EVOLUTION OF ROSE DIAGRAMS
CHAPTER 5
EVOLUTION OF ROSE DIAGRAMS

5.1 Introduction

An air quality management program requires reliable information on air quality to be collected, analyzed and evaluated regularly and efficiently. There is paramount need to protect man and important domestic animals and crops 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, transformation etc. Hence, it is necessary to know the processes in different scales based on meteorological aspects [82]. Rose diagrams represent the two-way joint frequency distribution of wind direction and any parameter under consideration.

5.2 Wind rose diagrams

One of the most useful ways of expressing meteorology of airflow is in terms of wind roses [83], which depict the relative frequency with which the wind flows from various sectors around the compass. The wind directions were classified as eight directions namely N, NE, E, SE, S, SW, W, NW. If the observed wind direction is exactly 0 degrees, it refers to N and if it is between 0 to 90 degrees it refers to NE and so on. The wind speed less than 3.4 km/h has been termed as calm condition. The wind speed between 3.4 to 5.0 km/h has been grouped as I category, 5.0 to 10.0 km/h as II category and 10.0 to 15.0 km/h as III category.

The number of times a wind speed occurred in a particular wind direction is referred as frequency and the frequency tables for all the four seasons namely post monsoon, summer, premonsoon, monsoon for each station were generated using the C program [85] developed for this purpose. The program is given in
Appendix III. The frequency table for wind rose generated for Peelamedu in premonsoon season is given in Table 5.1 for example. Similar tables have been generated for all the seasons and for all the stations. Wind roses summarise the occurrence of winds at a location, showing their strength, direction, and frequency.

The percentage of calms was represented by the size of the center circle. If all the eight arms meet at the center it shows, that occurrence of calm condition was not observed. Each branch represents wind coming from that direction, with north to the top of the diagram. The branches were divided into segments of different thickness, which represent wind speed ranges from that direction. The length of each branch segment was proportional to the percentage of winds in that speed range, blowing from that particular direction.

5.3 Analysis of wind rose diagrams

The following observations were made with the help of wind rose diagram drawn for all the four seasons namely post monsoon, summer, pre monsoon, monsoon.

Peelamedu

The wind roses drawn for all the seasons are given in Fig 5.1 a. The prevailing wind direction in the post monsoon period was SW. The maximum wind speed range occurred in this direction was 5.0-10.0 km/h. The wind flow was not there in N, S, E, W directions. The maximum wind speed range in the NW direction was 10.0-15.0 km/h. The maximum wind speed range in the NE direction was 3.4-5.0 km/h. The maximum wind speed range in the SE direction was 5.0-10.0 km/h. The percentage of occurrence of calm condition was 5.88.

The prevailing wind direction in the summer period was SW. The maximum wind speed range occurred in this direction was 5.0-10.0 km/h. The wind flow was not there in N, S, E, W, NE, SE directions. The maximum wind
Table 5.1

Frequency Table for Wind Rose Diagram
Peelamedu - Premonsoon

<table>
<thead>
<tr>
<th>WS</th>
<th>PWD</th>
<th>3.4-5.0 Km/HR.</th>
<th>5.0-10.0 Km/HR.</th>
<th>10.0-15.0 Km/HR.</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>NE</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SE</td>
<td>20</td>
<td>13.33</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>S</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SW</td>
<td>33.33</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>W</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>NW</td>
<td>13.33</td>
<td>6.67</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>CALM</td>
<td>13.33</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
speed range in the NW direction was 5.0-10.0 km/h. During the period of
observation calm condition has not occurred.

The prevailing wind direction in the pre monsoon period was SW. The
maximum wind speed range occurred in this direction was 10.0-15.0 km/h. The
wind flow was not there in N, S, E, W, NW, NE directions. The maximum wind
speed range in the SE direction was 5.0-10.0 km/h. The percentage of
occurrence of calm condition was 11.11.

The prevailing wind direction in the monsoon period was SE. The
maximum wind speed range occurred in this direction was 5.0-10.0 km/h. The wind
flow was not there in N, S, E, W, NW, SE directions. The maximum wind speed range
in the NW direction was 5.0-10.0 km/h. The maximum wind speed range in the
SW direction was 3.4-5.0 km/h. The maximum wind speed range in the SE
direction was 5.0-10.0 km/h. The percentage of occurrence of calm condition was
13.33.

Ganapathy

The wind roses drawn for all the seasons are given in Fig 5.1 b. The
prevailing wind direction in the post monsoon period was SW. The maximum
wind speed range occurred in this direction was 10.0-15.0 km/h. The wind flow
was not there in N, S, E, W, NW, SE directions. The maximum wind speed range
in the NE direction was 5.0-10.0 km/h. The percentage of occurrence of calm
condition was 15.38.

The prevailing wind direction in the summer period was SE. The maximum
wind speed range occurred in this direction was 5.0-10.0 km/h. The wind flow
was not there in N, S, E, W, NW directions. The maximum wind speed range in
the SW, NE direction was 5.0-10.0 km/h. During the period of observation calm
condition has not occurred.
Fig 5.1 b. Wind Rose Diagrams - GANAPATHY

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The prevailing wind direction in the pre monsoon period was SW. The maximum wind speed range occurred in this direction was 10.0-15.0 km/h. The wind flow was not there in N, S, E, W, NW, NE directions. The maximum wind speed range in the SE direction was 10.0-15.0 km/h. The percentage of occurrence of calm condition was 16.67.

The prevailing wind direction in the monsoon period was SE and the maximum wind speed range occurred in this direction was 5.0-10.0 km/h. The wind flow was not there in N, S, E, W, NE, NW directions. The maximum wind speed range in the SW direction was 3.4-5.0 km/h. The percentage of occurrence of calm condition was 55.55.

Gandhipuram

The wind roses drawn for all the seasons are given in Fig 5.1c. The prevailing wind direction in the post monsoon period was SE. The maximum wind speed range occurred in this direction was 5.0-10.0 km/h. The wind flow was not there in N, S, E, W, NE directions. The maximum wind speed range in the SW, SE direction was 5.0-10.0 km/h. The percentage of occurrence of calm condition was 7.14.

The prevailing wind direction in the summer period was SE. The maximum wind speed range occurred in this direction was 5.0-10.0 km/h. The wind flow was not there in N, S, E, W, NW, NE directions. The maximum wind speed range in the SW direction was 3.4-5.0 km/h. The percentage of occurrence of calm condition was 37.5.

The prevailing wind direction in the pre monsoon period was SW. The maximum wind speed range occurred in this direction was 5.0-10.0 km/h. The wind flow was not there in N, S, E, W, NW, NE directions. The maximum wind speed range in the SE direction was 5.0-10.0 km/h. The percentage of occurrence of calm condition was 25.0.
Fig 5.1 c. Wind Rose Diagrams - GANDHIPURAM
The prevailing wind direction in the monsoon period was SE. The maximum wind speed range occurred in this direction was 5.0-10.0 km/h. The wind flow is not there in N, S, E, W, NE, and NW directions. The maximum wind speed range in the SW direction was 5.0-10.0 km/h. The percentage of occurrence of calm condition was 10.0.

Gandhi Park

The wind roses drawn for all the seasons are given in Fig 5.1d. The prevailing wind direction in the post monsoon period was SW. The maximum wind speed range occurred in this direction was 5.0-10.0 km/h. The wind flow was not there in N, S, E, W directions. The maximum wind speed range in the NW direction was 5.0-10.0 km/h. The maximum wind speed range in the NE direction was 10.0-15.0 km/h. The maximum wind speed range in the SE direction was 3.4-5.0 km/h. During the period of observation calm condition has not occurred.

The prevailing wind direction in the summer period was SE. The maximum wind speed range occurred in this direction was 5.0-10.0 km/h. The wind flow was not there in N, S, E, W, NW, NE directions. The maximum wind speed range in the SW direction was 3.4-5.0 km/h. During the period of observation calm condition has not occurred.

The prevailing wind direction in the premonsoon period was SE. The maximum wind speed range occurred in this direction was 5.0-10.0 km/h. The wind flow was not there in N, S, E, W, NW, NE directions. The maximum wind speed range in the SW direction was 3.4-5.0 km/h. The percentage of occurrence of calm condition was 30.0.

The prevailing wind direction in the monsoon period was SW. The maximum wind speed range occurred in this direction was 5.0-10.0 km/h. The
Fig 5.1 d. Wind Rose Diagrams - GANDHI PARK
wind flow was not there in N, S, E, W, SE directions. The maximum wind speed range in the NW & NE direction was 5.0-10.0 km/h. The percentage of occurrence of calm condition was 41.7.

**Ukkadam**

The wind roses drawn for all the seasons are given in Fig 5.1e. The prevailing wind direction in the post monsoon period was SW. The maximum wind speed range occurred in this direction was 5.0-10.0 km/h. The wind flow was not there in N, S, E, W, SE directions. The maximum wind speed range in the NW direction was 10.0-15.0 km/h. The maximum wind speed range in the NE direction was 5.0-10.0 km/h. During the period of observation calm condition has not occurred.

The prevailing wind direction in the summer period was SW. The maximum wind speed range occurred in this direction was 5.0-10.0 km/h. The wind flow was not there in N, S, E, W, NW, NE directions. The maximum wind speed range in the SE direction was 5.0-10.0 km/h. During the period of observation calm condition has not occurred.

The prevailing wind direction in the premonsoon period was SE. The maximum wind speed range occurred in this direction was 5.0-10.0 km/h. The wind flow was not there in N, S, E, W, NW, NE directions. The maximum wind speed range in the SW direction was 5.0-10.0 km/h. The percentage of occurrence of calm condition was 25.0.

The prevailing wind direction in the monsoon period was SW. The maximum wind speed range occurred in this direction was 5.0-10.0 km/h. The wind flow was not there in N, S, E, W, NE directions. The maximum wind speed range in the NW direction was 5.0-10.0 km/h. The maximum wind speed range in
Fig 5.1 e. Wind Rose Diagrams - UKKADAM
the SE direction was 3.4 - 5.0 km/h. The percentage of occurrence of calm condition was 20.0.

5.4 Pollution rose diagrams

The dispersion and transport of pollutants in the atmosphere was of prime concern for the environmentalists, which was influenced by various meteorological parameters such as wind speed, direction etc. The present investigation attempted to represent the frequency of occurrence of different concentration ranges of pollutants with respect to wind direction in the form of pollution rose diagrams. Since wind flow was circular, it was easy to interpret and visualize the pollution roses, which give the frequency of occurrence of pollutant concentration ranges for each direction oriented according to the azimuth for that direction.

Pollution Rose Diagrams are the two-way joint frequency distribution between wind direction and pollution concentration. The data of pollutant concentration frequency of occurrence of a specific range in a particular wind direction are the basic requirement for air quality management programme. This data in the form of pollution rose can be easily interpreted and effectively manipulated. Pollution roses portray the occurrence of a particular pollutant at a location, its concentration, direction and frequency.

5.4.1 Construction of Pollution Rose Diagrams

The wind directions considered were N-North, NE-North East, E-East, SE-South East, S-South, SW-South West, W-West, and NW-North West. The ranges of wind direction chosen were N-0, NE-0< PWD <90, E-90 and so on.

The ranges of SPM concentrations considered were 0-250 µg/m³, 250-500 µg/m³, 500-750 µg/m³, 750-1000 µg/m³ and greater than 1000 µg/m³. The ranges of NOₓ and SO₂ were classified as 0-25, 25-50, 50-75, 75-100, >100 µg/m³ respectively.
The procedures for generating the frequency tables for constructing the rose diagrams have been transformed into C programs and are given in Appendix IV. This program obtains the pollutant concentrations and prevailing wind directions on a particular day as input and compares these observations with the classification ranges and gives the frequency table as output as shown Tables 5.2, 5.3, 5.4. The frequency tables generated using these programs have been used for evolution of roses for the four seasons namely, post monsoon, summer, pre monsoon and winter through Auto CAD package.

Each arm of the pollution rose shows a specific direction and the percentage frequency of occurrence of pollutant concentration range was plotted to a scale on that arm. In order to differentiate the ranges the thickness of the range box was varied.

5.4.2 Analysis of SPM pollution rose diagrams

The generated pollution roses for all the seasons exhibit seasonal variations and distribution of SPM, the knowledge of which is essential for air pollution control studies. Due to high humidity and low wind velocity, the pollution concentration was more in January to March. During April to June, the overall pollution concentration was less, as dispersion was more due to less humidity. In the pre monsoon season, the concentration was more due to dust storms.

Peelamedu

The generated pollution roses for all the seasons are shown in Fig 5.2 a. The prevailing wind direction in post monsoon season was SW and maximum concentration range occurred in this direction during this period was greater than 1000 µg/m³. The percentage frequency of occurrence of the SPM range 750-1000 µg/m³ was predominant. There was also dispersion along NW, NE and SE. In summer, the prevailing wind direction was SW with maximum range 250-500 µg/m³. The percentage frequency of occurrence of the SPM range 250-500
Table 5.2

Frequency Table for SPM pollution Rose Diagram

<table>
<thead>
<tr>
<th>PWD</th>
<th>0-250 μg/m³</th>
<th>250-500 μg/m³</th>
<th>500-750 μg/m³</th>
<th>750-1000 μg/m³</th>
<th>&gt;1000 μg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>NE</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5.88</td>
<td>0</td>
</tr>
<tr>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SE</td>
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<td>0</td>
<td>5.88</td>
<td>5.88</td>
</tr>
<tr>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SW</td>
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<td>5.88</td>
<td>29.41</td>
<td>11.76</td>
</tr>
<tr>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>NW</td>
<td>0</td>
<td>5.88</td>
<td>5.88</td>
<td>6.67</td>
<td>5.88</td>
</tr>
</tbody>
</table>

Table 5.3

Frequency Table for NOx Pollution Rose Diagram

<table>
<thead>
<tr>
<th>PWD</th>
<th>0-25 μg/m³</th>
<th>25-50 μg/m³</th>
<th>50-75 μg/m³</th>
<th>75-100 μg/m³</th>
<th>&gt;100 μg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>NE</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SE</td>
<td>0</td>
<td>20</td>
<td>13.33</td>
<td>6.67</td>
<td>0</td>
</tr>
<tr>
<td>S</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SW</td>
<td>0</td>
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<td>13.33</td>
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</tr>
<tr>
<td>W</td>
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<td>0</td>
<td>0</td>
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<tr>
<td>NW</td>
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</tbody>
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Table 5.4

Frequency Table for SO2 Pollution Rose Diagram

<table>
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<tr>
<th>PWD</th>
<th>0-25 μg/m³</th>
<th>25-50 μg/m³</th>
<th>50-75 μg/m³</th>
<th>75-100 μg/m³</th>
<th>&gt;100 μg/m³</th>
</tr>
</thead>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>NE</td>
<td>0</td>
<td>5.88</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SE</td>
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<td>5.88</td>
<td>0</td>
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</tr>
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<td>0</td>
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<td>35.29</td>
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<td>0</td>
</tr>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>NW</td>
<td>0</td>
<td>11.76</td>
<td>5.88</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Fig 5.2 a. SPM Pollution Rose Diagrams - PEELAMEDU
μg/m³ was predominant. There was also dispersion along NW direction in the concentration range of 0-250 μg/m³.

In the pre monsoon season, the prevailing wind direction was SE. The maximum SPM range was 750-1000 μg/m³. The percentage frequency of occurrence of the SPM range 0 - 250 μg/m³ was predominant. There was also dispersion observed along SW with the maximum concentration range of 0-250 μg/m³. During the monsoon season the prevailing wind direction was SE with maximum concentration range of 750-1000 μg/m³. The percentage frequency of occurrence of the SPM range 250-500 μg/m³ was predominant. There was also dispersion observed along SW and NW with the maximum concentration range of 0-250 μg/m³.

Ganapathy

The generated pollution roses for all the seasons are shown in Figure 5.2 b. The prevailing wind direction in post monsoon season was SW and maximum concentration range occurred in this direction during this period was greater than 1000 μg/m³. The percentage frequency of occurrence of the SPM range 500-750 μg/m³ was predominant. There was also dispersion along NE and SE. During summer, the overall pollution concentration was less due to less humidity. The prevailing wind direction was SE with maximum range 500-750 μg/m³. The percentage frequency of occurrence of the SPM range 250-500 μg/m³ was predominant. There was also dispersion along NE and SW directions in the concentration range of 500-750 μg/m³.

In the pre monsoon season, the prevailing wind direction was SW. The maximum SPM range was 250-500 μg/m³. The percentage frequency of occurrence of the SPM range 0 - 250 μg/m³ was predominant. There was also dispersion observed along SE and NW with the maximum concentration range of 500-750 μg/m³. During the monsoon season the prevailing wind direction was SE with maximum concentration range of 500-750 μg/m³. The percentage frequency of occurrence of the SPM range 0-250 μg/m³ was predominant.
Fig 5.2b. SPM Pollution Rose Diagrams - GANAPATHY
Gandhipuram

The generated pollution roses for all the seasons are shown in Figure 5.2
c. The prevailing wind direction in post monsoon season was SE and maximum concentration range occurred in this direction during this period was greater than 1000 µg/m³. The percentage frequency of occurrence of the SPM range 250-500 µg/m³ was predominant. There was also dispersion along NW and SW. During summer, the prevailing wind direction was SW with maximum range 250-500 µg/m³. The percentage frequency of occurrence of the SPM range 250-500 µg/m³ was predominant. There was also dispersion along SE direction in the concentration range of 250-500 µg/m³.

In the pre monsoon season, the prevailing wind direction was SW. The maximum SPM range was 250-500 µg/m³. The percentage frequency of occurrence of the SPM range 0 - 250 µg/m³ was high. There was also dispersion observed along SE with the maximum concentration range of 250-500 µg/m³. During the monsoon season the prevailing wind direction was SE with maximum concentration range of 750-1000 µg/m³. The percentage frequency of occurrence of the SPM range 250-500 µg/m³ was predominant. There was also dispersion observed along SW with the maximum concentration range of 250-500 µg/m³.

Gandhi Park

The generated pollution roses for all the seasons are shown in Figure 5.2
d. The prevailing wind direction in post monsoon season was SW and maximum concentration range occurred in this direction during this period was greater than 1000 µg/m³. The percentage frequency of occurrence of the SPM range 750-1000 µg/m³ was predominant. There was also dispersion along NE, NW and SE. During summer, the prevailing wind direction was SW with maximum range 250-500 µg/m³. The percentage frequency of occurrence of the SPM range 250-
Fig 5.2 c. SPM Pollution Rose Diagrams - GANDHIPURAM
Fig 5.2d. SPM Pollution Rose Diagrams - GANDHI PARK
500 µg/m³ was predominant. There was also dispersion along SW direction in the concentration range of 250-500 µg/m³.

In the pre monsoon season, the prevailing wind direction was SE. The maximum SPM range was 250-500 µg/m³. The percentage frequency of occurrence of the SPM range 0-250 µg/m³ was predominant. There was also dispersion observed along SW with the maximum concentration range of 250-500 µg/m³. During the monsoon season the prevailing wind direction is SW with maximum concentration range of 250-500 µg/m³. The percentage frequency of occurrence of the SPM range 0-250 µg/m³ was predominant. There was also dispersion observed along NW, SE and NE with the maximum concentration range of 0-250 µg/m³.

Ukkadam

The generated pollution roses for all the seasons are shown in Fig 5.2 e. The prevailing wind direction in post monsoon season was SW and maximum concentration range occurred in this direction during this period was 750-1000 µg/m³. The percentage frequency of occurrence of the SPM range 0-250 µg/m³ was predominant. There was also dispersion along NE and NW. During summer, the prevailing wind direction was SW with maximum range 250-500 µg/m³. The percentage frequency of occurrence of the SPM range 250-500 µg/m³ was predominant. There was also dispersion along SE direction in the concentration range of 250-500 µg/m³.

In the pre monsoon season, the prevailing wind direction was SE. The maximum SPM range was 250-500 µg/m³. The percentage frequency of occurrence of the SPM range 0-250 µg/m³ was predominant. There was also dispersion observed along SE and NW with the maximum concentration range of 0-250 µg/m³. During the monsoon season the prevailing wind direction was SW with maximum concentration range of 750-1000 µg/m³. The percentage frequency of occurrence of the SPM range 250-500 µg/m³ was predominant.
Fig 5.2e. SPM Pollution Rose Diagrams - UKKADAM
There was also dispersion observed along NW and SE with the maximum concentration range of 250-500 μg/m³.

This study portrays clear information on wind flow patterns and SPM dispersion in different seasons in the five selected survey stations. All the areas chosen are polluted and the monitoring may be continued in these stations. The stations chosen proves their representation of the areas of concern. With the observed data, modelling for air pollution forecasts may be done which has been the long-standing requirement of developing countries with respect to air pollution.

5.4.3 Analysis of NOₓ pollution rose diagrams

Peelamedu

The NOₓ pollution rose diagrams constructed for four seasons are illustrated in Fig 5.3 a.

Post monsoon

The prevailing wind direction was SW and the maximum percentage of frequency of occurrence range was 25-50 μg/m³ and the maximum concentration range in this direction was 50-75 μg/m³. The other directions in which the pollutant dispersion occurred were NW, NE and SE in the range 25-50 μg/m³.

Summer

The prevailing wind direction was SW and the maximum percentage of frequency of occurrence range was 50-75 μg/m³ and was found to be the maximum concentration range in this direction. The other direction of NOₓ dispersion was NW in the range of 50-75 μg/m³.

Premonsoon

The prevailing wind direction was SE and the maximum percentage of frequency of occurrence range 50-75 μg/m³ and was the maximum concentration
Fig 5.3 a. NOx Pollution Rose Diagrams - PEELAMEDU
range. The other direction of NO\textsubscript{x} dispersion was SW and the maximum concentration range that occurred in this direction was 50-75 μg/m\textsuperscript{3}.

Monsoon

The prevailing wind direction was SE and the maximum percentage of frequency of occurrence range was 25-50 μg/m\textsuperscript{3}. The maximum NO\textsubscript{x} dispersion concentration range in this direction was 75-100 g/m\textsuperscript{3}. The other direction in which the NO\textsubscript{x} dispersion occurred were SW, NW and the maximum NO\textsubscript{x} range in each of these directions were 50-75 μg/m\textsuperscript{3} and 75-100 μg/m\textsuperscript{3} respectively.

Ganapathy

The NO\textsubscript{x} pollution rose diagrams constructed for four seasons are illustrated in Figure 5.3 b.

Post Monsoon

The prevailing wind direction was SW and the maximum percentage of frequency of occurrence range was 25-50 μg/m\textsuperscript{3} and was found to be the maximum concentration range in this direction. The other directions in which the pollutant dispersion occurred were SE, NE in the range 0-25 μg/m\textsuperscript{3}.

Summer

The prevailing wind direction was SE and the maximum percentage of frequency of occurrence range was 25-50 μg/m\textsuperscript{3} and was found to be the maximum concentration range in this direction. The other direction of NO\textsubscript{x} dispersion was SW and NE in the range of 25-50 μg/m\textsuperscript{3}.

Premonsoon

The prevailing wind direction was SW and the maximum percentage of frequency of occurrence range 25-50 μg/m\textsuperscript{3} and was the maximum concentration range. The other directions of NO\textsubscript{x} dispersion were NW and SE and the maximum concentration range that occurred in this direction was 25-50 μg/m\textsuperscript{3}.
Fig 5.3b. NOx Pollution Rose Diagrams - GANAPATHY
Monsoon

The prevailing wind direction in SE and the maximum percentage of frequency of occurrence range was 50-75 μg/m³. The maximum NOₓ dispersion concentration range in this direction was 75-100 g/m³. The other direction in which the NOₓ dispersion occurred were SW, NE and the maximum NOₓ range in these directions was 50-75 μg/m³.

Gandhipuram

The NOₓ pollution rose diagrams constructed for four seasons are illustrated in Fig 5.3c.

Post Monsoon

The prevailing wind direction was SE and the maximum percentage of frequency of occurrence range was 75-100 μg/m³ and the maximum concentration range in this direction was 79-100 μg/m³. The other directions in which the pollutant dispersion occurred were NW and SW with the maximum concentration range of 75-100 μg/m³.

Summer

The prevailing wind direction was SW and the maximum percentage of frequency of occurrence range was 50-75 μg/m³ and was found to be the maximum concentration range in this direction. The other direction of NOₓ dispersion was SE with the maximum concentration range of 50-75 μg/m³.

Premonsoon

The prevailing wind direction was SE and the maximum percentage of frequency of occurrence range 75-100 μg/m³ and was the maximum concentration range. The other direction of NOₓ dispersion was SW and the maximum concentration range that occurred in this direction was 75-100 μg/m³.
Fig 5.3 c. NOx Pollution Rose Diagrams - GANDHIPURAM
Monsoon

The prevailing wind direction was SE and the maximum percentage of frequency of occurrence range was 50-75 μg/m³. The maximum NOₙ dispersion concentration range in this direction was 75-100 μg/m³. The other direction in which the NOₙ dispersion occurred was SW and the maximum NOₙ range in this direction was 75-100 μg/m³.

Gandhi Park

The NOₓ pollution rise diagrams constructed for four seasons are illustrated in Fig 5.3d.

Post Monsoon

The prevailing wind direction was SW and the maximum percentage of frequency of occurrence range was 50-75 μg/m³ and the maximum concentration range in this direction was 75-100 μg/m³. The other directions in which the pollutant dispersion occurred were NW, NE and SE in the range 25-50 μg/m³.

Summer

The prevailing wind direction was SE and the maximum percentage of frequency of occurrence range was 75-100 μg/m³ and was found to be the maximum concentration range in this direction. The other direction of NOₓ dispersion was SW in the maximum concentration range of 75-100 μg/m³.

Premonsoon

The prevailing wind direction was SE and the maximum percentage of frequency of occurrence range 50-75 μg/m³ and was the maximum concentration range. The other direction of NOₓ dispersion was SW and the maximum concentration range that occurred in this direction was 50-75 μg/m³.
Fig 5.3d. NOx Pollution Rose Diagrams -GANDHI PARK
Monsoon
The prevailing wind direction was SW and the maximum percentage of frequency of occurrence range was 50-75 $\mu$g/m$^3$ and was found to be the maximum NO$_x$ dispersion concentration range in this direction. The other direction in which the NO$_x$ dispersion occurred were SE, NW and NE. The maximum NO$_x$ range in each of these directions was 25-50, 50-75 and 75-100 $\mu$g/m$^3$ respectively.

Ukkadam
The NO$_x$ pollution rose diagrams constructed for four seasons are illustrated in Figure 5.3 e.

Post Monsoon
The prevailing wind direction was SW and the maximum percentage of frequency of occurrence range was 50-75 $\mu$g/m$^3$ and the maximum concentration range in this direction was >100 $\mu$g/m$^3$. The other directions in which the pollutant dispersion occurred were NW, NE with the maximum concentration range of 75-100, >100 $\mu$g/m$^3$ respectively.

Summer
The prevailing wind direction was SW and the maximum percentage of frequency of occurrence range was 50-75 $\mu$g/m$^3$ and the maximum concentration range in this direction was 75-100 $\mu$g/m$^3$. The other direction of NO$_x$ dispersion was SE with the maximum concentration range of 50-75 $\mu$g/m$^3$.

Pre monsoon
The prevailing wind direction in SE and the maximum percentage of frequency of occurrence range 50-75 $\mu$g/m$^3$ and the maximum concentration range in this direction were 75-100 $\mu$g/m$^3$. The other directions of NO$_x$ dispersion were SW and NW the maximum concentration range that occurred in these directions were 75-100 and 50-75 $\mu$g/m$^3$ respectively.
Fig 5.3e. NOx Pollution Rose Diagrams - UKKADAM
Monsoon

The prevailing wind direction in SW and the maximum percentage of frequency of occurrence range was 50-75 μg/m³. The maximum NOₓ dispersion concentration range in this direction was 75-100 μg/m³. The other direction in which the NOₓ dispersion occurred were SE, NW and the maximum NOₓ range in each of these directions were 25-50 μg/m³ and 75-100 μg/m³ respectively.

5.4.4 Analysis of SO₂ Pollution Rose Diagrams

Peelamedu

The SO₂ pollution rose diagrams for all seasons shown in Figure 5.4 a exhibit the variation of SO₂ concentration with wind direction.

Post monsoon

The prevailing wind direction was SW and the maximum percentage of frequency of occurrence of concentration range was 25-50 μg/m³. The maximum concentration range in this direction was 50-75 μg/m³. The other directions in which the concentration has been observed were NW, NE, SE with the maximum concentration range of 50-75, 25-50, 50-75 μg/m³ respectively.

Summer

The prevailing wind direction was SW and the maximum percentage of frequency of occurrence of concentration range was 75-100 μg/m³ and was found to be the maximum concentration range in this direction. The other direction in which the concentration has been observed was NW with the maximum concentration range of 50-75 μg/m³.

Pre monsoon

The prevailing wind direction was SE and the maximum percentage of frequency of occurrence of concentration range was 50-75 μg/m³. The maximum concentration range in this direction was 75-100 μg/m³. The other direction in which the concentration has been observed was SW with the maximum percentage of occurrence of concentration range 50-75 μg/m³.
Fig 5.4a. SO2 Pollution Rose Diagrams - PEELAMEDU
Monsoon

The prevailing wind direction was SE and the maximum percentage of frequency of occurrence of concentration range was 50-75 µg/m³. The maximum concentration range in this direction was 75-100 µg/m³. The other directions in which the concentration has been observed were NW, SW with the maximum concentration range of 50-75 µg/m³.

Ganapathy

The SO₂ pollution rose diagrams for all seasons shown in Fig 5.4b exhibit the variation of SO₂ concentration with wind direction.

Post monsoon

The prevailing wind direction was SW and the maximum percentage of frequency of occurrence of concentration range was 25-50 µg/m³. The maximum concentration range in this direction was 50-75 µg/m³. The other directions in which the concentration has been observed were NE, SE with the maximum concentration range of 0-25, 50-75 µg/m³ respectively.

Summer

The prevailing wind direction was SE and the maximum percentage of frequency of occurrence of concentration range was 50-75 µg/m³ and was found to be the maximum concentration range in this direction. The other direction in which the concentration has been observed were SW, NE with the maximum concentration range of 50-75 µg/m³.

Pre monsoon

The prevailing wind direction was SW and the maximum percentage of frequency of occurrence of concentration range was 50-75 µg/m³ and was found to be the maximum concentration range in this direction. The other directions in which the concentration has been observed were SE, NW with the maximum percentage of occurrence of concentration range 50-75 µg/m³.
Fig 5.4b. SO2 Pollution Rose Diagrams - GANAPATHY
Monsoon
The prevailing wind direction was SE and the maximum percentage of frequency of occurrence of concentration range was 50-75 \( \mu g/m^3 \). The maximum concentration range in this direction was >100 \( \mu g/m^3 \). The other directions in which the concentration has been observed were NE, SW with the maximum concentration range of 50-75 \( \mu g/m^3 \).

Gandhipuram
The \( SO_2 \) pollution rose diagrams for all seasons shown in Fig 5.4c exhibit the variation of \( SO_2 \) concentration with wind direction.

Post monsoon
The prevailing wind direction was SE and the maximum percentage of frequency of occurrence of concentration range was 75-100 \( \mu g/m^3 \) and was found to be the maximum concentration range in this direction. The other directions in which the concentration has been observed were NW, SW with the maximum concentration range of 75-100 \( \mu g/m^3 \).

Summer
The prevailing wind direction was SW and the maximum percentage of frequency of occurrence of concentration range was 50-75 \( \mu g/m^3 \). The maximum concentration range in this direction was 75-100 \( \mu g/m^3 \). The other direction in which the concentration has been observed were SE with the maximum concentration range of 50-75 \( \mu g/m^3 \).

Pre monsoon
The prevailing wind direction was SE and the maximum percentage of frequency of occurrence of concentration range was 75-100 \( \mu g/m^3 \). The maximum concentration range in this direction was >100 \( \mu g/m^3 \). The other direction in which the concentration has been observed was SW with the maximum percentage of occurrence of concentration range 50-75 \( \mu g/m^3 \).
Fig 5.4c. SO2 Pollution Rose Diagrams - GANDHIPURAM
Monsoon

The prevailing wind direction was SE and the maximum percentage of frequency of occurrence of concentration range was 50-75 \( \mu g/m^3 \). The maximum concentration range in this direction was 75-100 \( \mu g/m^3 \). The other direction in which the concentration has been observed was SW with the maximum concentration range of 75-100 \( \mu g/m^3 \).

Gandhi Park

The SO\(_2\) pollution rose diagrams for all seasons shown in Figure 5.4 exhibit the variation of SO\(_2\) concentration with wind direction.

Post monsoon

The prevailing wind direction was SW and the maximum percentage of frequency of occurrence of concentration range was 50-75 \( \mu g/m^3 \). The maximum concentration range in this direction was 75-100 \( \mu g/m^3 \). The other directions in which the concentration has been observed were NW, NE, SE with the maximum concentration range of 50-75, 50-75, 25-50 \( \mu g/m^3 \) respectively.

Summer

The prevailing wind direction was SE and the maximum percentage of frequency of occurrence of concentration range was 50-75 \( \mu g/m^3 \) and was found to be the maximum concentration range in this direction. The other direction in which the concentration has been observed was SW with the maximum concentration range of 50-75 \( \mu g/m^3 \).

Pre monsoon

The prevailing wind direction was SE and the maximum percentage of frequency of occurrence of concentration range was 50-75 \( \mu g/m^3 \). The maximum concentration range in this direction was 75-100 \( \mu g/m^3 \). The other direction in which the concentration has been observed was SW with the maximum percentage of occurrence of concentration range was 50-75 \( \mu g/m^3 \).
Fig 5.4 d. SO2 Pollution Rose Diagrams - GANDHI PARK
Monsoon

The prevailing wind direction was SW and the maximum percentage of frequency of occurrence of concentration range was 50-75 μg/m³. The maximum concentration range in this direction was 75-100 μg/m³. The other directions in which the concentration has been observed were NW, SW, NE with the maximum concentration range of 50-75 μg/m³.

Ukkadam

The SO₂ pollution rose diagrams for all seasons shown in Figure 5.4 exhibit the variation of SO₂ concentration with wind direction.

Post monsoon

The prevailing wind direction was SW and the maximum percentage of frequency of occurrence of concentration range was 75-100 μg/m³ and was found to be the maximum concentration range in this direction. The other directions in which the concentration has been observed were NW, NE with the maximum concentration range of 75-100, 50-75 μg/m³ respectively.

Summer

The prevailing wind direction was SW and the maximum percentage of frequency of occurrence of concentration range was 75-100 μg/m³ and was found to be the maximum concentration range in this direction. The other direction in which the concentration has been observed was SE with the maximum concentration range of >100 μg/m³.

Pre monsoon

The prevailing wind direction was SE and the maximum percentage of frequency of occurrence of concentration range was 75-100 μg/m³ and was found to be the maximum concentration range in this direction. The other directions in which the concentration has been observed were SW, NW with the maximum percentage of occurrence of concentration range 75-100 μg/m³.
Fig 5.4e. SO2 Pollution Rose Diagrams - UKKADAM
Monsoon

The prevailing wind direction was SW and the maximum percentage of frequency of occurrence of concentration range was 50-75 µg/m³. The maximum concentration range in this direction was 75-100 µg/m³. The other directions in which the concentration has been observed were NW, SE with the maximum concentration range of 75-100, 50-75 µg/m³ respectively.

5.5 Conclusion

5.5.1 Wind Rose Diagrams

1. The meteorological observations taken in the monitoring stations differ from each other, which strengthen the idea that these parameters obtained from meteorological department will not be sufficient for an extensive ambient air quality study.

2. The prevailing wind direction changes from season to season and station to station.

3. For ambient air quality survey, meteorological observations at each of the monitoring stations are necessary.

4. Interrelationship of wind speed with other meteorological parameters can give more understanding of the role of meteorology on dispersion of pollutants.

5. Comparison of these results with the concentration of pollutants will improve the air quality management programme.

6. The dispersion of pollutants can be understood well with the help of these wind roses.

7. They are useful for the location of survey station for continuous monitoring.

8. They are useful for the identification of pollution sources in the directions where the wind flow is minimum so that proper preventive measures can be taken at the sources.
5.5.2 Pollution Rose Diagrams

The pollution rose is advantageous than the AQI banding because it is easy to interpret and apart from giving an idea about the air quality, it provides information about prevailing wind direction.

1. The SPM concentration has been observed high almost in all the AAQMS. Though Ganapathy seems to be less polluted when compared to other stations, elevated concentrations seldom occurred in this station.

2. The concentration of NO\textsubscript{x} in the ambient air is more during the post monsoon period due to high humidity and in summer, it is less due to low humidity.

3. The concentration range has been observed to be minimum in Ganapathy and maximum in Gandhipuram, Gandhi Park and Ukkadam where there is a heavy traffic flow.

4. The dispersion of pollutants has not been observed along the primary direction, as the wind has not blown in those directions.

5. The control measures on polluting sources along the primary directions in each of the survey stations have to be taken.

6. Proposals for new industries and permitting more number of vehicles to ply in the primary directions are to be monitored with utmost care.

7. Reducing the number of speed brakes and traffic signals along the highways in the primary wind direction can reduce the pollution largely.

8. Diverting the vehicles that ply along the primary wind directions to take alternate routes can reduce pollution largely.

9. Proposed industrial activities can be permitted in the prevailing wind direction in the area of concern.

10. The program developed in ‘C’ language can be used for generating frequency table for any pollutant at any place.