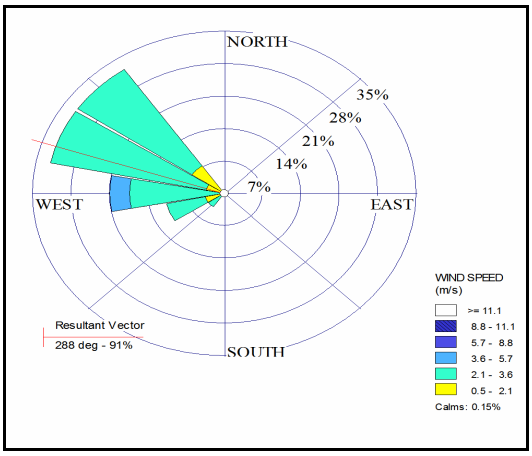


Figure 4.4 Wind Rose-February 2014

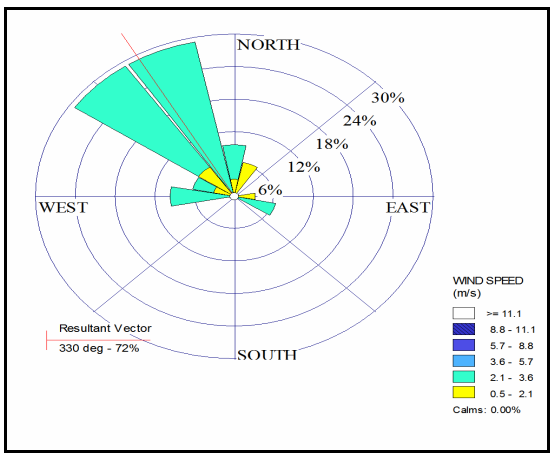


Figure 4.5 Wind Rose-March 2014

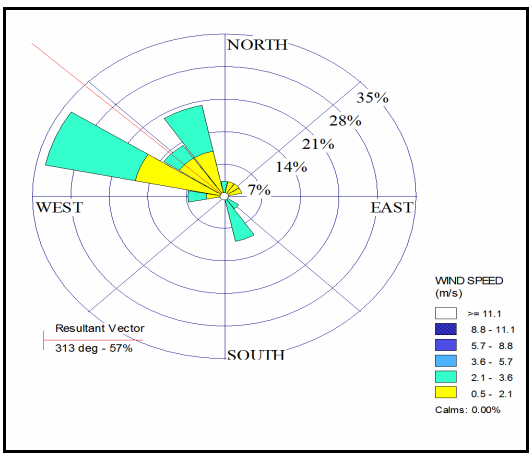


Figure 4.6 Wind Rose-April 2014

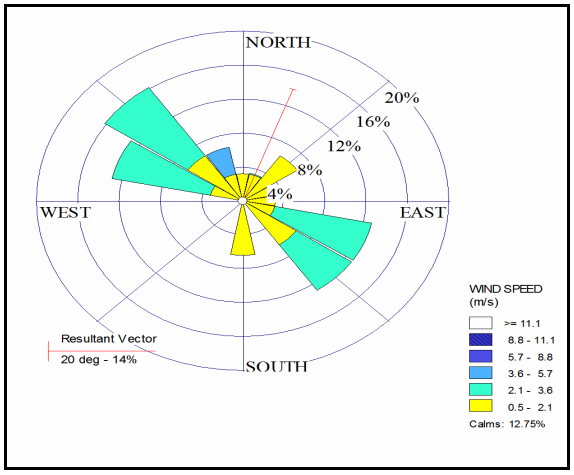


Figure 4.7 Wind Rose- May 2014

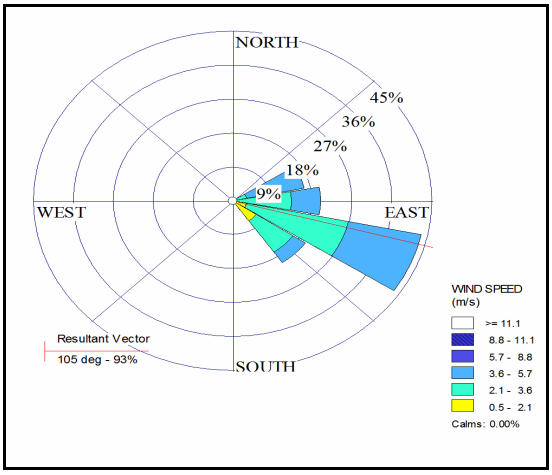


Figure 4.8 Wind Rose-June 2014

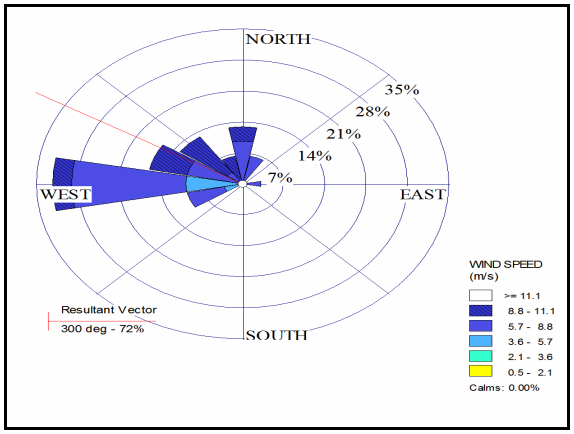


Figure 4.9 Wind Rose- July 2014

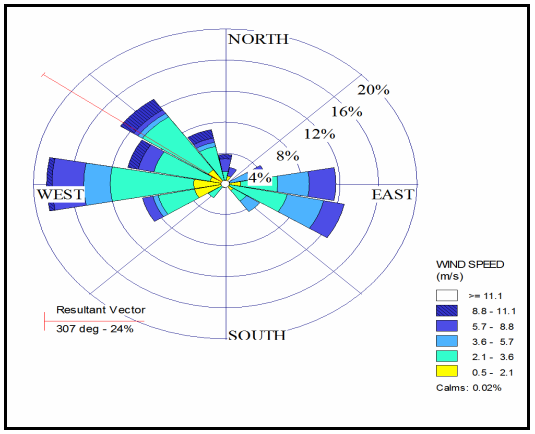


Figure 4.10 Wind Rose-August 2014

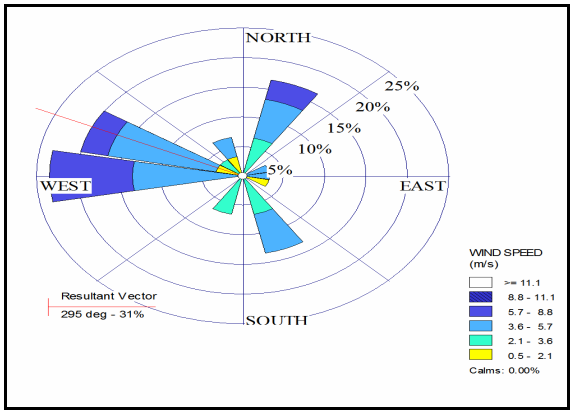


Figure 4.11 Wind Rose- September 2014

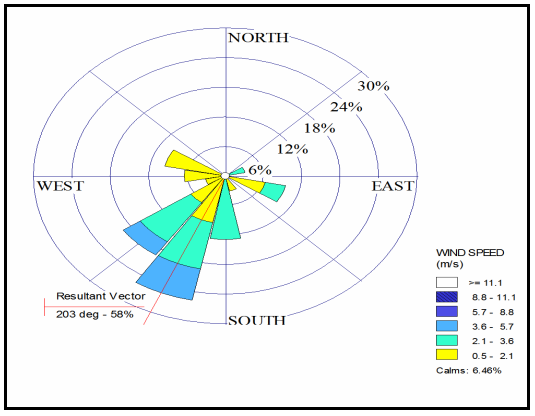


Figure 4.12Wind Rose-October 2014

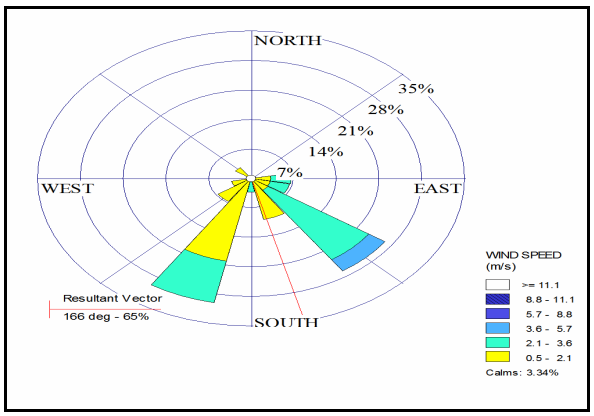


Figure 4.13 Wind Rose- November 2014

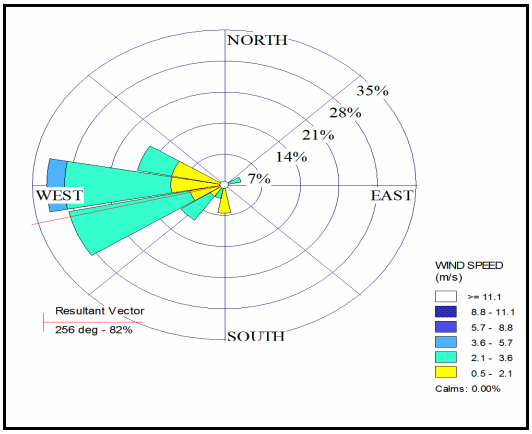


Figure 4.14Wind Rose-December2014

Conclusion:

wind rose have huge viable quality of predicting the typical trend of time – integrated ground level concentration due to emission from the source which is essential for air pollution management. Wind roses constructed for Kadapa station is appropriate to study the distribution pattern of pollutants namely SPM, SO_2, and NO_X for all the months from Rayalaseema Thermal Power Project which is the source of pollutants. Wind speed finds the moving time of an air pollutant from its source to a receptor and represent for the concentration of pollutant dispersion in the wind ward direction. Therefore the concentration of pollutants at any receptor is inversely proportional to the wind speed. Wind direction gives the direction in which a pollutant travels and which receptor is affected at a given time and place.

Pollution roses can be developed based on wind roses. Pollution rose explains the frequency distribution of wind direction temporally interrelated with a selected pollutant. This object may be used for research, training, and private consultation purposes.

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