PRESENTATION OF AIR POLLUTION DATA USING GIS : A CASE STUDY

Ashish Dhamaniya

Department of Civil Engineering, S.V. National Institute of Technology, Surat (INDIA)

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ABSTRACT

Air pollution is becoming one of the biggest dangers for the future of the planet, causing premature deaths of humans and damaging flora and fauna. With their vantage point from space, satellites are the only way to carry out effective global measurements of air-polluting emissions. Air pollution in Indian cities are very visible now a days due to rapid urbanization, commercialization, and industrialization and it has now acquired a threatening posture, although of course, the problem has become gigantic only in some of our big cities, where either the industries are concentrated or there are too many automobiles. The impact of Air Pollution occurs in front of us as ‘Acid Rains’, Green House effect, increasing concentration of Ozone, Carbon mono Oxide etc. which creates hazardous problems on human beings as well as on vegetation. The present paper describes the pollution prevention rules in the country, special action plan prepared for sensitive area and an attempt is made to show the Air Pollution level in Agra city. As the Taj Trapezium Zone being declared as a sensitive region by Ministry of Environmental and Forests, Govt. of India. Central Pollution Control Board (CPCB) installed and operating four monitoring stations at Taj Mahal, Itmad – ud – daulah, Rambagh and Nunhai respectively. First three are basically the city locations whereas Nunhai is the industrial area where the pollution level is highest due to industries. Data on Suspended Particulate Matter (SPM), Respirable Suspended Particulate Matter (RSPM), Sulphur di oxide (SO$_2$) and Nitrogen di oxide (NO$_2$) for all the days (24 hours/day and 365 days/year) are being generated from these representative locations. It is visible that the pollution level in Taj Zone is decreasing from last three successive years. RSPM level reduced from 147 to 125 µgms/m$^3$, SPM level from 369 to 252 µgms/m$^3$, NO$_2$ concentration reduced from 22 µgms/m$^3$ to 12 µgms/m$^3$ similarly SO$_2$ concentration from 7 to 4.5 µgms/m$^3$. This reduction in pollution level is mainly due to the development of green belt all around the Taj Mahal. In the same manner Thematic Maps are also generated by using the GIS technology to have a clear vision on the pollution level during summer and winter seasons and it is seen that pollution level is more in winter season rather then the summer which is due to the fact that in the winter season the average mixing height is less as compared to summer seasons.

Key Words: Acid rain, Green house effect, SPM, RSPM, Air pollution.

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INTRODUCTION
Air pollution was not very visible in our country, only up to a decade ago. However, due to rapid urbanization, commercialization, and industrialization, it has now acquired a threatening posture, although of course, the problem has become gigantic only in some of our big cities, where either the industries are concentrated or there are too many automobiles. The impact of Air Pollution occurs in front of us as Acid Rains, Green House effect, increasing concentration of Ozone, Carbon mono Oxide etc. which creates hazardous problems on human beings as well as on vegetation.

Protection of environment stressed in the sixth five-year plan. During this plan period, a separate Department of Environment was set up on November 1, 1981, at the National level. Air pollution was also recognized, and a Central Legislation, called Air (Prevention and Control of Pollution) Act, 1981, was enacted. Under this Act, the Air (Prevention and Control of Pollution) Rules 1982 were notified by GOI on November 18, 1982. Then the Board for Prevention and Control of Water Pollution has been entrusted with additional charges of looking after prevention and control of air pollution control also. A third act, called The Environment (Protection) Act, 1986 has also been promulgated by the Parliament after the occurrence of the Bhopal Gas Tragedy. This act extends to whole of India, and Central Government has been empowered for taking any measures, which in its opinion are necessary for improving and protecting the environment. Side by side, in order to check the emitted smokes from badly maintained automobiles, containing too much of lead, carbon monoxide and particulate matter, a fourth legislation, called Motor Vehicles Act, 1988, has been passed by the parliament. The implementation of exhaust standards framed under Central Motor Vehicle Rules 1989 was to come into force with effect from July 01, 1989. However, due to non-availability of monitoring equipments, like smoke-meters and gas-analyzers, for checking the quality of exhaust emissions, and also due to political and other influences, this act largely remains on the statue books of the country.

Realizing the need for ambient air quality objectives, the Central Pollution Control Board (CPCB) has developed various emission standards for all most all type of major and medium industries in the country and to know the performances of these standards, the CPCB also monitoring ambient air quality at 300 odd stations across the country. The city of Agra though not a major city, but comes under this category. The historical data on ambient air quality being not available, in the paper attempts have been made to interpret the data with the help of GIS information.

MATERIAL AND METHODS
In the present study an attempt is made to show the Air Pollution level in Agra city. As the Taj Trapezium Zone being declared as a sensitive region by Ministry of Environmental and Forests, Govt. of India, Central Pollution Control Board (CPCB) installed four monitoring stations at Taj Mahal, Itmad – ud – daulah, Rambagh and Nunhai respectively and are being operated by CPCB. Data on Total Suspended Particulate Matter (TSPM), Respirable Suspended Particulate Matter (RSPM), and Sulphur di oxide (SO₂) and Nitrogen di oxide (NO₂) for all the days (24 hours/day and 365 days/year) are being generated from these representative locations. The primary objective of such extensive and monitoring is
to know the dispersion of pollutions generated from the industrial areas so as to ascertain the impact of industrial emission on Taj Mahal and other important monuments located in the city and close proximity. From the collected data Thematic Maps, are generated by using GIS Software to show the pollution level in the city. Geographical Information System (GIS) is a computerized mapping tool capable of assembling, storing, manipulating and displaying geographically referenced information, i.e., data identified according to their locations and Thematic Mapping is a powerful way to analyze and visualize our data. It gives graphic form to the data so that we can see it on a map. Patterns and trends which are almost impossible to detect in lists of data, reveal themselves clearly when thematic shading is used to display the data on the map.

These maps are based upon the average values of pollutants during the summer and winter season. In this way the very first step is taken to digitize the map from survey of India map and the location of monitoring stations are picked up on the map. Data in the form of average concentration of pollutants are assembled with their specific locations. Thematic maps are generated by using the software capability to show the concentration of the pollutants over the entire zone and based upon these maps conclusions are made.

Study area
Agrabana—it means Paradise, in Sanskrit—offers the modern traveler an unforgettable experience of beauty and history, enlivened with a host of rich anecdotes. On this journey into the fabled past, the traveler enters a world where every stone, pillar and marble slab speaks of the consummate artistry of the Mughals and their love of all things beautiful.

Agra was a leading educational center during the time of the Mughals. The origin of Urdu, a fine blend of Hindi and Persian, is traced to Akbar’s court. The origin of Agrabana in all probability goes back to ‘Arya Griha’ (abode of the Aryans), in the green belt of the Yamuna and the Ganga where the Earliest Aryans settled. Agrabana is also referred to in the great Hindu epic, Mahabharata. Eventually, according to the historian Tallboys Wheeler, ‘Arya’ and ‘Griha’ were abbreviated and became ‘Agra’—The city of Taj Fig. 1.

![Fig. 1: Study Area](image-url)

Taj Mahal
It has been described as an “a tender elegy in marble”, a “lustrous pearl”. The delicate Makrana marble of this world-famous tomb takes on different hues from sunrise to sunset; it is cool and dreamy at dawn, sun kissed and gleaming by morning, golden-tinged and warm by day, dazzling and soft by sunset, remote and ethereal by moonlight.
Several of artists from Baluchistan, Syria, Bokhara, Baghdaa, Samarkand and South India were brought to assemble this stupendous creation. The mausoleum took 17 years to complete by a labor force of 20,000 who were housed in a new village, Taj Ganj, which still stands. The cost of the Taj is estimated today at more than 700 million rupees. Legend relates that, on completion of the construction of Taj Mahal, Shah Jahan ordered the chief mason’s right hand to be cut off because he wanted to be sure that no copy of this wonderful building would ever be made.

RESULTS AND DISCUSSION

Data collected from the four monitoring stations in the form of excel spreadsheet are used to join it with the GIS tool. Although these data are collected throughout the year from last three years, we have just taken into account the previous year data to generate the maps. Based upon the data, Thematic Maps are prepared to show the concentration of pollutants for previous year and in winter and summer seasons. Similarly the yearly variation shows that the concentration is reducing from last three years in the Taj zone.

![Fig. 2 : SPM Concentration during summer and winter](image-url)
Fig. 3: RSPM Concentration during summer and winter

Fig. 4: NO$_2$ Concentration during Summer and Winters
Fig. 5: SO₂ Concentration during summer and winter

The Thematic Maps (Fig. 2 and Fig. 5) gives us the actual picture of the concentration of pollutants. From the maps it is very clear that the concentration of pollutants at Taj is very less as compare to the other stations, this is due to the formation of green belt all around the Taj. The seasonal comparison shows that the pollutants concentration is higher in winter as compare to summer; this is due to the fact that in the winter season the average mixing height is less as compared to other seasons. The dispersion of pollutants is very less which increases the atmospheric stability. Due to this reason concentration of the pollutants increases in the winter seasons. In rainy season, the concentration of all the pollutants is very low as compared to other seasons. This is because of this reason that in rainy season due to humidity the gases and suspended particles present in the atmosphere settle down. Hence due to blowing wind these pollutants are taken away from there point of origin. The concentration of sulphur dioxide is found to be less than its maximum value.

This is because of the use of C.N.G and L.P.G. engines in automobiles. Rather these maps are based upon the average value of pollutants; it is very difficult to reach the exact value at a time, as the concentration may be change even in a day but we can easily predict the future conditions from the GIS tool. Here we have discarded the abrupt values because they may be due to the sudden change in the atmospheric conditions.
Steps taken to control air pollution in Agra

1. Due to the sensitiveness of Taj Mahal Govt. of India established Taj trapezium zone and also Taj Trapezium Zone Pollution (prevention and Control) Authority whose chief tasks are:
   - To observe Taj Trapezium Zone Project.
   - To see whether the industries are fulfilling the emission standards or not.
   - Conservation of environment as well as development of Taj Trapezium Zone.
   - To implement the law as per the Environment (Prevention) Act 1986.

2. On the basis of Vardrajan Committee report “Impact of Mathura Refinery on Environment” thermal power generation plant in Mathura Refinery was closed and the railway yards were electrified.

3. As per the directives made by the honourable Supreme Court, 212 Industries in Agra and Firozabad was closed.

4. As per the directives made by the honorable Supreme Court, 45 brick kilns located in 20 km. dia meter from Taj Mahal was closed (Dated 10.5.1996).

5. As per the directives made by the honorable Supreme Court, dated 30.12.96 the sulphur recovery plant was established in the Mathura Refinery.

6. The use of unleaded petrol and sulphur diesel was started in Agra.

7. As per the directives made by the honorable Supreme Court (Dated 14.11.2000) the use of diesel and petrol vehicles inside 500 m diameter from Taj Mahal was banned.

8. As per the directives made by the honorable supreme court dated 27.7.2000 the Regional Transportation Office of Agra standardize the life of different vehicles inside Agra they are:
   - For Auitorickhaw-10 years (from the date of Registration)
   - City bus - 8 years (from the date of Registration)
   - Personal buses - 10 years (from the date of Registration)
   - on different routes.

9. The use of scrubber in diesel vehicles and generator with silencer was started.

10. The use of C.N.G in place of coal in the Petha Industries was started.

Different policies are still running by which air quality control can be achieved which is also an important aspect and has equal importance as the city development has.

CONCLUSION

The pollutant generated as stack emission or as tail pipe, due to human activity is statistically insignificant, but nevertheless poses great concern or danger because it contains more toxic elements or compounds as opposed to natural pollution. Industrial air pollution is often around human habitation resulting in the living population being badly affected. Wind profile, atmospheric chemistry viz. humidity, temperature and topography are the major meteorological factors, which govern the dispersal and disposal of pollutants from the source into the surrounding atmosphere. The mechanics commonly used for control of pollution are (a) dilution method by means of better...
dispersion is done in case of stack diameter, stack height, flue gas temperature; (b) cleaning of air to remove or recover suspended solid in the flue gas emission (viz. bag filters, electrostatic precipitator, cyclone etc.), liquid (use of scrubber in the system) and vapours (use of absorbers); (c) substitution method as has been done in case of benzene in place of heavy metal in gasoline; (d) reduced use of substances as has been done in case of percentage composition of sulfur in diesel; (e) use of clean fuel as has been done in Delhi for use of CNG in place of diesel, use of natural gas in glass industries in Firozabad; (f) proper land use pattern as has been done for demarcation of industrial site based on the topography, wind direction, population density etc. (g) plantation of green belt towards restriction of pollutants to travel and act on sensitive area / protected area. Among all these technologies as described above, the most trusted concept is to prepare the Environmental Management Plan for the city/ area. The most important aspect is as under:

- Need for planned development with specific focus on area-wide improvement, restrictions relocation of certain activities, and improvement in the road networks;
- Enlistment of Urban Economy by selective enhancement of certain category of industries, trade and commerce tourism are as well as specialization in certain economic activities;
- Measures for protection of environmental resources and;
- Management of air quality, water quality and solid waste management

The high RSPM levels are mainly attributed to vehicular pollution. The vehicle population is exponentially increasing in most of cities. This is the single major factor for high RSPM. It is observed that highest level of RSPM in residential areas was observed in Ahmedabad followed by Kanpur, Solapur. Lucknow, Delhi, Bangalore, Dehradun, Thiruvananthapuram, Kolkata, Rourkela, Nagpur, Pune, Jaipur, Cochin, Hyderabad, Mumbai, Angul, Parwanoo, Visakhapatnam and Chennai. The concentration of RSPM not only depends on total emission load but on meteorological conditions like ventilation, inversion, humidity, wind direction and velocity, rainfall pattern and thus a city with low emission load may have high ambient air concentrations of pollutants. Lower levels of RSPM are observed during monsoon months possibly due to wet deposition. Higher levels of RSPM are observed during winter months possibly due to lower mixing heights and more calm conditions. The annual average concentration in residential areas varies between 253 µgms/m$^3$ in Ahmedabad and 34 µgms/m$^3$ in Shillong in industrial areas the annual average concentration varied between 262 µgms/m$^3$ in Ahmedabad and 26 µgms/m$^3$ in Kozhikode. Dhamaniya A. (2003) studied on pollution in Jaipur City. On the basis of the collected data he generates thematic maps and found that the pollution level at the major road corridors are higher then the prescribed limit even the road conditions are fair and widened roads exists. He concluded that the increasing numbers of vehicles are the major reason of increased pollution. He suggests the new traffic plan to avoid the concentration of pollutants. In spite of this certain recommendation has been made from the study. These are as follows:
1. The poor road condition of Yamuna Bank road is also increases the pollution level. As this is one of the major road and the vehicles goes from Delhi to Gwalior has to cross this road. The road should be rehabilitating.

2. A Bye pass road should give to the vehicles that go to Delhi to Gwalior route.

3. The Bijlighar Bus stand should be shifted to Transport Nagar.

4. The seriousness of pollution is so much that certain policies should be made to control the increasing rate of pollution concentration in the atmosphere.

5. The data for RSPM, SPM, Sulphur dioxide and Nitrogen dioxide is not sufficient since it does not give us any information about sources of pollution. So, emphasis should be given to collect the data of pollution with its source of emission. Also industrial development should be correlated with environmental conditions.

REFERENCES


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