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# Evolution of Wind Rose Diagrams for RTPP, KADAPA, A.P., India

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***Abstract:***
*An air quality management program requires reliable information on air quality to be collected, analyzed and evaluated. There is paramount need to protect man, domestic animals, crops and materials from damaging exposure to air pollution. In addition, it is necessary to know the trends in air quality so that control efforts can be regulated accordingly. Air pollution processes vary in time and space according to their transport, dispersion, removal, transportation etc. hence, it is necessary to know the processes in different scales based on meteorological aspects. Wind Rose diagrams represent the two - way joint frequency distribution of wind direction and any parameter under consideration.*
*This paper presents the evolution of wind rose diagrams for various environmental applications and to understand the distribution pattern of air pollutants emitted from Rayalaseema Thermal Power Project (latitude of 14°42'52"N and longitude of 78°27'29"E) VV Reddy Nagar, Kadapa, and Andhra Pradesh, India.*

***Key words:*** *Air quality; Meteorology; Wind direction; Wind velocity; Power project; pollutants*

## 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 specified site and time period (Md. Firoz Khan 2010) (Rao.M.N et al 1989). The most regular structure consists of a circle from which eight or sixteen lines come out, one for each direction. The length of each line is comparative to the occurrence of wind from that direction and the occurrence of calm conditions is entered in the centre. There are a lot of variations in the construction of wind roses. Some point out the range of wind speeds from each direction, and some indicate wind direction with other meteorological conditions.
The wind roses are widely applicable 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 (Lira et al 2012), noise impact modeling and soil impact modeling (India Meteorological Department).

## 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, it is necessary to keep in mind the meteorological convention that wind direction (Jan Curtis 2007) refers to the direction from which the wind is blowing. A line or bar extending to the north on the wind rose indicates the frequency of winds blowing from the north. The wind rose diagram is prepared using an appropriate scale to represent percentage frequencies of wind directions and appropriate index shades; lines etc., to represent various wind speeds.
A wind rose (Dan Reboussin 2005) gives a very concise but information-laden view of how wind speed and direction are usually spread at a meticulous site. Obtainable in a circular design, the wind rose shows the occurrence of winds blowing from meticulous directions. 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, emanating from zero at the centre to growing frequencies at the external circles. The wind roses revealed here have extra information, in that each spine is broken down into separate frequency categories that explain the percentage of time that winds blow from a meticulous direction and at definite speed ranges. All wind roses evolved here use 16 basic directions, such as north (N), (NNE), (NE), etc, (www.wcmaa-rc.comhtm). Wind

roses for all the months were constructed for Kadapa station. The software used to produce these high-class wind roses is consideration of Lakes Environmental Software and is said to be WR-PLOT.

*2.1. Main Features*

Rapidly and simply visualize the wind rose for the given meteorological data (Thoen et al 2011). This is an outstanding method to précis huge amounts of wind data, and performs excellent declaration.

Rapidly evaluate the given meteorological data in a lot of ways: a) Wind rose plots b) Frequency distribution tables c) Wind Class frequency distribution graphs

Every 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 (www.symmetron.gr).

*2.2. Working*

Wind Rose can read the data (Jan Curtis 2007) from files consists of data in columns; the majority of data-loggers accepted the output format. A minimum of five columns of data are essential to run the program: wind speed, wind direction, hour, day, month, and year. With hour, day, month, and year many formats are accepted. If cloud cover, precipitation, cloud height, stability class, temperature, pressure and relative humidity are recorded, the suitable analysis is performed (www.symmetron.gr).

*2.3. Input Data*

The essential parameters (faculty.washington.edu) used by WRPLOT View comprise the following:

Surface Station Number: the five - digit number/name identifying the surface observation station.

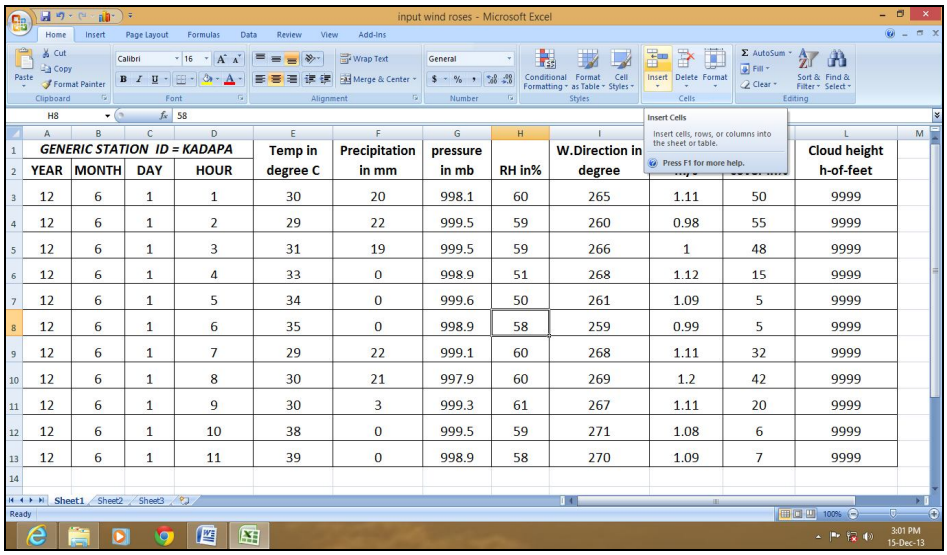
Year, Month, Day and Hour of Record: identifies the year, month, day and time for the period of which the meteorological data (tecnet0.jcte.jcs.mil/RCC/manuals/meteor/w.htm) were recorded. Only the last two digits of the year are reported. Time is on the basis of 24 - hour clock and is recorded as 00 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 (Lira et al 2012) measured in knots (00=Calm).

*2.4. Meteorological Data*

The data required for the evolution of wind roses for Kadapa station is obtained from India Meteorological Department from June 2011to May 2012 (India Meteorological Department). Using monthly data of one year, wind roses are developed for every month.

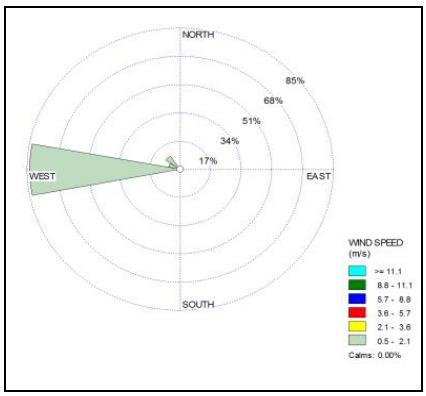


| GENERIC STATION ID = KADAPA | | | | Temp in | Precipitation | pressure | | W.Direction in | | | Cloud height |
|---|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | MONTH | DAY | HOUR | degree C | in mm | in mb | RH in% | degree | | | h-of-feet |
| 12 | 6 | 1 | 1 | 30 | 20 | 998.1 | 60 | 265 | 1.11 | 50 | 9999 |
| 12 | 6 | 1 | 2 | 29 | 22 | 999.5 | 59 | 260 | 0.98 | 55 | 9999 |
| 12 | 6 | 1 | 3 | 31 | 19 | 999.5 | 59 | 266 | 1 | 48 | 9999 |
| 12 | 6 | 1 | 4 | 33 | 0 | 998.9 | 51 | 268 | 1.12 | 15 | 9999 |
| 12 | 6 | 1 | 5 | 34 | 0 | 999.6 | 50 | 261 | 1.09 | 5 | 9999 |
| 12 | 6 | 1 | 6 | 35 | 0 | 998.9 | 58 | 259 | 0.99 | 5 | 9999 |
| 12 | 6 | 1 | 7 | 29 | 22 | 999.1 | 60 | 268 | 1.11 | 32 | 9999 |
| 12 | 6 | 1 | 8 | 30 | 21 | 997.9 | 60 | 269 | 1.2 | 42 | 9999 |
| 12 | 6 | 1 | 9 | 30 | 3 | 999.3 | 61 | 267 | 1.11 | 20 | 9999 |
| 12 | 6 | 1 | 10 | 38 | 0 | 999.5 | 59 | 271 | 1.08 | 6 | 9999 |
| 12 | 6 | 1 | 11 | 39 | 0 | 998.9 | 58 | 270 | 1.09 | 7 | 9999 |

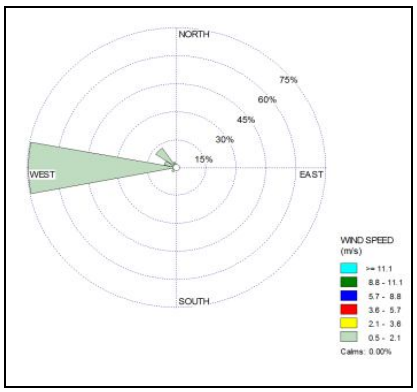
*Table 1: Meteorological Data as Input Data in Microsoft Excel*

*2.5. Output*

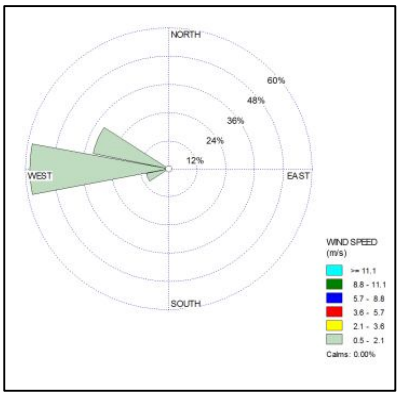
Monthly wind rose diagrams generated for RTPP, Kadapa station, A.P, India, from June 2011 to May 2012 are shown below:



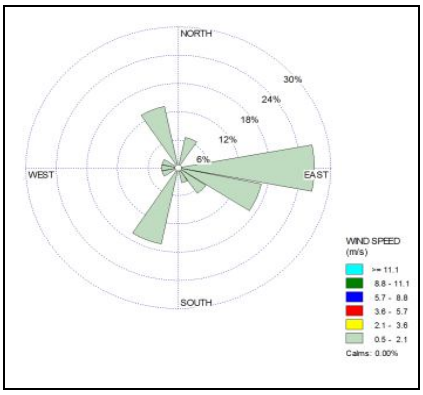

*Wind Roses - June*



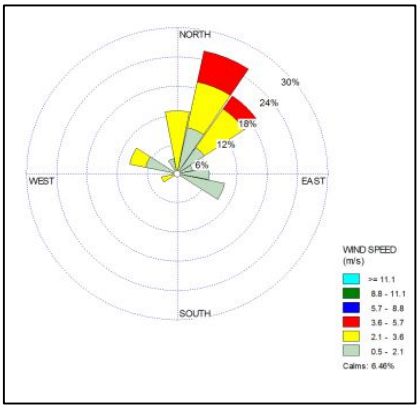

*Wind Roses - July*



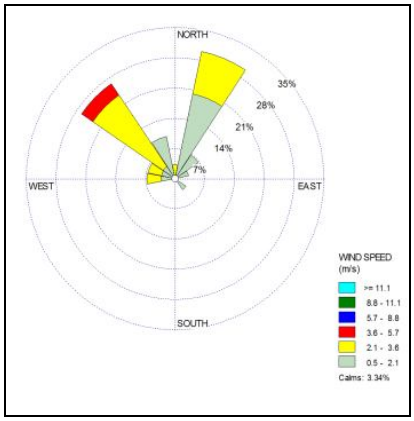

*Wind Roses - August*



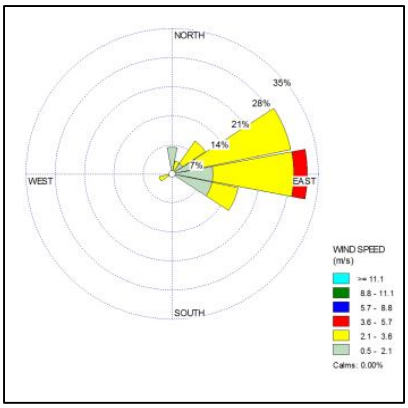

*Wind Roses – September*



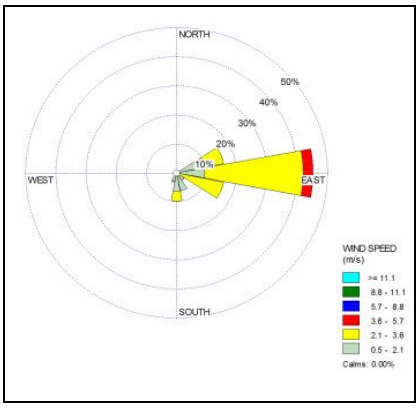

*Wind Roses - October*



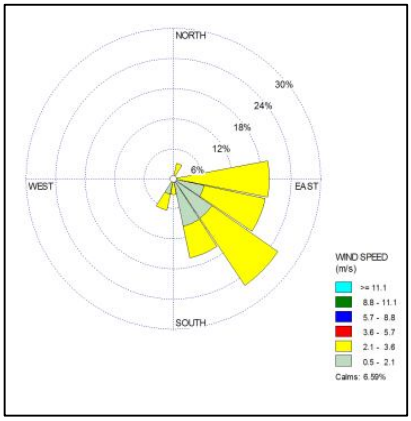

*Wind Roses - November*



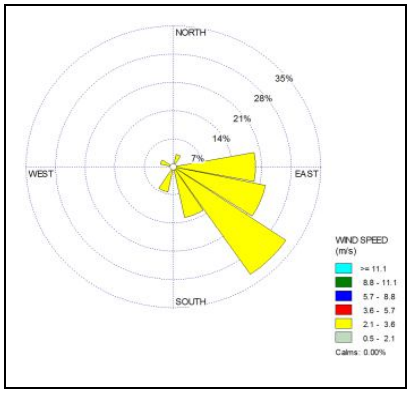

*Wind Roses - December*



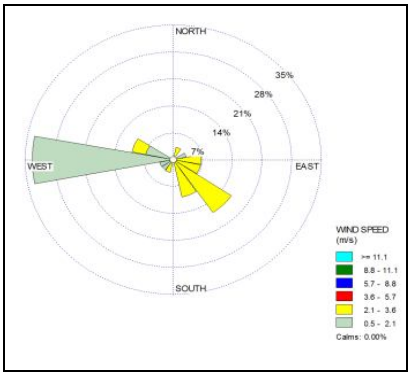

*Wind Roses - January*



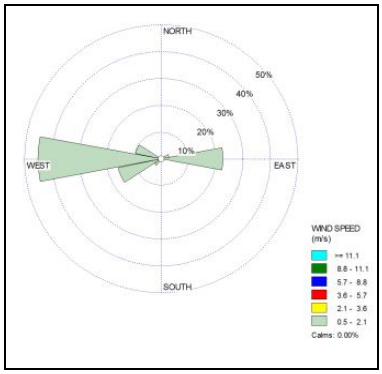

*Wind Roses - February*




*Wind Roses - March*




*Wind Roses - April*




*Wind Roses - May*

**3. Conclusion**

Rayala Seema Thermal Power Project Kadapa is the source of pollutants namely SPM, $SO_2$, $NO_X$ and CO. Wind roses constructed for Kadapa station is applicable to study the distribution pattern of pollutants for all the months. Wind speed finds the moving time of an air pollutant from its source to a receptor and account 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 can give in which direction a pollutant travels and which receptor is affected at a given time and place.

Pollution roses can be developed based on wind roses. The pollution rose is in essence of explain 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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