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Acid Rain & Atmospheric Pollution

Indian Institute of Tropical Meteorology, Pune

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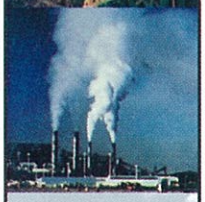
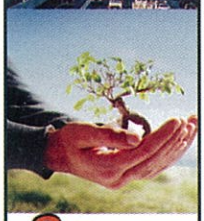





Contents

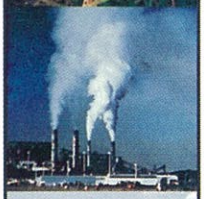
Editorial

We are happy to bring out this ENVIS Newsletter's first issue of Volume 9. The issue focuses on the ***SAFAR*** *(System for Air Pollution Forecasting and Research) project which is supposed to be one of the major steps taken by our country for increasing local awareness about air pollution. The issue covers the work carried out in the project and other related details therein.*

We thank to all who contributed with their valuable suggestions for our newsletters, it would be highly appreciated if you could keep up for our future improvement.











Making of SAFAR: A Journey towards Reality

"SAFAR" which stands for System of Air quality Forecasting And Research will be one of the prestigious scientific achievements of India in the year 2010. For the first time, India will be having a system for forecasting pollutants in air. This major project is undertaken in the view of the Commonwealth Games(CWG) which will be held at Delhi in 2010. This project on pollutant monitoring and forecasting, is being developed by the Ministry of Earth Sciences, Government of India. In this project, the part of air quality monitoring and forecasting for pollutants is being done by the Indian Institute of Tropical Meteorology, Pune whereas the part of weather monitoring and forecasting will be done by the India Meteorological Department(IMD). Till date, only a few developed countries have demonstrated the strength towards developing such a kind of system during major games like during the Olympic Games in Beijing, China and Melbourne, Australia. However, after successful running of this SAFAR project, India will be among the few countries to take a big leap in environmental research.

The system SAFAR basically comprises of four essential components:

(1) Experimental Component: Setting up pollution monitoring stations to measure respective pollutant levels along with automatic weather station within the model domain (around 50 km^2 area of Commonwealth Games(CWG) - village in Delhi).

(2) Data Collection and Assimilation: The data collected on a particular day along with meteorological parameter data will be processed by the modelling team.

(3) Computational Modelling: The respective data sets will go as input to the air quality forecasting model which will be run on high performance computer at IITM or at Delhi on daily basis by the dedicated team of scientists to predict the air quality of Delhi 24 hours in advance in 4 km x 4 km grid resolution.

(4) Display: Once 24 hour advance forecast is obtained, it will be transmitted to central server remotely and will be displayed along with

current level on hourly basis (24x7) in simple public friendly way.

Briefly, information of air quality on real time basis (hourly) and forecast the future level of pollution a day in advance at various key locations of Commonwealth Games(CWG-2010) through wireless true color digital display panels will b provided. This information about pollutant levels provided on day-to-day basis and the forecast will be helpful in deciding the mitigation strategies towards controlling the pollution levels. Additionally, the model will also be able to identify the hot spot regions for mitigation measures. SAFAR system will forecast the levels of air pollutants such as: Ozone, Oxides of Nitrogen (NOx), Carbon Monoxide (CO), Particulate Matters ($PM_{2.5}$, PM_{10}), Black Carbon, Benzene, Toluene and Xylene. For this, monitoring stations will be set up in and around the Games venues in Delhi. The monitoring stations are just one room facilities, each of which has nine automatic Air Quality (AQ) analysers (see figure 1) which measure the pollutants and one Automatic Weather Station (AWS) which record parameters like temperature, pressure, wind speed, direction, rainfall, heat and humidity.

Figure 1. Air Quality Analyzers

The pollutant and weather related data from all the stations will be collected through GSM network and stored in a centrally situated SAFAR server and IMD server respectively (Figure 2). The data will further be processed as an input to the air quality forecasting model. This model will be run on high performance computer at IITM, Pune on daily basis by the dedicated team of scientists to predict the air quality of Delhi 24 hours in advance. Once the 24 hour advance forecast is obtained it will be transmitted to central server remotely and will be displayed on the display boards in

simple public friendly way in terms of Air Quality Index (on Delhi's geographical map, bar chart, color animated diagrams etc.). The Air Quality Index (AQI) will be calculated as per the latest standards released by MoEF for India. The display boards will also display environmental friendly messages along with the advisory on how to keep the clean environment. In addition, the current and forecasted AQI data of the CWG venues will also be made available online on SAFAR website.
(http://safar.tropmet.res.in/)

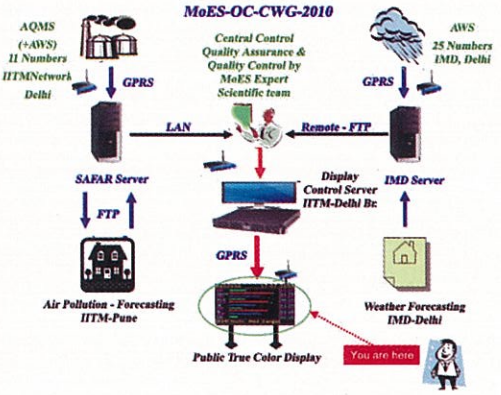


Figure 2. Working of SAFAR

Pollutants generally originate from industries, hence surveys and climatology studies have been carried out. In addition, the emission sources are also identified, and information on emission levels and patterns has also been gathered in advance by the involved scientists. Accordingly meteorological data for pollutant monitoring and prediction have been generated which will prove to be extremely important during the forecasting.

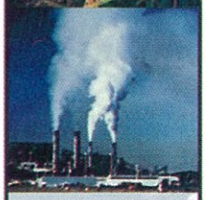
Thus in conclusion, the data collected during SAFAR project will greatly help and guide in planning the mitigation strategies to achieve the motto of CWG i.e. Green Games, as we will be in a position to identify the major sources of air pollutants and can take immediate measure to improve the air quality. The data will be further utilized to fulfill purely the scientific research objectives of the Ministry of Earth Sciences.

Air Quality Index: Indian Scenario

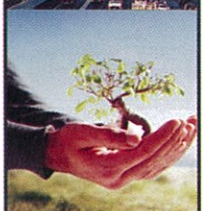
Air Quality Index (AQI) used for reporting the daily air quality asserts about the quality of air we breathe in and the associated health effects. Air pollution is a well-known environmental problem all around the world. Various monitoring programmes have been undertaken to know the quality of air by generating vast amount of data on concentration of each air pollutant like: O_3, NO_x,










CO, Particulate Matter (PM_{10}, $PM_{2.5}$ etc.) in different parts of the world. However, the large data fails to convey the air quality status to the scientific community, government officials, policy makers, and in particular to the general public in a simple and straightforward manner. Nevertheless, one can overcome this problem by determining the Air Quality Index (AQI) of a given area.

The AQI is a rating scale ranging from 0 to 500 as per the Environmental Protection Agency (EPA) which is meant for reporting the ambient air pollution recorded at monitoring sites on a particular time scale (e.g., daily). The main objectives of AQI comprise of (a) informing and cautioning the public about the risk of exposure to daily pollution levels and (b) enforcing required regulatory measures for immediate local impact. The higher the AQI value, the greater the level of air pollution and health risk. Although the AQI itself is simply a number which reflect some aspects of air quality, in practice it is associated with color schemes, graphics, air quality category labels such as: "good", "moderate" or "poor", and various messages so that its meaning is easily interpreted to a layman. As per the USEPA, AQI values below 100 are considered to be satisfactory, if not good. When AQI values are above 100, the air quality is considered to be unhealthy at first for certain sensitive group of people, and then as the AQI value rises it is considered to be unhealthy for everyone. To mention, so far no consensus has reached to freeze the range of AQI yardstick and so it needs to be fixed by the respective countries as per their convenience.

India revised the Air Quality Standards recently. The revised Indian NAAQS (2009) for criteria pollutants are summarized in Table 1. As per the norms, the residential & industrial areas have the same standards. As such, it is difficult to incorporate these standards into a reference scale. Further, the awareness of high air pollution concentrations and or even the frequency of with which the NAAQS are exceeded is not sufficient for the citizens to assess the air quality. The general public needs information on the levels and potential health risks of air pollution presented in simple, understandable format. Thus, an AQI needs to be developed for India

based on the health criteria of the USEPA and the revised Indian air quality standards.

Pollutants	Time - weighted Average	Concentration of Pollutants in Ambient Air	
		Industrial, Residential, Rural and Other Area	Ecologically Sensitive Area
Ozone (O_3), µg/m³	8 h *	100	100
Carbon Monoxide (CO), µg/m³	8 h *	02	02
Nitrogen Dioxide (NO_2), µg/m³	24 h *	80	80
Particulate Matter (size less than 10 µm) (PM_{10}) µg/m³	24 h *	100	100
Particulate Matter (size less than 2.5 µm) ($PM_{2.5}$) µg/m³	24 h *	60	60

(* 24 hourly or 08 hourly monitored values, as applicable, shall be compiled with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.)

Table 1: Revised Indian NAAQS (2009)

In India, based on the maximum operator concept, determination of overall AQI for some of major cities in India has been carried out by scientist. The maximum value of sub indices of each pollutant was taken to represent overall AQI of the location. However, the mathematical equations for calculating sub-indices were developed by considering the health criteria of the EPA (1998) of the Environmental Protection Agency (1998) and Indian NAAQS (Central Pollution Control Board, 2000) which needs to be revised based on the new standards. Thus considering the above mentioned fact of revised air quality standards and the relevant literature survey an AQI has been defined as shown in (Table-2). For reflecting the air quality status and its effect on human health, the range of index values has been designated as "Good", "Moderate", "Poor" and "Very Poor". The key reference point in the calculated AQI value is 100 indicating a safe limit is based on the attainment of NAAQS for India.

In case of ozone, an in depth study was carried out under the project, simulations for the temporal and long-term trends in ozone. The precursors are made on regional scale using the three dimensional chemistry transport model. Theoretical work was complemented by regular observations (Round-the-clock) of ozone and its precursors. It was noticed that the high levels of ozone in this region are usually reported in the afternoon and early evening. In a typical Indian urban site, ozone variations during summer and winter are 30-75 ppb and 10-85 ppb respectively (here 'ppb' indicates part per billion of ozone molecule in total volume of air). During the monsoon season these level shows the significant decrease because of insufficient photo-chemical energy for the production

of ozone and other wash out effects of the ozone precursors, varying between 10 ppb to 30 ppb. The ozone standards in USA by EPA and in some of the European countries are fixed on the basis of 8 hr average values. However, for the Indian region to a great extent, conditions are of diverse quality. These includes availability of solar radiation (Day Time) which varies to very high extend according to season, solar flux is more due to tropics, average temperature is comparatively higher from western countries and average humidity is also relatively high. This temperature and humidity difference will decrease the overall lifetime of ozone in the Indian sub-continent. The duration for which population is exposed to the ozone is also different in Indian region. Thus considering all the above mentioned factors, the revised Indian standards and USEPA norms the breakpoints for Ozone were decided.

Sr. No.	Description	AQI Index	Ozone (8h avg.) (ppb)	CO (8h avg) (ppb)	NO_2 (24h avg.) (ppb)	PM_{10} (24h avg.) ($\mu g/m^3$)	$PM_{2.5}$ (24h avg.) ($\mu g/m^3$)
1.	Good	0 -100	0 -50	0 - 1.7	0 - 42	0 - 100	0 - 28.6
2.	Moderate	101 -200	51- 90	1.8 - 10.3	43 - 94	101 - 150	28.7 - 107.1
3.	Mildly Poor	201-300	91-129	10.4 - 14.7	95 - 295	151 - 350	107.2 - 249.9
4.	Poor	301-400	130 & above	14.8 & above	296 & above	351 & above	250 & above

Table 2: Proposed AQI Sub-index & breakpoint pollution concentration for India

Thus in summary, a preliminary AQI for India is now proposed by incorporating the new revised NAAQS standards, the available data and based on the scientific judgment, understanding and knowledge of the subject.

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