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# MODELING OF AMBIENT FOR RSPM AND SPM POLLUTANTS THROUGH ARTIFICAL NEURAL NETWORK IN SENSITIVE AREA OF UJJAIN CITY

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**Key words:** Ambient air quality, Artificial neural network, RSPM, SPM, Vehicular exhaust emission (VEE), Mean square error (MSE).

## ABSTRACT

**This paper aims to analyze the pollutant level of the sensitive area in Ujjain. Application of Artificial Neural Network analyzes the pollutant RSPM and SPM. The result reported pertains to a site successive preliminary air sampling excessive carried out at selected location in Ujjain mahakal temple. The Artificial neural network system was run by giving the inputs of meteorological data's and giving the outputs of concentration of various pollutants and accordingly the estimation of Errors was done by this study. Analysis of consecutive four years of data from the sensitive area through ANNS has been found, the concentrations of RSPM = 53.91 and SPM = 195. High volume sampler was used to measure the concentration of critical pollutants RSPM and SPM. This model calculates pollution concentrations due to observed traffic, meteorological and pollution data after an appropriate relationship has been obtained empirically between these parameters. The system is made of various devices which have to be chosen based on the characteristics of the pollutant: aerosol, solid particles, and droplets or gaseous. The chosen framework and facilities depend on the type of the pollutant: aerosol, solid particles, and droplets or gaseous. There are a number of basic parameters which have to be considered in order to define air pollution control devices. This study represents a modeling of the named parameters which are related to the framework and facilities of air pollution control. In order to set the optimal parameters of a purification device, a deterministic model of the process of purification should be determined.**

## INTRODUCTION

Air pollution modeling is a numerical tool used to describe the causal relationship between emissions, meteorology, atmospheric concentration, depositions and other factor. About 60 percent of air pollution in Indian cities is due to automobile exhaust, emission of sulphur dioxides (SOx) and nitrogen dioxides (NOx) which has adverse effects on surrounding ecosystem. Air pollution is a complex issue, fuelled by multiple sources ranging from vehicular exhaust, industrial emissions, emissions from fossil fuels, construction activities to domestic activities. Air pollution may cause

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pernicious effects on human health, especially in areas with high population density. Forecasting air quality is one of the most sought after topic of research today for urban air pollution studies and specifically for prediction of pollution episodes i.e. high Pollutants concentration causing adverse health effects. Air quality models play a vital role in all aspects of air pollution control and air quality planning, where prediction is a major component. Air quality forecasts provide the public with air quality information which allows people to take precautionary measures to avoid or limit their exposure to unhealthy levels of air pollution. Hence it is quite essential to predict criteria pollutants. Artificial neural network began with the pioneering work of MCCulloch and pitts and has its root in rich interdisciplinary history from the early 1993s (McCulloch and Pitts, 1993). The reduction of the number of vehicles circulating and there for fossil fuel consumption decreases emissions and greenhouse gases outcome related to on road traffic sector (Fenger, 1999).

Air pollution in urban centers are associated with sudden occurrence of high concentration of vehicular exhaust emissions (VEEs), which are generally governed by the local meteorology and dispersion mechanism (Nagendra and Khare, 2002a). Since the relationship of VEE with the meteorology and traffic characteristic data is highly nonlinear, both deterministic and statistical models under perform in predicting the air quality (Nagendra and Khare, 2002a). Monitoring of air pollutants is a prerequisite to air quality control. Their impact on the chemical composition of plants is often used as an indicator of and a tool for monitoring environmental pollution (Posthumus, 1984; Agrawal and Agrawal, 1989 and Dmuchowski and Bytnerowicz, 1995).

The main objectives of these methods include investigating and assessing trends in air quality, making environment forecasts and increasing scientific understanding of the mechanisms that govern air quality (Thompsonn *et al.*, 2001). Air pollution is highly correlated with meteorological variable's (Cogliani, 2001). This is regarded as an intelligent, cost-effective approach and has received much attention in environmental engineering.

Air pollution is highly correlated with variable's (Cogliani, 2001). To data studies of predictions of RSPM and SPM levels in downtown Hong Kong are still limited (Luet *et al.*, 2002; Lo, 2003) and greatly needed to allow pollution control and environmental assessment.

This paper represents a part of a wider study concerning air purification from pollutants originating from small sources. Integrated air pollution control devices, consists of two or more air purifying mechanisms whose combination should improve the efficiency with which impurities are collect. Those impurities are heterogeneous and they are present in a limited air stream production with a limited concentration. such a model is often difficult to construct since physical and chemical characteristic of the source of pollution are not completel known (Todorovic, 2000).

## MATERIAL AND METHOD

### Artificial Neural Network (ANN)

An artificial neural network is a mathematical model inspired by biological neural networks. A neural network consists of an interconnected group of artificial neurons, and it processes the information's using a connectionist approach to computation. Neural networks are used to model complex relationships between inputs and outputs or to find patterns in data.

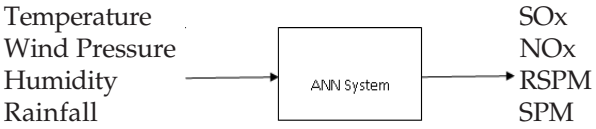


**Fig. 1** The Artificial Neural Network system

### Data sets

The data used in this study are daily ambient air temperature, relative humidity, air velocity and daily concentration of SPM and RSPM, in Ujjain for 3 years period from 2009, 2010, and 2012. All of these data were provided by Ujjain (M.P) central pollution control board (CPCB) Department of pollution control (DOPC). The data was divided into two sets which is learning set for Artificial Neural Network training and testing set to verify the efficiency and correctness of the developed model.

### Measurement of SPM

High volume air sampler was used for the monitoring of particulates. Before sampling, the wattman filter GFA (20.3cm x25.4cm) of the high volume sampler was kept at 15=34 °C, 50% relative humid-

ity for 24=hour and then weighed. The mass concentration of suspended particulates in ambient air, expressed in micrograms per cubic meter, was calculated by measuring the mass of particulates collected and the volume of air sampled.

**Experimental data**

Monthly data $SO_X$, $NO_X$, RSPM, SPM concentration data have been collected from State Pollution Control Board for the period of 4 years from Jan 2010 to 2012.The meteorological data including wind pressure, temperature, humidity, rainfall have been collected from meteorological department. ANN has been used to develop the model for given data's. The inputs to model are directly connected to the quantity of information given to the neural network and was generally constituted from meteorological and air quality data. Four inputs are given as meteorological data. The output corresponding to these inputs was monthly average $SO_X$ , $NO_X$, RSPM , SPM concentration. The number of hidden layers and its neuron, learning rate (g), momentum term (McCulloch and Pitts, 1993), learning algorithm and activation function, depend on the problem complexity viz. the number of training patterns and the amount of noise in the data.

An ANN is typically defined by three types of parameters:

1. The interconnection pattern between different layers of neurons
2. The learning process for updating the weights of the interconnections.
3. The activation function that converts a neuron's weighted input to its output

## RESULTS AND DISCUSSION

In this survey and after the experimentation it was found that the air pollutants were greatly affected the selected areas in years 2009, 2010, 2011 and 2012 as shown in figure .

In 2009,As shown in Figure 2, the concentration of RSPM was 278 µg/m3 and SPM was 33 µg/m3 found as maximum in the month of October and these pollutants were found minimum i.e. RSPM was 97 µg/m3 and SPM was 33 µg/m3 and accordingly due to this the pollution load was high in this area.

In year 2010, As shown in Figure 3, the concentration of RSPM was 221µg/m3 and SPM was 75 µg/m3 found as maximum in the month of May and these pollutants were found minimum i.e. RSPM was 150 µg/m3 and SPM was 51 µg/m3 in August.

In year 2011, As shown in Figure 4, the concentration of RSPM was 91.5 µg/m3 and SPM was 33 µg/m3 found as maximum in the month of May and these pollutants were found minimum i.e. RSPM was 101.5 µg/m3 and SPM was 181.5 µg/m3 in August.

In 2012, As shown in Figure 5, the concentration of RSPM was 136 µg/m3 and SPM was 63.25 µg/m3 found as maximum in the month of May and these pollutants were found minimum i.e. RSPM was 78 µg/m3and SPM was 38.6 µg/m3.

**Comments on Using Neural Networks**

1. It is relatively easy to model using neural networks, in part because there are many commercial software available that are very user friendly; consequently, the modeling can be done without any extensive knowledge of coding.
2. The time taken to obtain the solution is usually less than or equal to the time taken by traditional models.
3. When modeling, using neural networks, a physical equation is not obtained that can predict the number of trips. But instead, a trained network is obtained which has weights stored in it. This is one of the criticisms of the researchers who support logit and other traditional models that give a physical equation. But, it is to be noted that, the trained network is as good as an equation and can be directly used on new data for predicting the output.

## CONCLUSION

In this study, model sets were developed. The set of ANN models were used to predict RSPM and SPM

**Table 1.** Result Tabulation

| Year | 2009 | 2010 | 2011 | 2012 | |
|---|---|---|---|---|---|
| Pollutant | RSPM (Min.) | 97 | 150 | 33 | 78 |
| | (Max.) | 278 | 221 | 91.5 | 136 |
| | SPM (Min.) | 33 | 51 | 101.5 | 38.6 |
| | (Max.) | 92 | 75 | 181.5 | 63.25 |

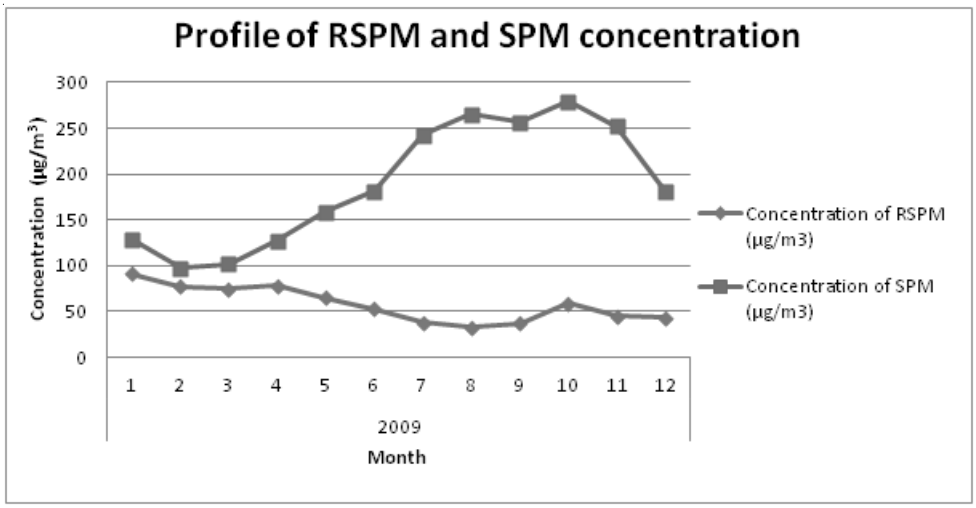


**Fig. 2** The concentration of RSPM and SPM in year 2009

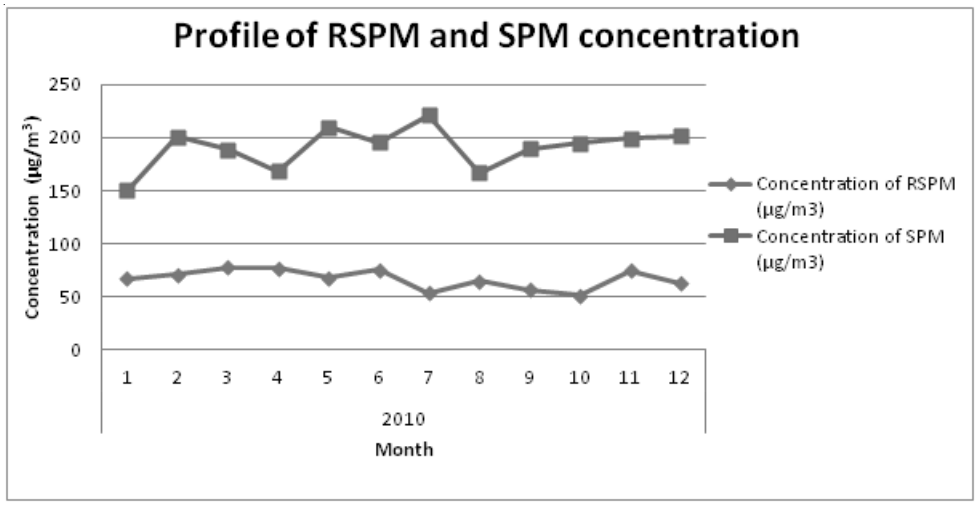


**Fig. 3** The concentration of RSPM and SPM in year 2010

emissions. The objective of developing these models is to discover the relationship of the levels of acid ions concentrations at each monitoring sites, i.e. sulphate, nitrate, with the corresponding gaseous pollutants, RSPM and SPM. Based on mass balance, it has been assumed that RSPM is deposited into the environment primarily as sulphate ion and SPM is deposited primarily as nitrate. Our main goal is to obtain a model of the air pollution control device. We shall assume that there is a nonlinear, non-stationary dependence between the bearing gas parameters (temperature, humidity, wind and rain), the bearing gas flow volume and the pollutant concentration. The only information about this nonlinear dependence is obtained through the measurements. In this paper, the study was carried out on modeling of air pollutants like SOx, NOx, SPM and RSPM using Artificial Neural Network. The study was focused at the estimation of the Mean Square Error (MSE) from the inputs and outputs which were given to ANN in the industrial area of Ujjain City in India. The investigation was carried out by giving inputs of meteorological datas like Temperature, Humidity, wind pressure and rainfall and giving outputs of collected datas of the various concentration of Pollutants from State Pollution Control Board and accordingly the mean square error was found in all cases was in the range of 0.01-0.03.

The results shown here are indications that the neural network techniques can be useful tool in the

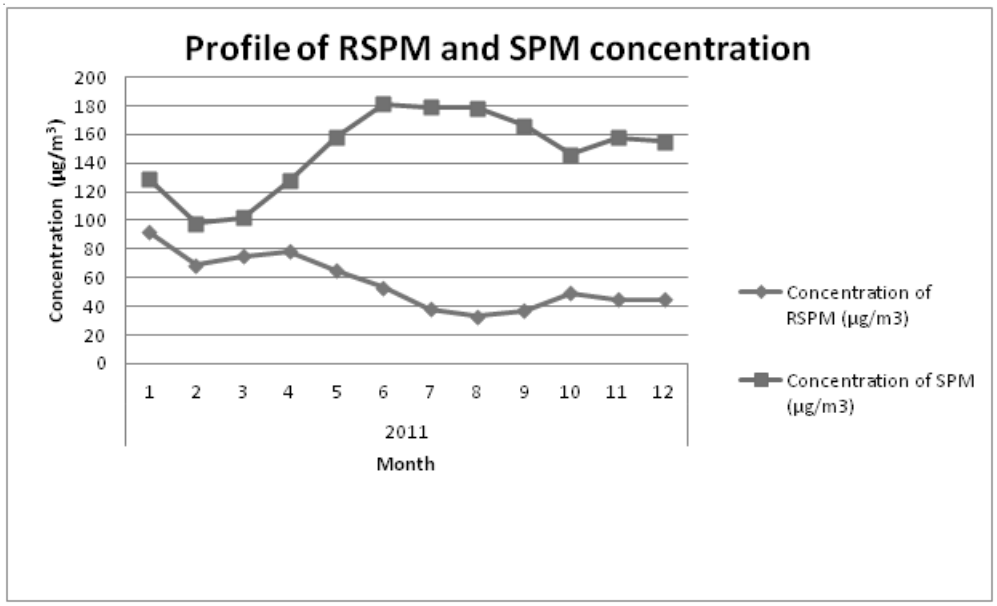


**Fig. 4** The concentration of RSPM and SPM in year 2011

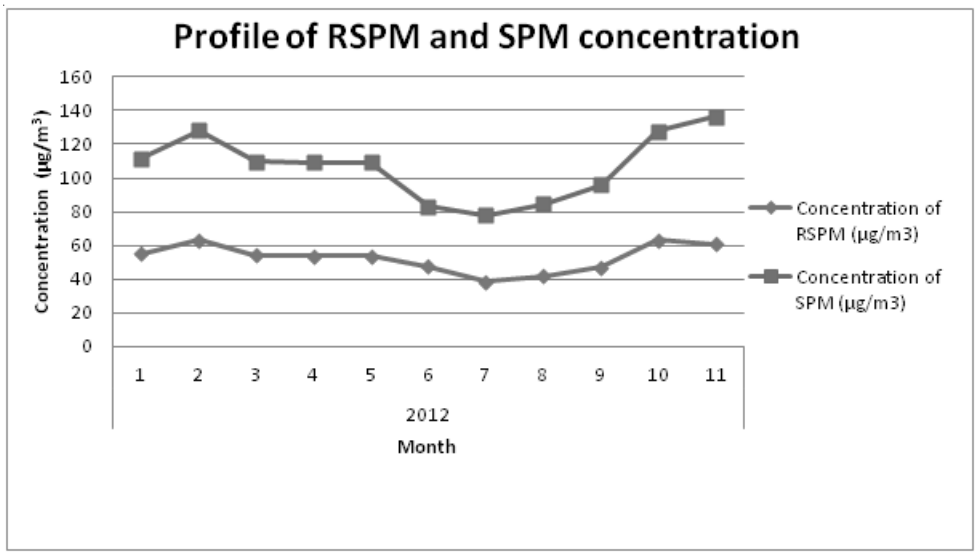


**Fig. 5** The concentration of RSPM and SPM in year 2012

hands of practitioners of air quality management and prediction. The models studied in this study are easily implemented, and they can deliver prediction in real time, unlike other modeling techniques.

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