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Analysis of Air Pollutant Levels using Artificial Neural Network in Chennai City

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ABSTRACT

Air pollution is one of the important ecological and human health issues. Economic expansion, urbanization, transportation, rapid population growth, industrial wastages are powerful forces of air pollution in large cities. Chennai signifies a diverse pollution challenge in atmosphere. Its annual average pollution levels are lower than other mega cities but the pollution level is still changing between moderate to critical. In this paper Thiy agaraya nagar (T. Nagar), Anna Nagar, Adyar and Kilpauk have been selected for air pollution analysis in Chennai city and it explores respirable suspended particular matter (RSPM), sulphur dioxide (SO_2), and nitrogen dioxide (NO_2) pollutants level and compare these air pollutants emission levels in Chennai city. As per the national ambient air quality monitoring standards, the RSPM, SO_2 and NO_2 levels are 60, 50, and 40 respectively. Outdoor air pollution is the fifth leading cause of deaths in India. The ambient air pollution is a health threat. It is more essential in developing area in Chennai within the environment of pollution level and population density. Refining air quality has significant, determinate and important public health benefits.

Keywords: Air Pollution, Artificial Neural Network, Chennai City, Pollutant, RSPM, SO_2, NO_2

I. INTRODUCTION

Air pollution means the pollutant presence in the atmosphere. It contains one or more contaminants such as dust, fumes, gas, mist, odour, smoke or vapour. Air pollution is one of the dangerous environmental concerns of Indian cities, especially Chennai, where poor air quality came from over population. It is the accretion in the atmosphere of substances that inadequate concentrations. It is dangerous to human health or produces other measured effects on living matter and other materials. Vehicle, power, industry and heat generation are the major sources of pollution, the burning of solid waste, industrial processes, and transportation which is shown in Figure 1.RSPM, **SO_2 and NO_2** pollutants have been taken in four areas in Chennai for analysis. In urban areas, maximum effect of air pollution is generated by vehicles.

Rapid urbanization and growth of motor vehicles impose a serious effect on human life and its environment in recent years. Most of the cities of India are being suffered by extremely high level of urban air pollution particularly in the form of CO, SO2, NO2, PM (Particulate Matter) and RSPM (Respirable Suspended Particulate Matter). Transport sectors contribute a major share to environmental pollution around 70% andaccording to the year 2013 Global Burden of Disease estimates, one-fifth of deaths across the world occur from outdoor air pollution. Also, outdoor air pollution is the fifth leading cause of deaths in India [9].

A neural network model is a connectionist model that simulates the biophysical information processing occurring in the nervous system. So, even though connectionist models and neural network models have same meaning in some literature, we prefer to regard connectionist models as a more general concept and neural networks is a subgroup of it. A preliminary definition of neural network is a computing system, it highly interconnected processing elements and these processing elements (neurons) inspired by the way biological nervous system, such as the brain processing elements given by Kevin Gurney. Artificial Neural Network (ANN) is made up of huge number of extremely interconnected processing elements working

with simultaneous performance to solve specific problems. The simulation of neural network appears to be in recent years. Neural networks are usually structured in layers.We give the input values or patterns to the network via 'input layers' which communicates to one or more 'hidden layers'. The definite processing is done through a system of weighted 'connections' then hidden layers communicate to an 'output layers' and produce the answer as output. Most ANNs have some form of 'learning rule'. Neural networks have been successfully implemented in many industries to real world business problems. Neural networks are best at recognizing patterns or trends in data and they are well suited for prediction or forecasting needs like sales forecasting, industrial process control, customer research, data validation, risk management and target management.

1.2 Sources of Air Pollution

The sources of air pollutions are factories, smelters, power plants, dry cleaners, degreasing processes, cars, buses, trucks and trains. The naturally occurring sources like volcanic explosion and windblown dust and human being activities also affect the atmosphere. Air pollution makes worse improvement in the environment if the country has many industries.

II. METHODS AND MATERIAL

A. Objectives Of The Study

The study analysethe air pollution concentrations in Chennai city and its aims of following:

- Analyse the air pollution range among T.Nagar, Anna Nagar, Adyar and Kilpauk areas using Artificial Neural Network.
- To find out the maximum air pollution emission level in among the above said areas.
- To find out the sources of the air pollution of the above said four areas.

B. Literature Review

Rapid Urbanization and growth of motor vehicle enforce a series of effect on air pollution due to road side transportation shrivastavet al developed an integrated transport and environmental program, measures time, behavioural changes in transport demand and develops environmentally substantial transport system. The work also suggested alternative fuels and effective public transport system [1]. The work by sharad Gokahle from IIT, Guwathi explores sampling procedures including analysis, sample locations, period of sampling, auxiliary measurements and processing data [2].

The work done by Sharma et al is used to find out the vehicular pollution concentration due to observed traffic using ANN modelling with multiple regression and time series analysis in meteorological area [3]. Anita Dubey [4] compares the different types of air quality models and studiesthe complex phenomenon of air pollution. Gaussian models, narrow plume models, box models, trajectory models and gradient transport models are the basic models of air pollution modelling.The work by Tharit et alpredicts the air pollution based on the inputs like roadside fine particles, wind speed and traffic using Artificial Neural Network. It showed the predicted result has been good for $PM_{2.5}$andchanges the environment [5].

Madhavi et al have developed the ANN model for predicting NO_2concentrations using eight predictor variables like wind speed, wind direction, solar radiation, temperature, relative humidity as well as "hour of the day", "day of week" and "month of the week". These input variables are used to identify the air pollution concentration in meteorological area [6].The exceedencesconcentrations were calculated and predicted PM_{10}pollutant level in industrial area in Malaysia using the cumulative density function (cdf) from the best-fit distributions. They use four performance indicators; they are mean absolute error (MAE), root mean squared error (RMSE), coefficient of determination (R^2) and prediction accuracy (PA) for determine the best-fit distributions [7].

C. The Analytical Study

MATLAB (matrix laboratory) is a multi-pattern, high performance language for numerical computing environment. It is an interactive system which integrates computation, visualization, and programming and it has Graphical User Interface (GUI) which is easy-to-use. Matlab includes tools for emerging, handling, debugging, and summarizing M-files, MATLAB applications. Matlab provides Neural Network (NN) toolbox which has methods and manyapplications for modelling multipart nonlinear system. With the help of Neural

Network toolbox we can design, train, visualize and simulate neural networks. In our analysis we use MATLAB 7.6.0 (R2008a), Neural Network Fitting tool.

This Neural Network Fitting tool has two-layer feed-forward and enough hidden layers network with using sigmoid hidden neurons and linear output neurons (newfit). The network trained with "Levenberg-Marquardt back propagation" algorithm (trainlm). The RSPM/PM10, SO_2, NO_2 pollutants level collected which the areas are T.Nagar, Anna nagar, Adyar and Kilpauk from "Tamil Nadu Pollution Control Board (TNPCB)" at Guindy in Chennai.The air pollution components emission levels for the year 2014 are considered for this analysis.

Table 1: Estimated Pollution level in T.Nagar, Anna Nagar, Adyar and Kilpauk at 2014

S.No	Month and Year	City	RSPM / PM10	SO2	NO2
1	JAN-14	ANNA NAGAR	72	15	19
2	JAN-14	T NAGAR	103	21	27
3	JAN-14	ADYAR	64	17	21
4	JAN-14	KILPAUK	80	23	26
5	FEB-14	ANNA NAGAR	79	17	23
6	FEB-14	T NAGAR	98	26	31
7	FEB-14	ADYAR	65	15	21
8	FEB-14	KILPAUK	91	23	30
9	MAR-14	ANNA NAGAR	77	12	17
10	MAR-14	T NAGAR	100	17	23
11	MAR-14	ADYAR	65	13	17
12	MAR-14	KILPAUK	94	17	24
13	APR-14	ANNA NAGAR	66	14	20
14	APR-14	T NAGAR	113	19	26
15	APR-14	ADYAR	49	13	18
16	APR-14	KILPAUK	85	19	26
17	MAY-14	ANNA NAGAR	73	14	20
18	MAY-14	T NAGAR	115	18	29
19	MAY-14	ADYAR	46	13	18
20	MAY-14	KILPAUK	76	20	28
21	JUN-14	ANNA NAGAR	78	13	20
22	JUN-14	T NAGAR	109	18	31
23	JUN-14	ADYAR	72	13	19
24	JUN-14	KILPAUK	103	19	31
25	JUL-14	ANNA NAGAR	108	13	18
26	JUL-14	T NAGAR	106	17	79
27	JUL-14	ADYAR	67	12	17
28	JUL-14	KILPAUK	131	18	30
29	AUG-14	ANNA NAGAR	59	13	30
30	AUG-14	T NAGAR	132	16	44
31	AUG-14	ADYAR	52	13	20
32	AUG-14	KILPAUK	81	17	25
33	SEP-14	ANNA NAGAR	58	14	26
34	SEP-14	T NAGAR	76	19	31
35	SEP-14	ADYAR	50	13	20
36	SEP-14	KILPAUK	67	19	26
37	OCT-14	ANNA NAGAR	51	13	23
38	OCT-14	T NAGAR	76	18	28
39	OCT-14	ADYAR	53	13	19
40	OCT-14	KILPAUK	74	16	24
41	NOV-14	ANNA NAGAR	68	14	22
42	NOV-14	T NAGAR	97	18	28
43	NOV-14	ADYAR	51	14	19
44	NOV-14	KILPAUK	93	19	27
45	DEC-14	ANNA NAGAR	66	16	21
46	DEC-14	T NAGAR	96	21	29
47	DEC-14	ADYAR	51	14	20
48	DEC-14	KILPAUK	78	20	27

Figure1: Air pollution in Chennai city

III. RESULTS AND DISCUSSION

Comparison of RSPM in different places of Chennai city

0– below 60µg/m^3, **1**- 60µg/m^{3}to 99µg/m^3, 2 – above 99µg/m^3

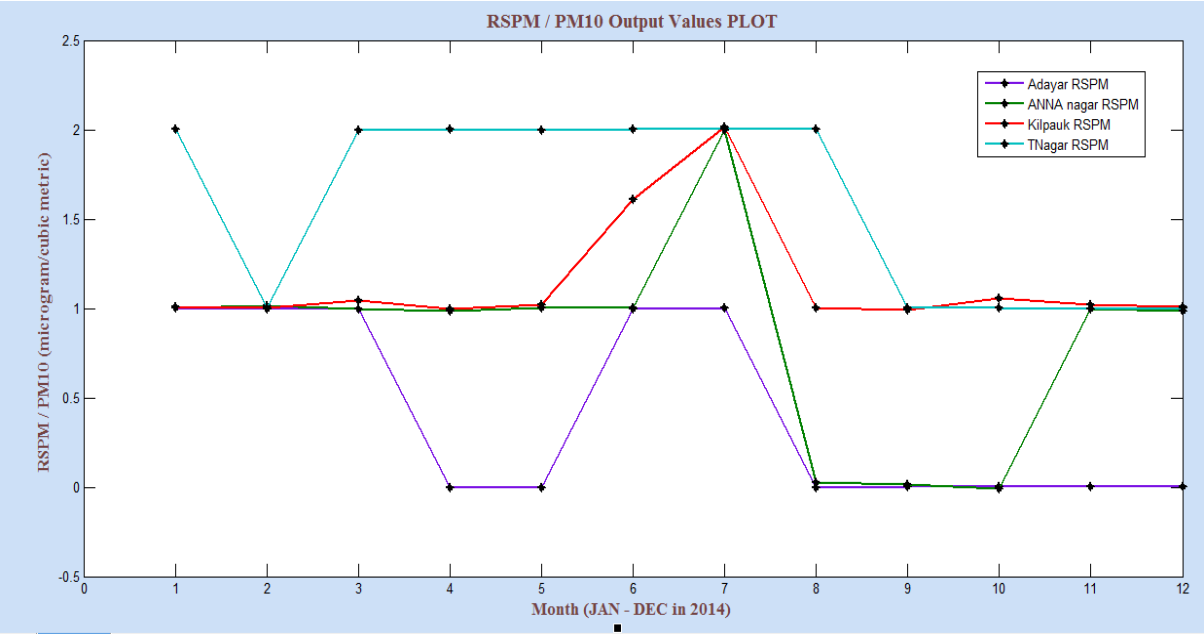

Figure.2: RSPM/PM10 comparison level in T.Nagar, Anna nagar, Adyar and Kilpauk areas in Chennai

Comparison of SO_2 in different places of Chennai city

0- below 14 µg/m^3, **1**- 14 µg/m^{3}to 20 µg/m^3, **2** – above 20 µg/m^3

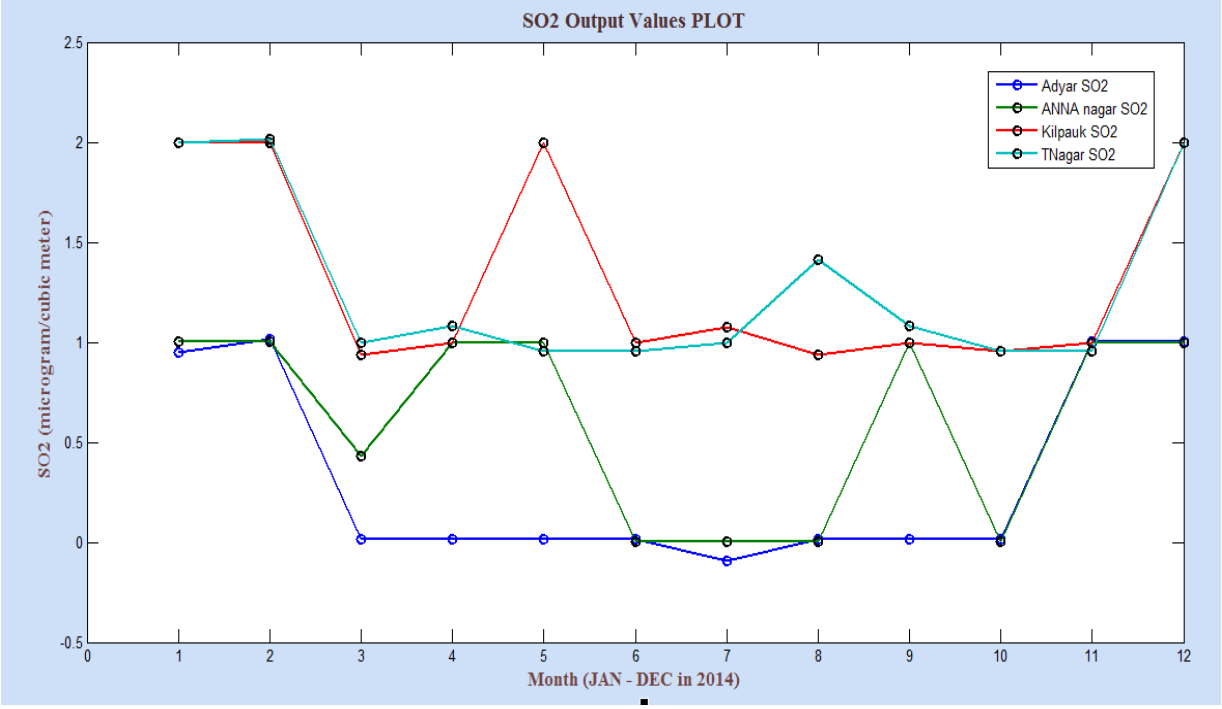

Figure.3: SO_2 comparison level in T.Nagar, Anna Nagar, Adyar and Kilpauk areas in chennai

Comparison of NO_2 in different places of Chennai city

0-below 20 µg/m^3, **1**- 20 µg/m^3 to 29 µg/m^3, **2**– above 29 µg/m^3

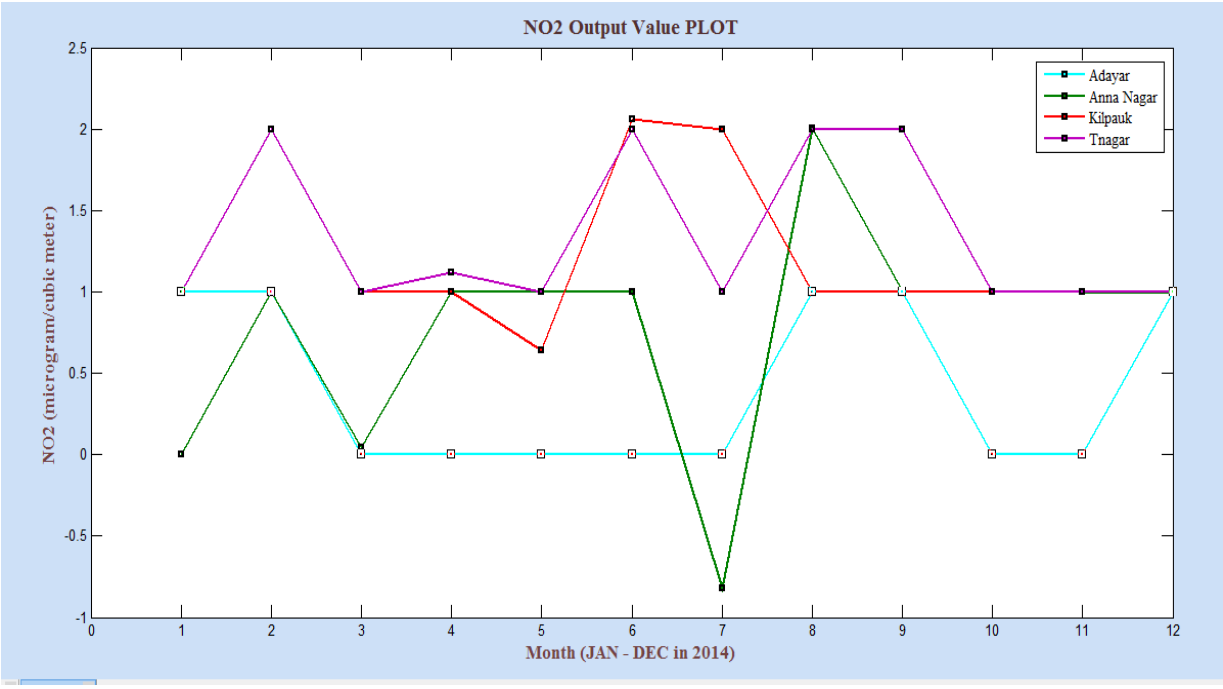

Figure.4: NO_2 comparison level in T.Nagar, Anna Nagar, Adyar and Kilpauk areas in Chennai

a) Air Pollution level in T. Nagar

The Figure.2 to Figure.4 shows that T.Nagar area is the most polluted one among the other areas. Compared to the other areas, particle pollutants (RSPM, SO_2 and NO_2) are more in T.Nagar. T.Nagar is affected more because of increased transportation and population. T.Nagar is known for its road-side shops, textile showrooms and shopping malls which lead to increased moving population. Moreover all the vehicles routing to

Mambalam, Ashok Nagar, K.K. Nagar, Saidapet, Guindy etc have to pass through T.Nagar and its acts as a gateway leading to increased pollution. T.Nagar and the surrounding areas have many small and medium scale industries. Construction work of metro rail also leads to pollution.

b) Air Pollution level in Anna Nagar

In Anna Nagar area, the residential places look so bad because of air pollution. Anna Nagar area is a heavy traffic area it forms thick smog in the air. The roads are so dusty and it produces maximum RSPM pollution in air. Pollution experts point out 80% of vehicular emission increases RSPM levels in Anna Nagar and vehicular emission also plays larger role in the steady increase of RSPM levels [8]. RSPM and NO_2 pollutants are gradually increased here. Based on the input data the plot(Figure.2 to Figure.4) explores SO_2 and NO_2 pollutants levels are low compared to RSPM. Building Construction works and metro rail work are the main sources of air pollution. A dust fog looks to be constantly floating over us.

c) Air Pollution level in Adyar

Adyar air pollution level has been growing rapidly in the last decade and it will cross the permissible limit shortly. In Adyarthe RSPM emission level is high compared to other pollutants. Particulate matter has been increased 40% in the last seven years which is shown in TNPCB [8]. The industrial units, automobiles, vehicle population, construction of complexes, restaurants are increasing in Adyar. This is the main reason for traffic. Trees are help to trap pollutants in air but most proprietors cut them down to create more space for profitable establishments and buildings.$SO_2$and NO_2 are levels low compared to other three cities. The pollutant levels in Adyar like RSPM, SO_2 and NO_2have gone from 'good' to 'satisfactory'.

d) Air Pollution level in Kilpauk

The Kilpauk is the second most polluted area in among four areas based on the plot outputs. The RSPM levelhas crossed the permitted level due the metro rail construction and thousands of vehicles are going through Kilpauk daily. Kilpauk placed in Ponnamalle high road, so it is the main way to Chennai Mofussil Bus Terminus (CMBT). It increases the pollution level in atmosphere. The RSPM, SO_2 and NO_2 emission level also increased gradually in Kilpauk after T.Nagar air pollution emission level. According to the Centre for Science and Environment (CSE) analysis, vehicles contribute 70% for NO_2emission [10]. Insufficient sweeping of roads, fossil fuels also play an important role in Kilpauk environmental changes.

IV. CONCLUSION

Over the last few decades, the increased process of industrialization and urbanization, coupled with rapid population expansion has caused atmosphere degradation. In particular, T. Nagar, Kilpauk and Anna Nagararea, the pollutant RSPM/PM10 level even exceeds air quality guidelines recommended by the Tamil Nadu Pollution Control Board (TNPCB). Particulate and gaseous emissions of pollutants from vehicles and industries exhaust are responsible for rising uneasiness, increasing airborne diseases, decreasing efficiency and respiratory illness. SO2 and NO2 pollutants are moderate level in Chennai city. The major sources of air pollution include vehicles, road dust, fuel burning, and construction activities. In conclusion T. Nagar area has polluted more than other three areas. In T. Nagar area majority of the population is exposed to poor air quality.

V. FUTURE ENHANCEMENTS

The work can be extended to predict pollution level in future for the above said four areas. The same work can be extended to other cities in Tamilnadu to analyse the air pollution levels and also to take prevent measures to control pollution levels. So we can discover alternative ways for cleaner, greener environment without air pollution.

VI. REFERENCES

[1] R. K. Shrivastava, Saxena Neeta, GautumGeeta, "Air Pollution Due to Road Transportation in India: A Review on Assessment and Reduction Strategies", Journal of Environmental Research and Development, Vol.8 No.1, July-September, 2013.

[2] Dr.SharadGokahle, "Air Pollution Sampling and Analysis", Indian Institute of Technology, Guwathi, May 2009.

[3] N. Sharma, K.K Chaudhry, C.V. ChalapatiRao, "Vechicular Pollution Modelling using artificial neural network technique: A review", Journal of Scientific & Industrial Research, Vol. 64, September 2005.

[4] Anita Dubey, "Air Pollution Modeling for Human Exposure Predictions: A Review", Research Journal of Recent Sciences, Vol. 3 (ISC-2013), 24-27 (2014).

[5] Tharit, Issarayangyum, Stephen Greaves, "Predicting Fine Particulate Concentrations near a Busy Intersection in Sydney using Artificial Neural Networks", July, 2007.

[6] MadhaviAnuskhaElangasinghe, NareshSinghal, Kim N. Driks, Jennifer A. Salmond, "Development of an ANN-based air pollution forecasting system with explicit knowledge through sensitivity analysis", Atmospheric Pollution Research 5, 2014.

[7] www.academia.edu/1113729/Prediction_of_exceedences_concentration_of_PM10_in_Industrialized_Area_in_Malaysia_A_Case_Study_in_Shah_Alam.

[8] www.thehindu.com/news/cities/chennai/

[9] http://timesofindia.indiatimes.com/city/chennai/

[10] http://www.cseindia.org/category/thesaurus/chennai.

[11] www.tnpcb.gov.in

[12] Esteban Garcia-cuesta, Susana Briz, Isabel Fernandaz-Gomez and AntonioJ.de Castro, "Applications of Neural Network to Atmospheric Pollutants Remote Sensing", 2007.

[13] Anon, "Evaluation and Applied Research Department", Govt. of Tamil Nadu, EconomicAppraisal 2003-04 & 2004-05.