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GIS Based Air Quality Mapping for Dharwad City

Dr. Nagraj S. Patil[1]
[1] Associate Professor
Dept. of Water & Land Management,
VTU PG Studies,
Visvesvaraya Technological University,
Belagavi, India,

Dr. V. S. Hegde[2]
[2] Professor, Dept. of Civil Engg.,
SDMCET, Dharward, India

Abdulhamid Yadwad[3] & Mohemad Asif[3]
[3] Student Dept. of Civil Engg.,
SDMCET, Dharward, India

Abstract :- **Air pollution is one of the major problems the world is facing today. The concentration of air pollutants depend not only on the quantities that are emitted from air pollution sources but also on the ability of the atmosphere to either absorb or disperse these emission. The pollution concentration vary spatially and temporarily causing the air pollution pattern to change with different locations and time due to changes in meteorological and topographical condition. These substances are produced by various anthropological activities such as usage of vehicles, factory activities, etc. The parameters considered are Suspended Particulate Matter (SPM), Respirable Suspended Particulate Matter (RSPM), Sulphur dioxide (SO2), Oxides of Nitrogen (NOx), and Carbon Monoxide (CO) etc. Based on these parameters and location selection it is possible to prepare GIS based Air Quality maps which will serve as a baseline for management and policymakers.**

Keywords: Air pollution, Air quality Map, GIS.

I. INTRODUCTION

Air pollutants are added in the atmosphere from variety of sources that change the composition of air and affect the environment. The concentration of air pollutants depend not only on the quantities that are emitted from air pollution sources but also on the ability of the atmosphere to either absorb or disperse these emission [1]. The pollution concentration vary spatially and temporarily causing the air pollution pattern to change with different locations and time due to changes in meteorological and topographical condition. The sources of air pollutants include vehicles, industries, domestic and natural sources [4]. The presence of air pollutants in the ambient air adversely affects the health of the population. In order to prevent and control air pollution, the Air (Prevention and Control of Pollution) Act was enacted in1981. The responsibility has been further emphasized under Environment (Protection) Act, 1986. Despite of these Acts there is continuous pollution of environment and hence it is necessary to assess the present and anticipated air pollution through air quality survey/monitoring programs.[11]

II. METHODOLOGY

A. Study Area

Dharwad (Shown in fig.3) is situated just to the east of the Western Ghats and is surrounded by hills. Dharwad district (before re-organization, 1997) covers an area of 203 Sq. km with a population of 200000. Dharwad is the district headquarters and the Hubli-Dharwad twin city, is educational, financial, industrial hub for North Karnataka. The climate is hot during the summer and wet during the rainy seasons and pleasant during winters. Dharwad is the administrative capital of the district Hubli and Hubli serves as a commerce center and is larger city than Dharwad. Dharwad is about 20 km away from Hubli and form the twin cities of Hubli- Dharwad.

B. Flow Diagram

Figure1. Shows the procedure for developing Air quality map

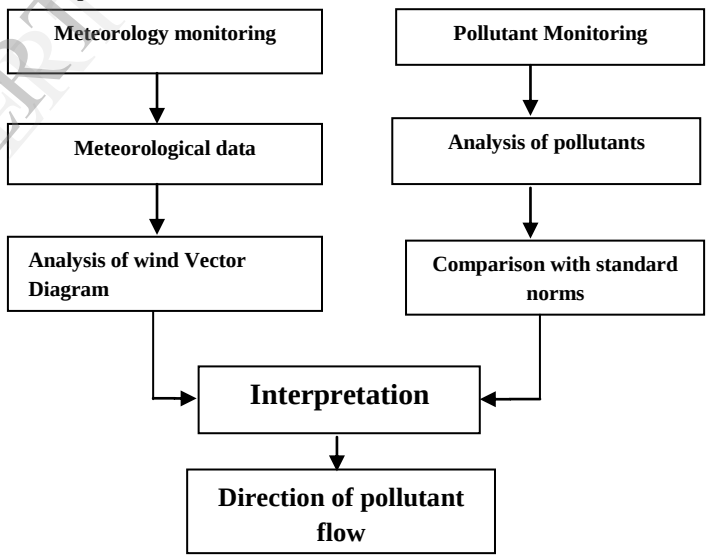

Fig.1. Procedure for Formulation of Air Quality Map

C. Analysis Method for RSPM, SO_2 & NO_x

Title:-Method for determination of respirable suspended particulate matter (RSPM) in the atmosphere (high volume method)[10]

Principle:-Air is drawn through a size selective inlet and through a 20.3x25.4 cm (8 x 10 in) filter at flow rate which is typically 1132 L/min (40ft^3/min). Particles with aerodynamics diameters less than the cut point of the inlet are collected by filter. The mass of these particles is determined by the difference in filter weights prior to and after sampling. The concentration of suspended particulate matter in the designated size range is calculated by dividing the weight gain of the filter by the volume of air sampled.

Fig.2. a. Filter paper

Fig. 2. b. Inside view of dust sampler


Fig.2. c. Complete setup of apparatus

Title:-Method for determination of sulphur dioxide in ambient air (modified west & Geake method).[3]
Principle:-Sulphur dioxide from air is absorbed in a solution of potassium tetrachloro-mercurate (TCM). A dichlorosulphito mercurate complex, which resists oxidation by the oxygen in the air, is formed. Once formed, this complex is stable to strong oxidants such as ozone and oxides of nitrogen and therefore, the absorber solution may be stored for some time prior to analysis. The complex is made to react with pararosaniline acid, and formaldehyde to form the intensity colored parasanilinem ethyl sulphonic acid. The absorbance of the solution is measured by means of a suitable spectrophotometer. Concentration of sulphur dioxide is in the range of 25-1050 µg/m^3 in an air sample of 30 litres.
TITLE: -Method for determination of Nitrogen Dioxide in the Ambient Air (Sodium Arsenite method).[2]

PRINCIPLE: -Ambient nitrogen dioxide (NO_2) is collected by bubbling air through a solution hydroxide and sodium arsenite. The concentration of nitrite ion (NO_2) produced during sampling is determined colorimetrically by reacting the nitrite ion with phosphoric acid, sulfanilamide, and N_(1-naphthyl)-ethylenediamine di-hydrochloride (NEDA) and measuring the absorbance of the highly colored azo dye at 540 nm. The nominal range of the method is 9 to 750 µg NO_2/m^3) the range of the analysis is 0.04 to 2.0 µg NO_2/ml, following Beer's law throughout this range (0 to 1.0 absorbance units).

III. MAPPING AIR POLLUTION CONCENTRATION

The steps involved are

- Digitization of Dharwad map.
- Input ground data to map.
- Generation of thematic maps.
- Generated continuous data by interpolation method(IDW) for NOx,SO2, RSPM.

The procedure adopted is to develop a GIS based air pollution surface model using different continuous surface generation techniques. In this study, interpolation technique for mapping the variation of point data over space has been compared. The methods of spatial prediction used for the study are some local deterministic interpolation methods such as Thiessen Polygons, Inverse Distance and Thin Plate Splines. Data used for the study comprised values of different pollutants observed at point locations, sparsely distributed over the study area. Different interpolation methods mentioned above have been compared to find out the best suitable method for studying the seasonal air pollution levels.[12]

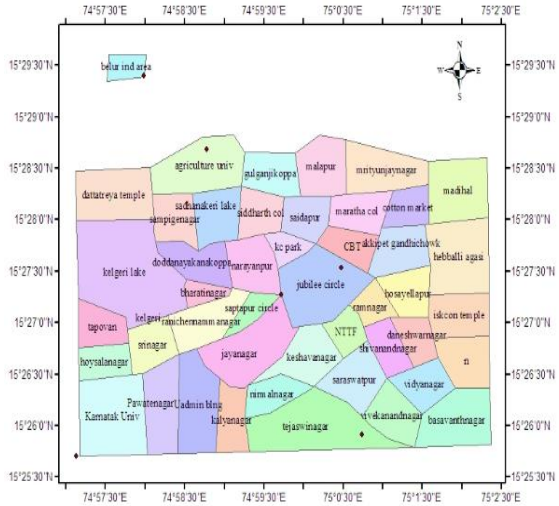

Fig 3. Maps for different locations of Dharwad

IV. WIND ROSE PLOTS

Figure 4. Shows wind rose plot for rainy season in Dharwad which indicates that the predominant winds are mainly flowing from North-East direction. Calm conditions are observed for 1.01% of the total time.

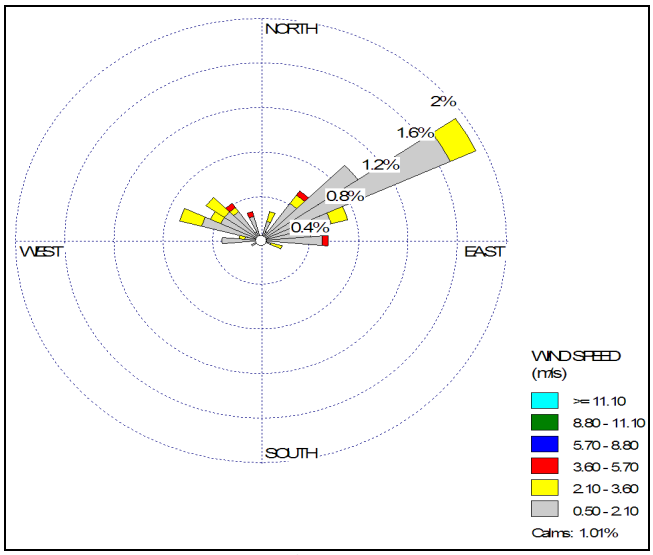

Fig.4 Wind Rose Plot for Rainy Season in Dharwad

Figure 5. shows wind rose plot for winter season in Dharwad which indicates that the predominant winds are mainly flowing from North-East, with the secondary wind direction being from the North-West. Calm conditions are observed for 1.06% of the total time.

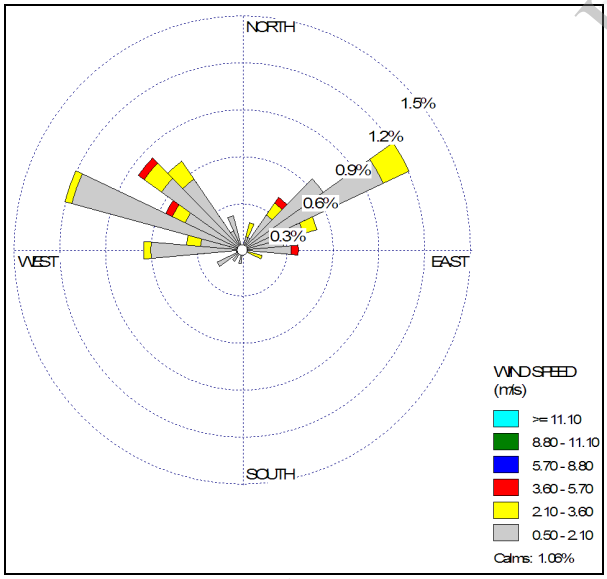

Fig. 5.Windrose Plot for Winter Season in Dharwad

V. FORMULATION OF AIR QUALITY MAP USING GIS

The formulations of air quality atlas using GIS are discussed below.

A. Pollutant concentration maps (Rainy Season)

In Dharwad city, during rainy season oxides of nitrogen concentration varies from 2µg/m^3 to 15.99µg/m^3 and is in desirable limit. Figure 6. shows that spatial distribution of nitrous oxide in the study area, low concentration of nitrous oxide was observed in South-West part of the study area, which comes under Karnataka University and maximum concentration of nitrous oxide was observed at Belur industrial area.

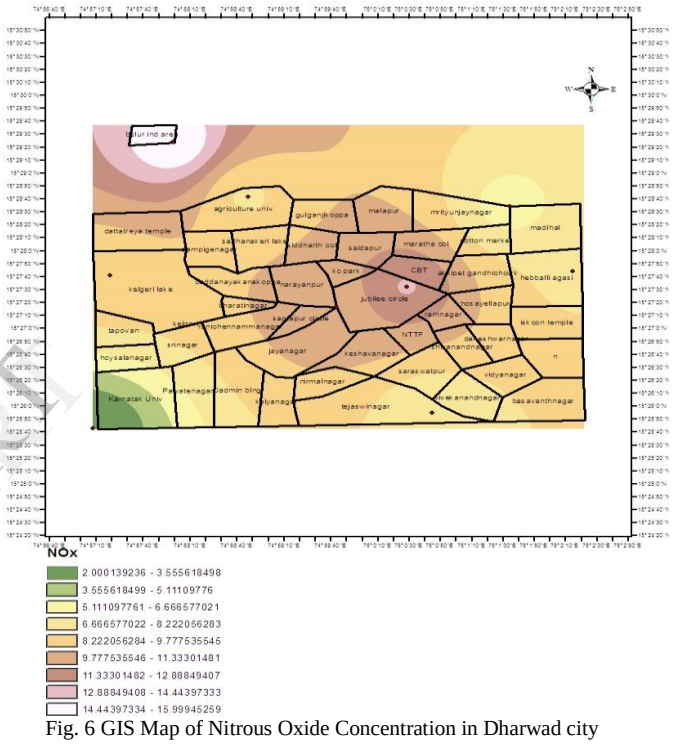

Fig. 6 GIS Map of Nitrous Oxide Concentration in Dharwad city

In Dharwad city, during rainy season respirable suspended particulate matter concentration varies from 20µg/m^3 to 79.99µg/m^3 and is in desirable limit. Figure 7. shows that spatial distribution of respirable suspended particulate matter in the study area, low concentration of respirable suspended particulate matter was observed in South-West part of the study area, which comes under Karnataka University and maximum concentration of respirable suspended particulate matter was observed at Belur industrial area.

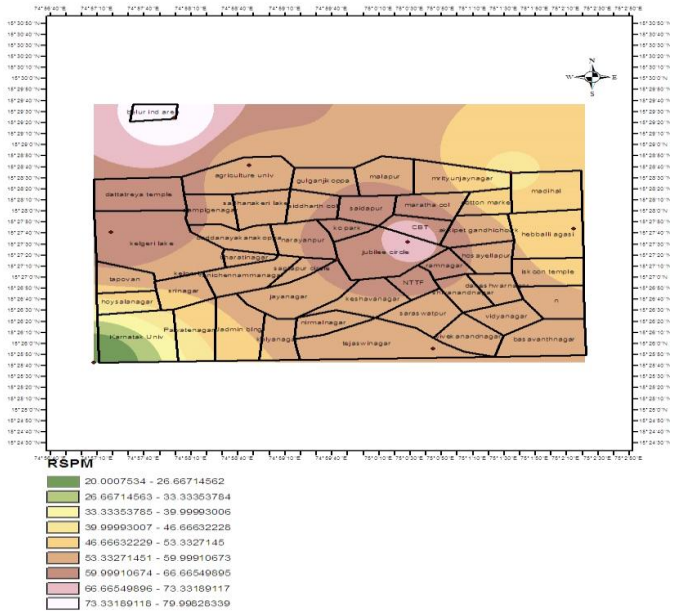

Fig.7. GIS Map of Respirable Suspended Particulate Matter Concentration in Dharwad city

In Dharwad city, during rainy season sulphur dioxide concentration varies from 1µg/m^3 to 5.99µg/m^3 and is in desirable limit. Figure 8. shows that spatial distribution of sulphur dioxide in the study area, low concentration of sulphur dioxide was observed in South-West part of the study area, which comes under Karnataka University and maximum concentration of sulphur dioxide was observed at Belur industrial area.

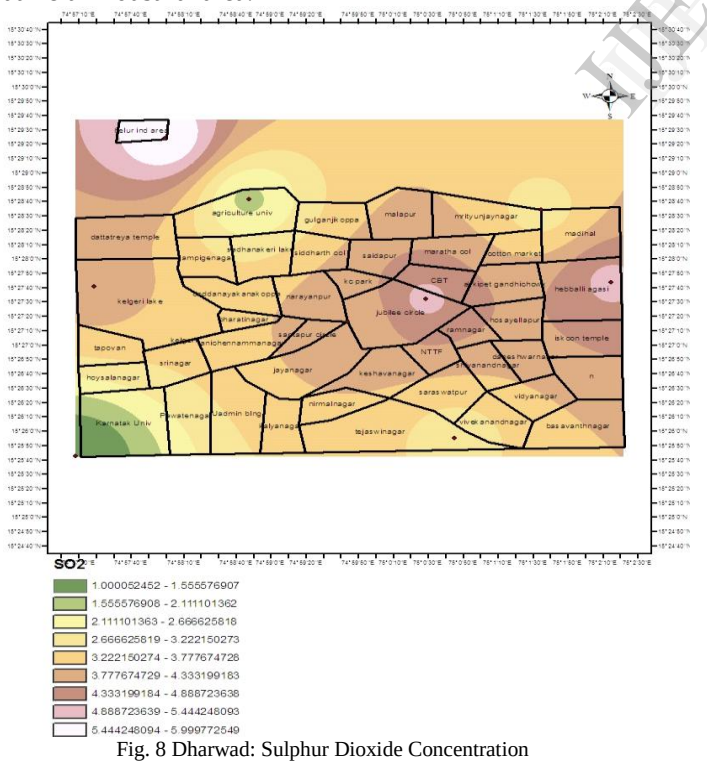

Fig. 8 Dharwad: Sulphur Dioxide Concentration

B. Pollutant Concentration Maps (Winter Season)

In Dharwad city, during winter season oxides of nitrogen concentration varies from 2µg/m^3 to 16.99µg/m^3 and is in desirable limit. Figure 9 shows that spatial distribution of nitrous oxide in the study area, low concentration of nitrous oxide was observed in South-West part of the study area, which comes under Karnataka University and maximum concentration of nitrous oxide was observed in North-West part of the study area, which comes under Belur industrial area.

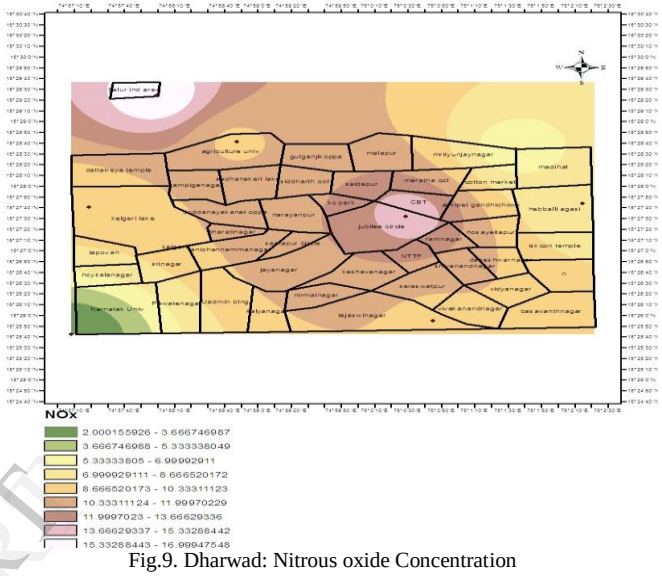

Fig.9. Dharwad: Nitrous oxide Concentration

In Dharwad city, respirable suspended particulate matter concentration varies from 40µg/m^3 to 90.79µg/m^3 and is in desirable limit. Figure 10 shows that spatial distribution of respirable suspended particulate matter in the study area, low concentration of respirable suspended particulate matter was observed in northeast part of the study area, which comes under Karnataka University and maximum concentration of respirable suspended particulate matter was observed at Belur industrial area and Jublee circle.

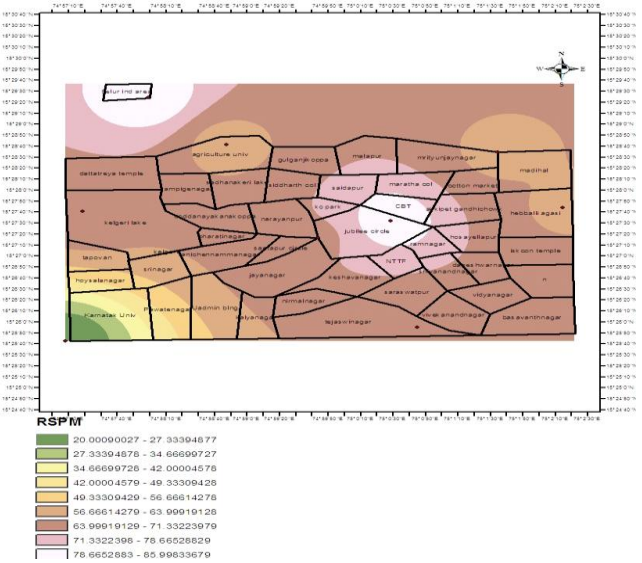

Fig.10. Dharwad: Respirable Suspended Particulate Matter Concentration

In Dharwad City, sulphur dioxide concentration varies from 1μg/m^3 to 8.99μg/m^3 and is indesirable limit. Figure 11. shows that spatial distribution of sulphur dioxide in the study area, low concentration of sulphur dioxide was observed in southwest part of the study area, which comes under Karnataka University and maximum concentration of sulphur dioxide was observed in northwest part of the study area which comes under Belur industrial area.

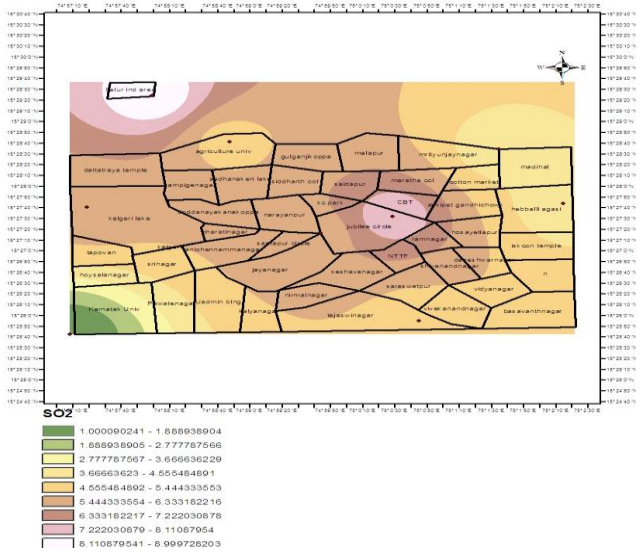

Fig.11 Dharwad: Sulphur Dioxide Concentration

VI. CONCLUSIONS

Based on the above finding the following conclusions can be drawn.

The atlas we developed helps to demarcate the buffer areas. This information is critical to select a suitable location for:

- New industries
- Type of industry
- Number of industries
- Pollution control board can use this model to decide upon location for new industries.
- Helps ecologists and environmentalists to evolve suitable techniques for maintenance of healthy environment.

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