

## Modeling of Ambient Air Pollutants for RSPM and SPM Through Artificial Neural Network In Industrial Area of Ujjain City

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### Abstract

*The aim of this study was modeling of ambient air pollutants through ANN in industrial area of Ujjain city in India and the study was carried out on modeling of air pollutants like SPM and RSPM using Artificial Neural Network. Artificial neural networks (ANN), whose performances to deal with pattern recognition problems is well known, are proposed to identify air pollution sources. The ANN 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. The monthly data's in year from 2009 -2012 of meteorological data's like Temperature, Humidity, wind pressure and rainfall and the pollutants concentration were collected from the State Pollution Control Board. The ANN system used, as shown in figure 1, analyses all these data's and finds the error coming during the experiment. The study estimated the Mean Square Error (MSE) from the inputs and outputs which were given to ANN in the industrial area of Ujjain City in India was found satisfactory being in the range of 0.001-0.003. The results shown here indicate that the neural network techniques can be useful tool in the 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.*

### Introduction

The growth of both an industrial and residential area is unplanned in many developing cities of India, thus, contributing to the air pollution problems. About 60 percent of air pollution in Indian cities is due to automobile exhaust emission. Automobiles produce volatile organic compounds (VOC), suspended particulate matter (SPM), oxides of sulfur (SO<sub>x</sub>), oxides of nitrogen (NO<sub>x</sub>) and carbon monoxide (CO), which have adverse effects on surrounding ecosystem. Air pollutants exert a wide range of impacts on biological, physical, and economic systems. The decrease in respiratory efficiency and impaired capability to transport oxygen through the blood caused by a high concentration of air pollutants may be hazardous to those having pre-existing respiratory and coronary artery disease (Rao et.al. 2000).

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 (Rao, 1977; Posthumus, 1984, 1985; Agrawal and Agrawal, 1989; Kulump et al., 1994; Dmuchowski and Bytnerowicz, 1995). The modeling and forecasting of environmental parameters involves a variety of approaches. Artificial neural networks (ANN), developed in recent years, can handle nonlinear systems and have been used to model pollutant concentrations with promising results (Gardner and Dorling, 1996, 1998 ;). This is regarded as an intelligent, cost-effective approach and has received much attention in environmental engineering.

In recent years, feed - forward ANN trained with the back - propagation have become a popular and useful tool for modeling various environmental systems, including its application in the area of air pollution and vehicular exhaust emissions modeling under the complex urban conditions.

### Materials 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.

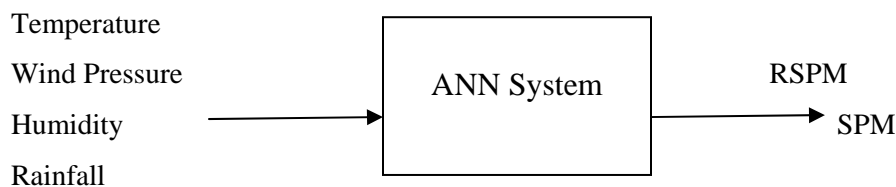


Figure .1 the Artificial Neural Network System

#### Air Pollution Monitoring Instruments:

The monitoring instrument is usually composed of three components, air remover, transducer and recorder. The air remover measures the flow rate of air and the pressure under which gas pollutants exist. The transducer measure a physical property, while the recorder notes change in physical property of gaseous pollutant. The instrument should be checked for response time, specificity, sensitivity, noise level, maintenance and downtime and overall accuracy.

### Measurement of Spm:

High volume air sampler was used for the monitoring for suspended particulates matter. Before sampling, the watt man filter GFA (20.3cm x25.4cm) of the high volume sampler was kept at 15-34 °C, 50% relative humidity for 24-hour and then weighed. The filter paper was placed into the filter holder of the high volume sampler and air was drawn through a 410 cm<sup>2</sup> portion of the filter at the flow rate of 1.70m<sup>3</sup>/min. The filter was removed after sampling. The concentration of suspended particulates in ambient air can be calculated by measuring the mass of particulates collected and the volume of air sampled.

### Experimental Data:

Monthly data of RSPM and 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 RSPM and SPM concentration. The number of hidden layers and its neuron, learning rate (g), momentum term (l), 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 had 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 91.4 µg/m<sup>3</sup> and SPM was 178 µg/m<sup>3</sup> found as maximum in the month of January and these pollutants were found minimum i.e. RSPM was 33 µg/m<sup>3</sup>

and SPM was  $58 \mu\text{g}/\text{m}^3$  in month of August and accordingly due to this the pollution load was high in this area.

In 2010, as shown in figure 3, the concentration of RSPM was  $154 \mu\text{g}/\text{m}^3$  and SPM was  $319 \mu\text{g}/\text{m}^3$  were found maximum in the month of May and these pollutants were found to be minimum i.e. RSPM was  $82 \mu\text{g}/\text{m}^3$  and SPM was  $168 \mu\text{g}/\text{m}^3$  in the month of November.

In year 2011, As shown in figure 4, the concentration of RSPM was  $153 \mu\text{g}/\text{m}^3$  and SPM was  $313 \mu\text{g}/\text{m}^3$  found as maximum in December and these pollutants were found minimum i.e. RSPM was  $88 \mu\text{g}/\text{m}^3$  and SPM was  $180 \mu\text{g}/\text{m}^3$  in the month of July.

In 2012, As shown in figure 5, the concentration of RSPM was  $145 \mu\text{g}/\text{m}^3$  and SPM was  $294 \mu\text{g}/\text{m}^3$  found as maximum in the month of April and these pollutants were found minimum i.e. RSPM was  $97 \mu\text{g}/\text{m}^3$  and SPM was  $196 \mu\text{g}/\text{m}^3$  in the month of August.

## Conclusions

In this paper, the study was carried out on modeling of air pollutants like RSPM and SPM 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 data's like Temperature, Humidity, wind pressure and rainfall and giving outputs of collected data's 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 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.

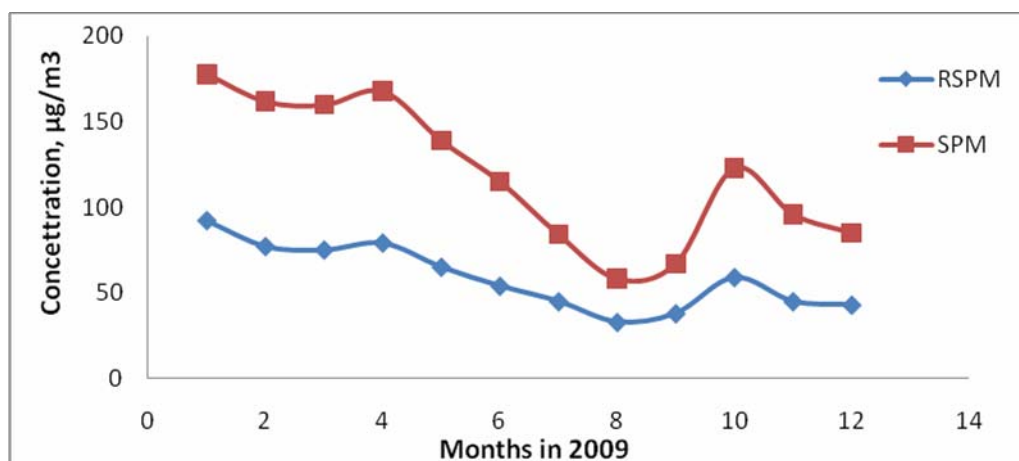


Figure .2 Concentrations of RSPM and SPM in Year 2009

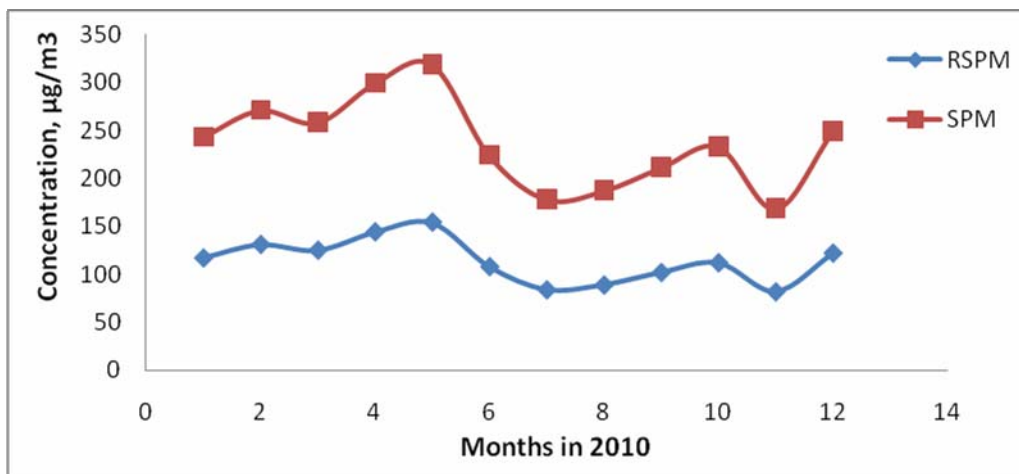


Figure .3 Concentrations of RSPM and SPM in year 2010

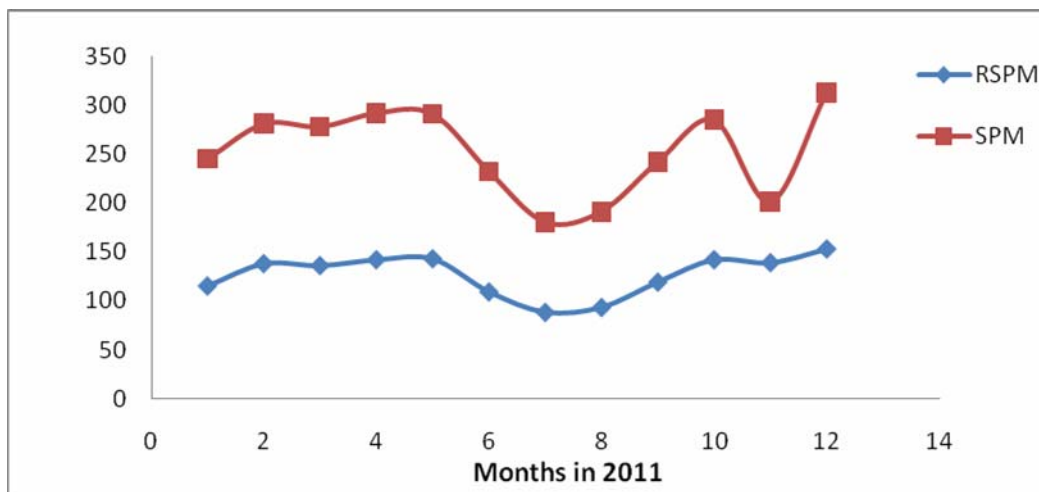


Figure .4 Concentrations of RSPM and SPM in year 2011

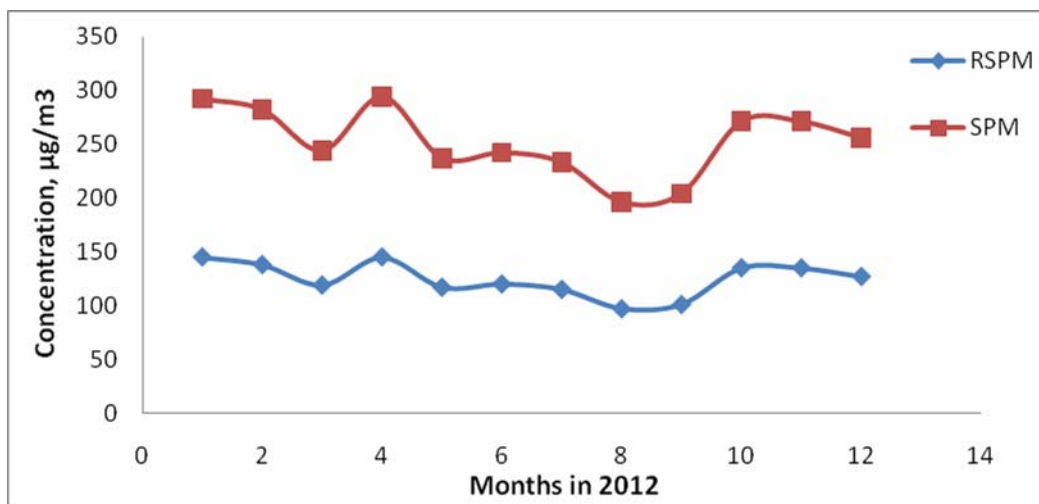


Figure .5 Concentrations of RSPM and SPM in year 2012

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