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MODELING OF AMBIENT FOR SOx AND NOx POLLUTANTS THROUGH ARTIFICAL NEURAL NETWORK IN INDUSTRIAL AREA OF UJJAIN CITY

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ABSTRACT

The aim of this study was the 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 SOx and NOx, using Artificial Neural Network. The ANN system was run by giving the inputs of meteriological datas and giving the outputs of concentration of various pollutants and accordingly the estimation of Errors was done by this study. The monthly datas in year from 2009 -2012 of meteorological 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 analyse all these datas and find 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 as in the range of 0.001-0.003. 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.

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 produces volatile organic compounds (VOC), suspended particulate matter (SPM), oxides of sulfur (SOx), oxides of nitrogen (NOx) 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

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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 modelling under the complex urban conditions.

MATERIALS AND METHODS

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 informations using a connectionist approach to computation. Neural networks are used to model complex relationships between inputs and outputs or to find patterns in data.

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.

Fig. 1 The Artificial Neural Network system

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 SOx

Sulphur dioxide from the air stream is absorbed in a sodium tetrachloromercurate solution it forms a stable di chlorosulphitomercurate. The amount of sulphur dioxide was then estimated by the color produced when prosaniline hydrochloride is added to the solution. The color was estimated by a reading from an absorption meter or spectrophotometer for which a calibration curve has already been prepared.

Measurement of NOx

Jacob's and Hochheiser method is used to determine the oxides of nitrogen.Nitrogen oxides as nitrogen dioxide are collected by bubbling air through a sodium hydroxide solution to form a stable solution of sodium nitrate. The nitrite ion produced during sampling was determined colorimetrically by reacting the exposed absorbing reagent with phosphoric acid, sulphanilamide, and N (i-napthyl) ethylenediamine dihydrochloride.

Experimental data

Monthly data SOx and NOx 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 SOx and NOx 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

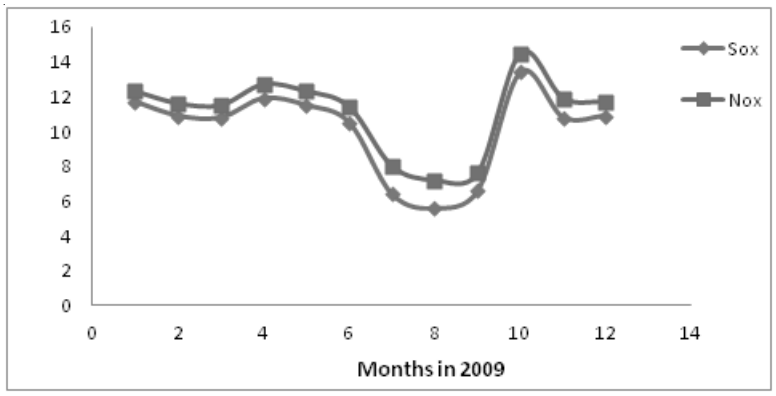

Fig. 2 The Concentration of SOx and NOx in year 2009

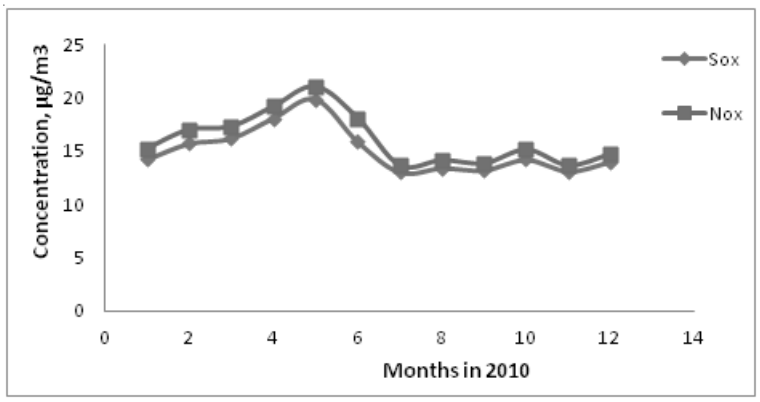

Fig. 3 The Concentration of Sox and NOx in year 2010

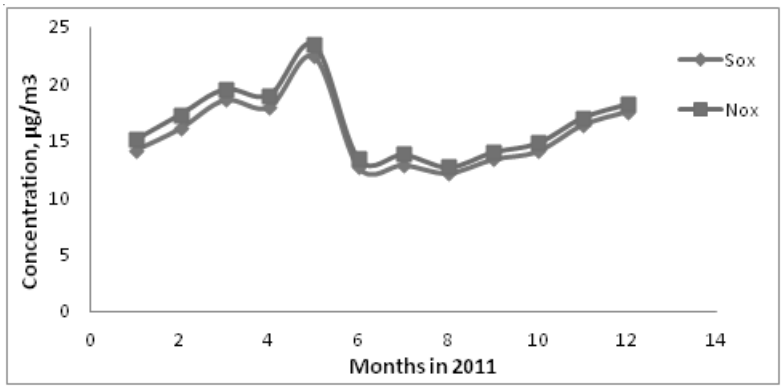

Fig. 4 the concentration of SOx and NOx in Year 2011

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 SOx was 13.4 µg/m^3 and NOx was 14.5 µg/m^3 found as maximum in the month of October and these pollutants were found minimum i.e. SOx was 5.6 µg/m^3 and NOx was 7.2 µg/m^3 and accordingly due to this the pollution load was high in this area.

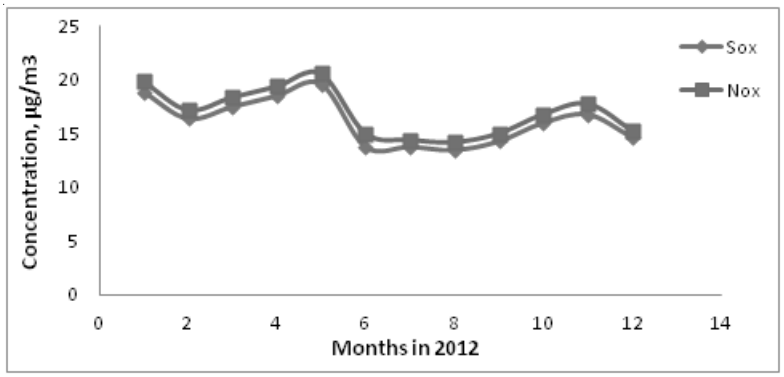

Fig. 5 The Concentration of SOx and Nox in year 2012

In 2010, As shown in Figure 3, the concentration of SOx was 19.9 µg/m^3 and NOx, was 21.1µg/m^3 were found to be maximum in the month of may and these pollutants were found to be minimum i.e. of SOx was 13 µg/m^3 and NOx, was 13.6µg/m^3 in the month of July.

In year 2011, As shown in Figure 4, the concentration of SOx was 22.4 µg/m^3 and NOx was 23.4 µg/m^3 found as maximum in the month of May and these pollutants were found minimum i.e. Sox was 12.2 µg/m^3 and NOx, was 12.7 µg/m3 in August.

In 2012, As shown in Figure 5, the concentration of Sox was 19.6µg/m^3 and NOx was 20.6 µg/m^3 found as maximum in the month of May and these pollutants were found minimum i.e. Sox was 13.5 µg/$m^3$and NOx was 14.2µg/m^3.

CONCLUSION

In this paper, the study was carried out on modeling of air pollutants like SOx and NOx 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 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.

REFERENCES

Agrawal, A. and Agrawal, S.B. 1989. Phytomonitoring of air pollution around a thermal power plant. *Atm. Environ*. 23 : 763-769.

Dmuchowski, W. and Bytnerowicz, A. 1995. Monitoring environmental pollution in Polland by chemical analysis of scots pineneedles. *Environ. Pollut*. (87) : 87-104.

Gardner, M.W. and Dorling, S.R. 1996. Neural network modelling of the influence of local meteorology on surface ozone concentrations. *Proceedings of 1st International Conference on Geo Computation, University of Leeds*, pp. 359–370.

Gardner, M.W., Dorling, S.R. 1998. Artificial neural networks (the multi-layer feed-forward neural networks)-a review of applications in the atmospheric sciences. *Atmos. Environ*. (30) : 2627–2636.

Kulump, A., Klumpp, G. and Domingos, M. 1994. Plants as bioindicators of air pollution at the serra Do Mar near the industrial complex of Cubatao, Brazil. *Environ. Pollut*. 85 : 109-116.

Mehendra, S.P. and Krishnamurthy, D. 2005. Impact of introduction of one way traffic system on ambient air quality. *Pollution Research*. 24 (1) : 213-216.

Nagendra, S.M.S. and Khare, M. 2002a. Line source emission modeling review. *Atmos Environ*. 36 (13) : 2083–2098.

Posthumus, A.C. 1984. Monitoring levels and effects of air pollutants. In: *Air Pollution and Plant Life* (Eds: M. Treshow), John Wiley & Sons. New York, U.S.A., pp. 73-95.

Posthumus, A.C. 1985. Plants as a bioindicators for atmospheric pollution. In: *Pollutants and Their Ecotoxicological Significance*, (Ed: HW. Nurnberg), John Wiley and Sons. New York, U.S.A., pp. 55-56.

Rao, M.N. and Rao, H.V. 2000. *Air Pollution*. Tata McGraw-Hill, New Delhi.