

# Prognosticate Trends in Air Pollution control and monitoring using Data mining, for Sterlite Corporation in Tuticorin

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**Abstract :** Over the past years the development and urbanization in Tuticorin has led to increase in air pollution. This has led to study and research in this area. We have used data mining to analyze the existing trends in air pollution in Tuticorin and make prediction about the future. Data mining is multi-disciplinary: it covers expert systems, database technology, Statistical data, machine learning and data apparition. The data mining techniques used are linear regression and multilayer perceptions. Clinical Learning Research center is one of the leading research laboratory has stacks of records. Thus there is the motivation to see how data mining techniques might supplement the more traditional scientific analysis in formulating and testing hypotheses. Of exact awareness are the orientation of convention and neural net models. Taking into consideration, environmental data measurement has possibly to control of air pollution. In applying the KDD process for finding an objectives. are We have seen the trends of an assortment of air pollutants like suspended particulate matter (SPM), sulphur dioxide (SO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>), carbon monoxide (CO), ozone (O<sub>3</sub>) . By using the above techniques we have observed that there will be an increase in amount of SPM by 42.9% in coming years. However amount of air pollutant may be increase due to increasing number of copper production . The other pollutants like SO<sub>2</sub> may show decrease due to usage of non sulphur dioxide fuel and stringent pollution control measures.

**IndexTerms -** Air Pollution, Machine Learning, Datamining Techniques, KDD Process.

## I. INTRODUCTION

The Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs) were set up under the Water Act of 1974 for controlling and monitoring environmental degradation in the country and they function under the Ministry of Environment and Forests (MoEF). The Indian Parliament enacted Air (Prevention and Control of Pollution) Act in 1981, to tackle the challenges posed by air pollution and entrusted the implementation of this law to the State Pollution Control Boards (SPCBs) and the Central Pollution Control Board (CPCB).

Environmental clearance has been made mandatory under the Environment Protection (EP) Act-1986, for the expansion or the modernization of any activity or for setting up new projects listed in Schedule-I. CPCB has laid down the ambient air quality standards for different areas and the SPCBs have fixed emission standards for the different industries. The SPCBs are also responsible for the compliance of industrial emissions with the National Ambient Air Quality Standards (NAAQS). Thoothukudi, also known by its British name Tuticorin, is a port city and a municipal corporation and an industrial city in Thoothukudi district in the Indian state of Tamil Nadu. The city lies in the Coromandel Coast of Bay of Bengal. This transformation has led to increase in the pollution level. The pollution rise in Tuticorinis a major area of concern nowadays. Thoothukudi is also known by the name 'Muthu Kuzhithurai'. It is also called as "Sea Gateway of Tamil Nadu". Thoothukudi is part of the Pearl Fishery Coast, and is known for its pearl fishing and shipbuilding industries.



Figure1. Study Area

## A. About Vedanta Limited

Sesa Sterlite Limited ('Sesa Sterlite' or 'the Company') hereby announces that it has changed the name of the Company from its present name, 'Sesa Sterlite Limited' to 'Vedanta Limited'. Vedanta Limited (Vedanta Ltd) is a diversified natural resources company, whose business primarily involves exploring and processing minerals and oil & gas. The Company produces oil & gas, zinc, lead, silver, copper, iron ore, aluminum and commercial power and has a presence across India, South Africa, Namibia, Ireland, Australia, Liberia and Sri Lanka.

Vedanta Ltd, formerly Sesa Sterlite Limited, is the Indian subsidiary of Vedanta Resources Plc, a London-listed company. Sustainable Development is at the core of Vedanta's strategy, with a strong focus on health, safety and environment and on enhancing the lives of local communities. Vedanta Ltd is listed on the Bombay Stock Exchange and the National Stock Exchange in India and has ADRs listed on the New York Stock Exchange.



Figure 2: Sterlite Plant in Tuticorin

### B. Pollution Board Action

During the closure, the Tamil Nadu Pollution Control Board rejected Vedanta's license to operate the smelter in April, saying the company had not complied with local environmental laws. Sterlite has challenged the step. The appellate authority of the pollution board has adjourned the next hearing to June. The board has accused Sterlite of dumping copper slag in a river and not furnishing reports of groundwater analysis of bore wells near the plant. This is not the first time the plant has shut down.

### C. Process Description

The major technological units envisaged for the copper smelter plant are as given below: Raw material handling system; I smelting; Converting; Ferro sand handling and disposal; Anode refining and casting; Electrolytic refining; Continuous copper rod; Sulphuric acid plant; Phosphoric acid plant; Oxygen plant; Precious metal recovery plant; and Desalination plant.

## II .FINDINGS OF THE STUDY AREA

1. Iron content in the groundwater in Kumareddiapuram and Therku Veerapandiapuram, the site of the ongoing protests, were 17 and 20 times higher than permissible levels prescribed by the Bureau of Indian Standards for drinking water. Chronic exposure to iron through drinking water could result in chronic fatigue, joint pain, and abdominal pain.

2. At 13.9%, respiratory diseases were significantly more prevalent in the areas surrounding the factory than in areas without industry and this was much higher compared to the state average. The incidence of asthmatic bronchitis is 2.8%, more than double the state average of 1.29%. Bronchitis is an inflammation of the airways lining caused by long-term exposure to environmental irritants such as tobacco smoke, dust or chemicals. Asthma is a condition where the muscles around the airways get tight resulting in the narrowing of the airways. Asthmatic bronchitis is a condition where asthma and bronchitis occur together. The report finds that "The increased prevalence rate of asthma and respiratory infections are due to the air pollution caused by industries and automobiles in the area.

3. The study also found that there were more people suffering from Ear, Nose, Throat (ENT) disorders near the factory. Among the ENT diseases, and sinusitis were very high. "Climatic conditions and atmospheric pollution could be the cause for the prevalence of ENT morbidity," the report concluded.

4. Myalgia, or general body pain, was another widely reported symptom in the study area closer to the factory.

5. "Women had more menstrual disorders, like hormonal imbalance problems. It needs an in-depth study," the report stated. This study has disturbing findings, since the high incidence of respiratory diseases found in 2007 was at a time when Sterlite was running at less than half its current production levels. Respiratory diseases are an indicator of air pollution which has been identified as the "world's largest single environmental health risk" by the World Health Organization. WHO reports that in 2012, around 7 million people died – one in eight global deaths – as a result of air pollution exposure.

### A. Health effects of copper

Long-term exposure to copper can cause irritation of the nose, mouth and eyes and it causes headaches, stomachaches, dizziness, vomiting and diarrhea. Intentionally high uptakes of copper may cause liver and kidney damage and even death. Whether copper is carcinogenic has not been determined yet.

There are scientific articles that indicate a link between long-term exposure to high concentrations of copper and a decline in intelligence with young adolescents. Whether this should be of concern is a topic for further investigation.

Industrial exposure to copper fumes, dusts, or mists may result in metal fume fever with atrophic changes in nasal mucous membranes. Chronic copper poisoning results in Wilson's Disease, characterized by a hepatic cirrhosis, brain damage, demyelization, renal disease, and copper deposition in the cornea.

Source: "Health Status and Epidemiological Study Around 5 km Radius of Sterlite Industries (India) Limited, Thoothukudi." Department of Community Medicine, Tirunelveli Medical College, 2008.



Figure 3: Proof of Sterlite Health Impact

According to World Health Organization (WHO) in 2014, Tuticorin is the most polluted city in the world. The standard annual average for SPM10 is 60 microgram per cubic meter given by the National Ambient Air Quality Standards. But according to the CPCB report from the period 2008-2010, SPM10 in Tuticorin has risen up from 198 in 2008 to 243 in 2009 and 259 in 2010 [11]. The rise in the pollution rate has affected people with serious health problems like asthma, pneumonia, lung infection etc. According to the report of the World Health Organization (WHO), air pollution plays a significant role in deteriorating health conditions like skin and eye problems.

## B. Chemical properties of copper

Atomic number	29
Atomic mass	63.546 g.mol <sup>-1</sup>
Electronegativity according to Pauling	1.9
Density	8.9 g.cm <sup>-3</sup> at 20°C
Melting point	1083 °C
Boiling point	2595 °C
Vanderwaals radius	0.128 nm
Ionic radius	0.096 nm (+1); 0.069 nm (+3)
Isotopes	6
Electronic shell	[ Ar ] 3d <sup>10</sup> 4s <sup>1</sup>
Energy of first ionisation	743.5 kJ.mol <sup>-1</sup>
Energy of second ionisation	1946 kJ.mol <sup>-1</sup>
Standard potential	+ 0.522 V ( Cu <sup>+</sup> / Cu ) ; + 0.345 V ( Cu <sup>2+</sup> / Cu )
Discovered by	The ancients

## C. Environmental effects of copper

When copper ends up in soil it strongly attaches to organic matter and minerals. As a result it does not travel very far after release and it hardly ever enters groundwater. In surface water copper can travel great distances, either suspended on sludge particles or as free ions. Copper does not break down in the environment and because of that it can accumulate in plants and animals when it is found in soils. On copper-rich soils only a limited number of plants has a chance of survival. That is why there is not much plant diversity near copper-disposing

factories. Due to the effects upon plants copper is a serious threat to the productions of farmlands. Copper can seriously influence the proceedings of certain farmlands, depending upon the acidity of the soil and the presence of organic matter. Despite of this, copper-containing manures are still applied. Copper can interrupt the activity in soils, as it negatively influences the activity of microorganisms and earthworms. The decomposition of organic matter may seriously slow down because of this. When the soils of farmland are polluted with copper, animals will absorb concentrations that are damaging to their health. Mainly sheep suffer a great deal from copper poisoning, because the effects of copper are manifesting at fairly low concentrations.

### III. TYPES OF AIR POLLUTANT

1. Suspended Particulate Matter (SSPM<sub>2.5</sub> and SPM<sub>10</sub>): Suspended Particulate Matter (SSPM) is a complex pollutant as it consists of a variety of components in different concentrations. The principle source of Suspended Particulate Matter in Tuticorin is road traffic emissions, particularly from diesel vehicles. It is also emitted from industrial combustion plants and power generation, commercial and residential combustion, and some non-combustion processes. Suspended Particulate Matter is further categorized on the basis of its size in micrometers. The particles under 10 micrometers, refers to SPM<sub>10</sub> sometimes called the 'coarse fraction'. The particles under 2.5 micrometers, refers to SPM<sub>2.5</sub> sometimes called the 'fine fraction'. SPM<sub>2.5</sub> is considered to be more damaging to human health than SPM<sub>10</sub>. The prominent health effects caused due to this are premature death, aggravation of respiratory and cardiovascular disease.

2. Nitrogen Dioxide (NO<sub>2</sub>): Nitrogen Dioxide is produced during high temperature burning of fuel from road vehicles, heaters and cookers. When this mixes with air, NO<sub>2</sub> is formed. NO<sub>2</sub> levels are highest in urban areas as it is related to traffic. It has harmful effects such as wide-range of respiratory problems in school children; cough, runny nose and sore throat etc.

3. Sulphur dioxide (SO<sub>2</sub>) SO<sub>2</sub> is an unpleasant and highly irritating gas, which is one of the major air pollutants, discharged by various natural and anthropogenic sources. It may be a primary or a secondary pollutant. Industries, volcanoes, and the ocean emit SO<sub>2</sub>, SO<sub>3</sub>, and SO<sub>x</sub> directly as primary pollutants. The combustion of fossil fuels and pyrate ores containing sulfur yield sulfur dioxide in direct proportion to the sulfur content of the fuel.

$S + O_2 \rightarrow SO_2$  For every gram of sulphur in the fuel, two grams of SO<sub>2</sub> are emitted into the atmosphere. In addition, biological decay processes and some industrial sources emit H<sub>2</sub>S, which is oxidized to form the secondary pollutant SO<sub>2</sub>.

$H_2S + O_3 \rightarrow SO_2 + H_2O$  Sulphur dioxide can react photo chemically, or catalytically with other pollutants or atmospheric constituents forming sulphur trioxide, sulphuric acid, and salts of sulphuric acid.

4. Carbon Monoxide (CO): Carbon fuels when burned, either in the presence of too high temperature or too little oxygen, and then CO is formed. Vehicle deceleration and idling vehicle engines are one of its main causes.

3. Ozone (O<sub>3</sub>): It is formed when a chemical reaction of volatile organic compounds and nitrogen dioxide occurs in the presence of sunlight, so level of ozone is generally higher in the summer. In rural areas, downwind of urban areas or industrial sites, the highest levels of ozone are mostly found.

In authors have developed transport sector emission inventory for Tuticorin from the period of 2000-2005 to measure vehicular emissions and drew out the consequences of relevant policy reforms on overall emissions of various air pollutants like CO<sub>2</sub>, NO<sub>2</sub>, HC, TSP and SO<sub>2</sub> over the years to help in making change for future policies

Many researchers have analyzed and monitored the air quality and air pollution in Tuticorin. In our work, we have used time series analysis method for analyzing the pollution trends in Tuticorin and predicting about the future. The time series method includes Multilayer Perceptron and Linear Regression.

### IV. Centre for Science and Environment Against Pollution

Centre for Science and Environment (CSE), has strongly condemned the killing of innocent protesters in Tuticorin, Tamil Nadu. The residents of the area were protesting against the proposed doubling of capacity of the Vedanta group's Sterlite copper plant. Further, citing long-festering pollution concerns, they were demanding permanent closure of the plant.

The 400,000-tonne-capacity smelting plant of Sterlite has been at the centre of pollution controversy since it was proposed in 1995. This plant was rejected by three states – Gujarat, Goa and Maharashtra – because of its highly polluting nature; before it was allowed to be set-up in Tamil Nadu. While taking Environment Clearance (EC), the company had flouted norms by misrepresenting facts and giving a faulty Environmental Impact Assessment (EIA) report. Firstly, it said that the plant is not located within 25 km of ecologically sensitive area, which was found to be wrong as the plant is located near Mannar Marine National Park. In addition, the company submitted a faulty rapid EIA report without conducting any public hearing.

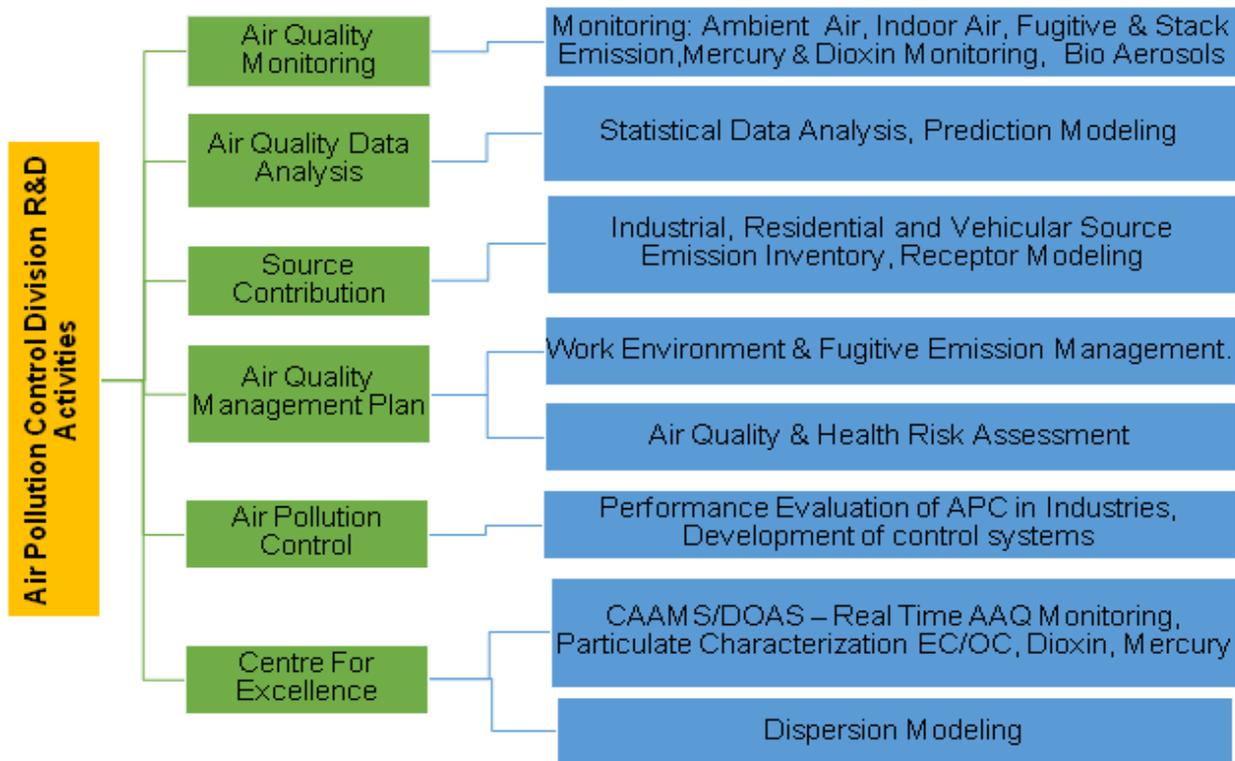


Figure4: Air Pollution control division result

Since its commencement in 1997, the plant has been found on numerous occasions to flout the pollution norms with impunity and foregone permit requirements by pollution regulators, as observed by the courts. In fact, a Supreme Court (SC) monitoring committee in 2004 found the plant had not provided adequate infrastructure and facilities for management of highly toxic arsenic-containing wastes. The plant was also found to be emitting sulphur dioxide far in excess of the permissible standards.

In 2010, the Madras High Court closed the plant because it was polluting the environment and had flouted norms while setting up the plant. In 2013, the Supreme Court imposed a penalty of Rs 100 crore on the company for polluting the environment.

In March 2013, a toxic gas leak from the plant made several hundreds of residents living in its vicinity sick. The Tamil Nadu Pollution Control Board ordered a closure of the smelting unit on March 29, but the Principal bench of the National Green Tribunal (NGT) gave a clean chit to Sterlite and revoked the closure order based on technicalities.

Sterlite stands as a classic case of failed environmental governance. Years of violations and concerns raised again and again by residents of the area seems to have mattered little.

“With such a poor track record on environment for nearly two decades, a plant like Sterlite’s copper unit, would not have been allowed to operate anywhere in the world. However, not only does it continue to operate in Tuticorin, but is also planning to double its capacity. This reflects the abject failure of the environmental governance in the country. It shows how weak and toothless are our pollution regulators” said Chandra Bhushan, Deputy Director General, CSE.

The big question today is, whether Sterlite will get a clean chit once again and be allowed to expand? Or whether regulators will come together, and court observations will be considered closely to look into the matter in people’s interest.

## V. RESEARCH DESIGN

Research Design The objectives of the study from the wider socio-economic perspective focusing on environmental hygiene practices among the selected in sterlite Tuticorin town. Based on the framed objectives some appropriate hypotheses are formulated. It is also discussed the methodology and frame work of study in terms of the nature of study variables used, sampling method, data collection process, data analysis procedure operational definition of key concepts and limitations.

## VI: OBJECTIVES

The following objectives are framed for the purpose of the present study:

- To study the socio-economic life of the respondents in Tuticorin town
- To analyze the problems of environment in the study area;
- To study the respondents' behaviour on household sanitation and environmental hygiene practices in the study area.
- To study the respondents' to control air pollution by the sterlite area the study area
- To find out the defects and problems in the existing environment hygiene and discomfort at their life

## VII. PROPOSED APPROACH

### A. Data set Used

We have taken the data from Central Pollution Control Board (CPCB). This data set consists of six attributes that are time (in months), air pollutants like SO<sub>2</sub>, NO<sub>2</sub>, CO, SPM<sub>10</sub> and Ozone (O<sub>3</sub>). Data is collected from 2011 to 2015 to predict the trends of the above pollutants in upcoming years.

**B. Flow Chart of Proposed Work**

The flowchart of the proposed work is shown in

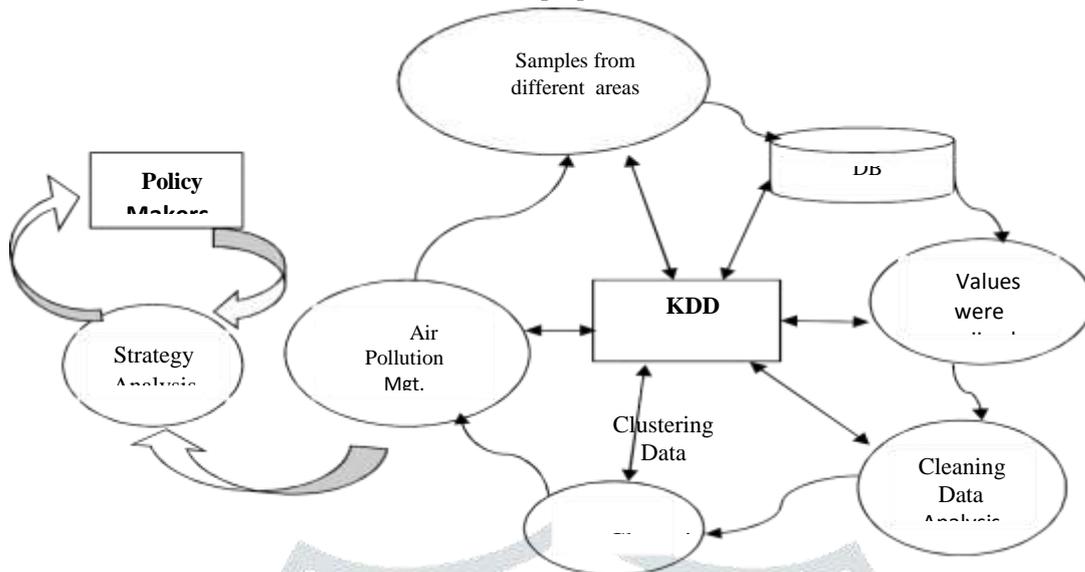


Figure 5. Proposed work

After collecting the data it is pre process ed. In preprocessing, data are cleaned by removing noise and filling up the missing values. For making analysis, we have used Time series analysis method. The two techniques of time series analysis method we have used are: Multilayer Perceptron and Linear Regression.

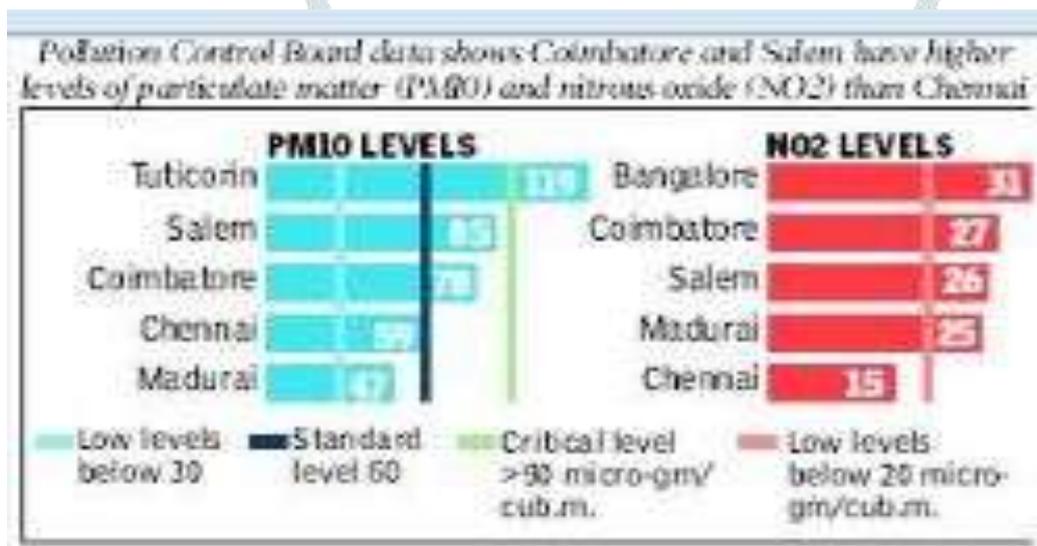


Figure6:Suspended particulate matter and nitrous oxide levels in various cities in TN

**C. Methods and Techniques Used**

**1. Time Series Analysis**

We have used Time series analysis is a statistical technique that deals with time series data, or trend analysis. Time series data means that data is in a series of particular time periods or intervals. The data is considered in three types:

1. Time series data: A set of observations on the values that a variable takes at different times.
2. Cross-sectional data: Data of one or more variables, collected at the same point in time.
3. Pooled data: A combination of time series data and cross-sectional data.

**2. Multilayer Perceptron**

A multilayer preceptor (MLP) is a class of feed forward artificial neural network. An MLP consists of at least three layers of nodes. Except for the input nodes, each node is a neuron that uses a nonlinear activation function. MLP utilizes a supervised learning technique called back propagation for training. Its multiple layers and non-linear activation distinguish MLP from a linear perceptron.

**3. Linear Regression**

Linear regression is used for finding linear relationship between target and one or more predictors. There are two types of linear regression- Simple and Multiple.

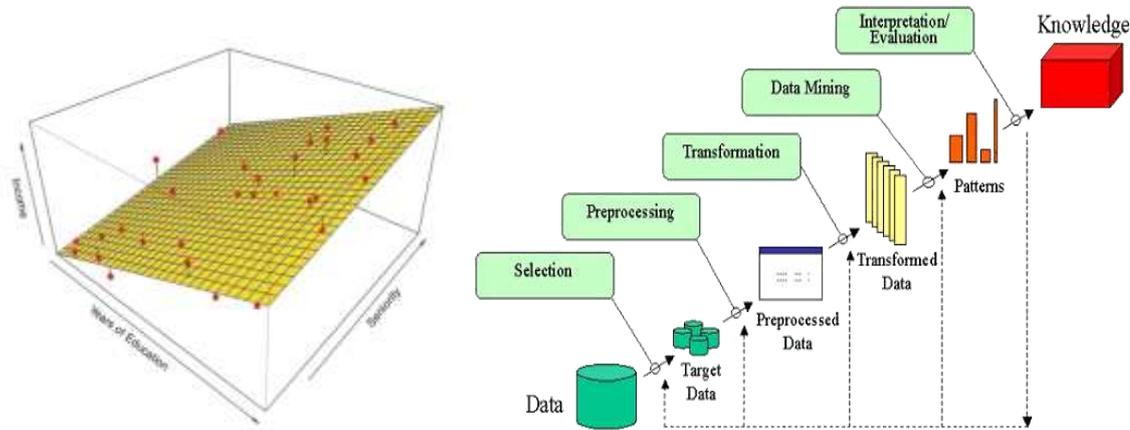


Figure 7: Linear Regression / KDD Process

4.KDD Process

The term Knowledge Discovery in Databases, or KDD for short, refers to the broad process of finding knowledge in data, and emphasizes the "high-level" application of particular data mining methods. It is of interest to researchers in machine learning, pattern recognition, databases, statistics, artificial intelligence, knowledge acquisition for expert systems, and data visualization.

VII.RESULTS

The snapshots of the results obtained for all the pollutants are the dotted lines show the future prediction made.

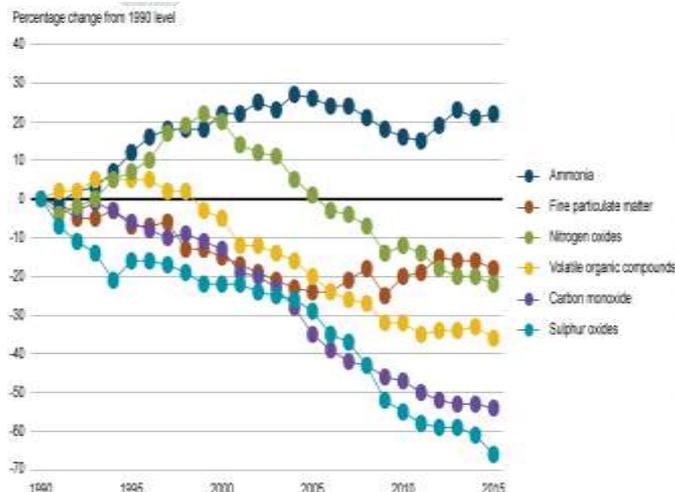
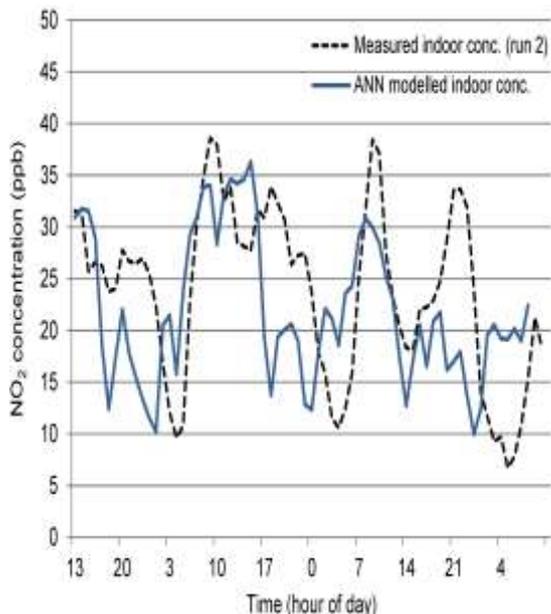
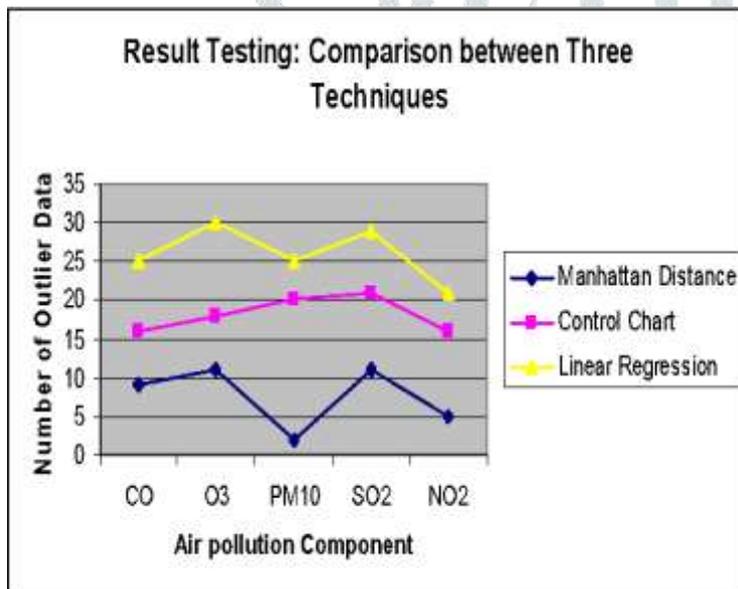


Figure 8: The variation of air pollutant due to copper production

### VIII.CONCLUSION AND FUTURE WORK

In this paper is presented control the air pollution inside the tuticorin district by the sterlite plant,study which will provide a quantified analysis of the ground level concentrations of pollutants in the coastal city of Tuticorin. SSPM has been identified as the major contributor to the deterioration of Air Quality Standards in the city. The annual average background concentrations are calculated as SO<sub>2</sub> -12 µg/ m<sup>3</sup> , NO<sub>2</sub>- 14 µg/ m<sup>3</sup> and SSPM (RSSPM + SPM)- 200 µg/ m<sup>3</sup> . The annual average ground level concentration of SSPM far exceeds the National Ambient Air Quality Standards (NAAQS) in all the stations except the AVM Jewellery station. The annual average ground level concentrations of SO<sub>2</sub> and NO<sub>2</sub> are well within the prescribed NAAQS standard. The uncertainties involved in the use of available emission factors is acknowledged. But calculating and measuring the emission factors for every activity is an expensive and time consuming process. As more information becomes available about emission factors, we can refine the model inputs. The future work of this paper is to analyze the scenario for CY 2013 (BAU) and future scenario for CY 2020.

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