IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 15, Issue 2 Ver. III (Mar. - Apr. 2018), PP 35-44
www.iosrjournals.org

Study of Air Pollutants and Its Effect on Health, Environment and Rainfall in Chennai for A Decade

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***Abstract**: This paper deals with a statistical and critical analysis of concentration of air pollutants in Chennai for a span of 10 years (2007 – 2017). Three major portions of the city is considered, that is Anna Nagar, a residential area, Manali , an industrial area and Thyagaraya Nagar (T. Nagar) , a commercial area. The concentration of air pollutants like NO_x , SO_2 and Respirable Suspended Particle Matter (RSPM) over a decade has been analyzed. And their effect on health, environment and rainfall has been discussed.*

***Index Terms—** air pollutants, rainfall, health, environment*

Date of Submission: 25-03-2018 Date of acceptance: 09-04-2018

I. Introduction

With the increased industrial and commercial activities in the vicinity of major cities, the quality of the ambient air is being affected by emission from the industries and from the ever increasing vehicular pollution. It is necessary to build a future in which human live in harmony with nature. In order to protect our ecological security we need to focus our attention and to take necessary steps both locally and globally.

According to the World Health Organization (WHO), outdoor air pollution is classified into four main categories: particulate matter, ozone, nitrogen dioxide, and sulfur dioxide. Additionally, air pollution is further divided into primary and secondary pollutants. Primary pollutants are released directly into the atmosphere from a source, where secondary pollutants occur as a result of complex chemical reactions taking place from two pollutants reacting with each other.Sources of air pollution can include but are not limited to industrial factories, automobile exhaust, construction, and natural disasters such as forest fires and volcanic eruptions. Particulate matter air pollution is what first comes to mind when considering air pollution because it has an unlimited number of sources. Numerous health problems can stem from outdoor air pollution involving the "respiratory, cardiovascular, Immunological, hematological, neurological and reproductive/ developmental body systems". Most health issues revolve around the respiratory system since they are typically inhaled through the mouth and nose.In this study the air pollutants and its effect on health , environment and rainfall in Chennai for a decade is analysed and disscussed.

II. Methodology

Three main parts of the city has been taken for analyzing, they are Anna Nagar (residential area), Manali (industrial area) and Thyagaraya Nagar (commercial area), which is also called T Nagar. The amount of concentrations of air pollutants such as NO_x , SO_2 and RSPM (respirable suspended particle matter) values obtained from the TNPCB (Tamil Nadu pollution control board) are taken and plotted. There is a permissible limit for the air pollutants standardized by the government and if they cross the limit, it is considered as emergency state.

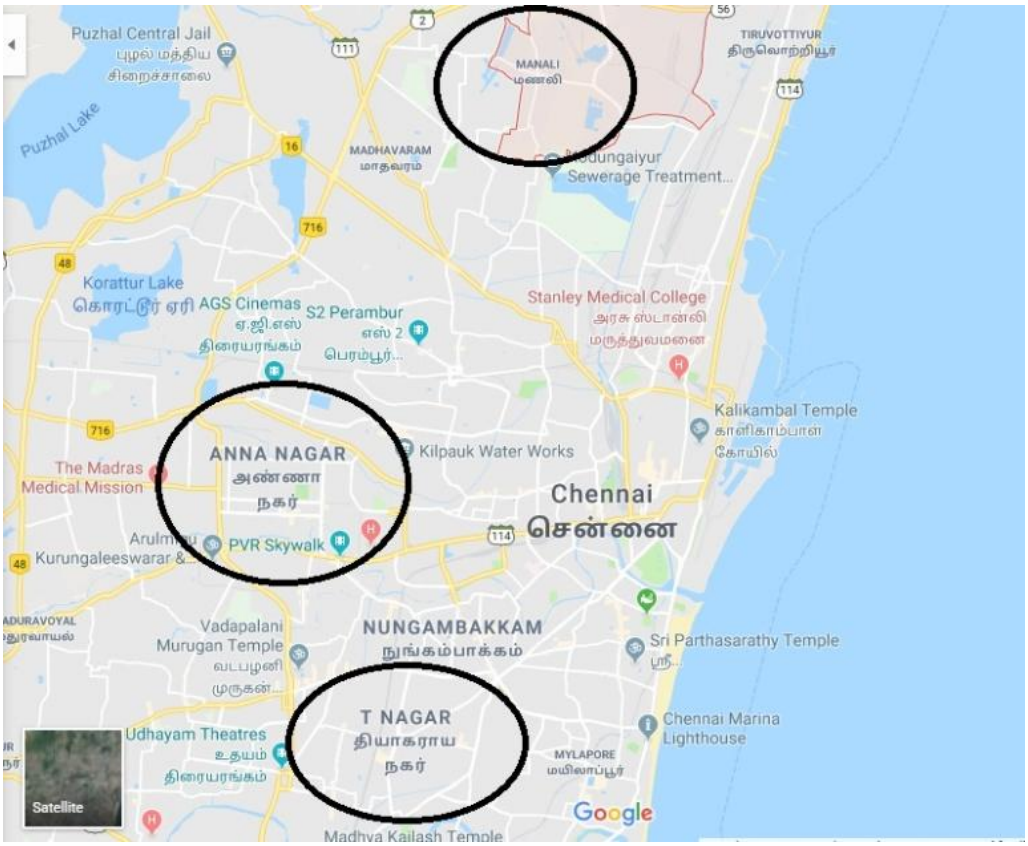


Figure1: Locations under study

Table1: Permissible limit

TYPE OF AREA	PERMISSIBLE LIMIT in $\mu g/m^3$		
	NO_X	SO_2	$RSPM$
INDUSTRIAL AREA	80	80	120
RESIDENTIAL AREA	60	60	60
COMMERCIAL AREA	60	60	60

III. Results

(i) MANALI

The values obtained from TNPCB are tabulated and plotted for Manali from 2007 to 2017

Table 2: Manali NO_2 and SO_2

Years	Concentration of SO_2 in $\mu g/m^3$	Concentration of NO_2 in $\mu g/m^3$
2007 – 2008	13	20
2008 – 2009	14	21
2009 – 2010	13	20
2010 – 2011	12	20
2011 – 2012	20	26
2012 – 2013	15	21
2013 – 2014	15	18
2014 – 2015	13	15
2015 – 2016	14	17
2016 – 2017	NA	NA

Graph 1: Manali graph

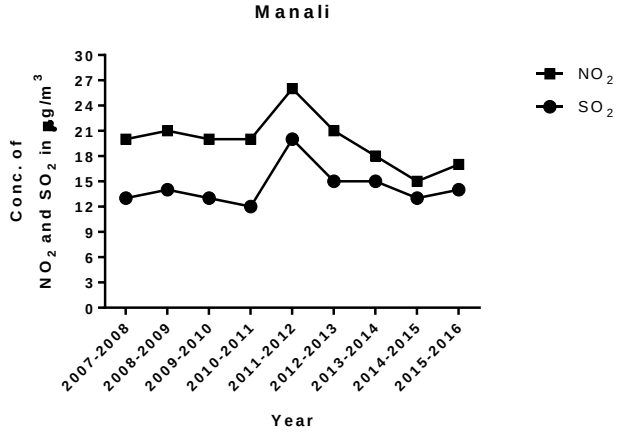
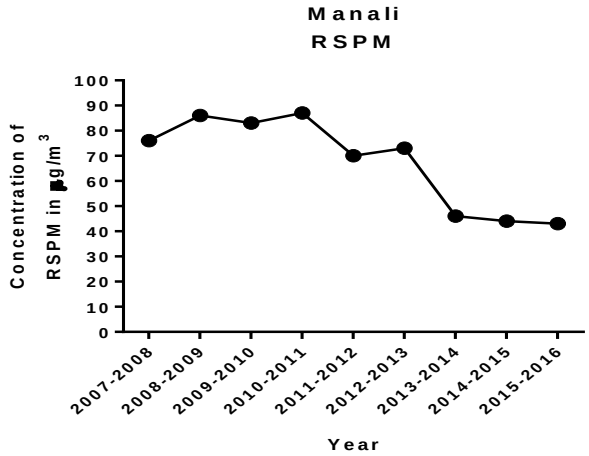


Table 3: Manali RSPM

Years	Conc. Of RSPM in $\mu g/m^3$
2007 – 2008	76
2008 – 2009	86
2009 – 2010	83
2010 – 2011	87
2011 – 2012	70
2012 – 2013	73
2013 – 2014	46
2014 – 2015	44
2015 – 2016	43
2016 – 2017	NA

Graph 2: Manali RSPM graph



(ii) ANNA NAGAR

The values obtained from TNPCB are tabulated and plotted for Anna Nagar from 2007 to 2017.

Table 4: Anna Nagar NO_2 and SO_2

Years	Concentration of SO_2 in $\mu g/m^3$	Concentration of NO_2 in $\mu g/m^3$
2007 – 2008	6	18
2008 – 2009	10	25
2009 – 2010	9	22
2010 – 2011	8	21
2011 – 2012	9	18
2012 – 2013	11	23
2013 – 2014	13	22
2014 – 2015	15	23
2015 – 2016	13	19
2016 – 2017	9	16

Graph 3: Anna Nagar Graph

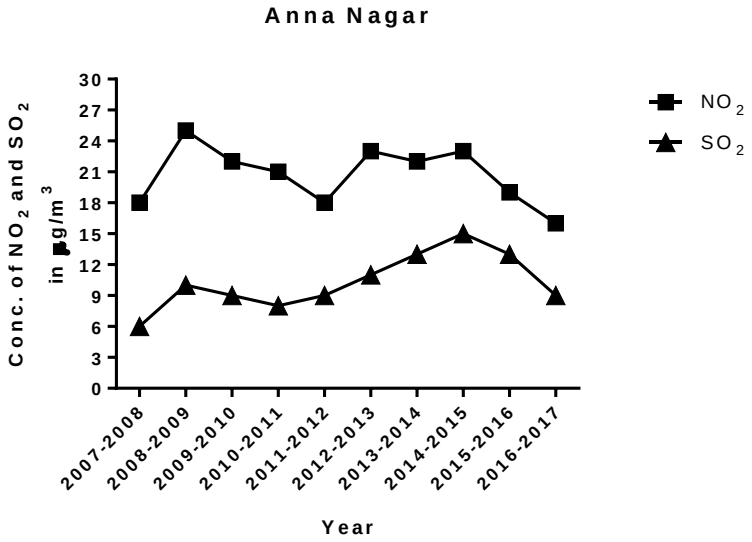
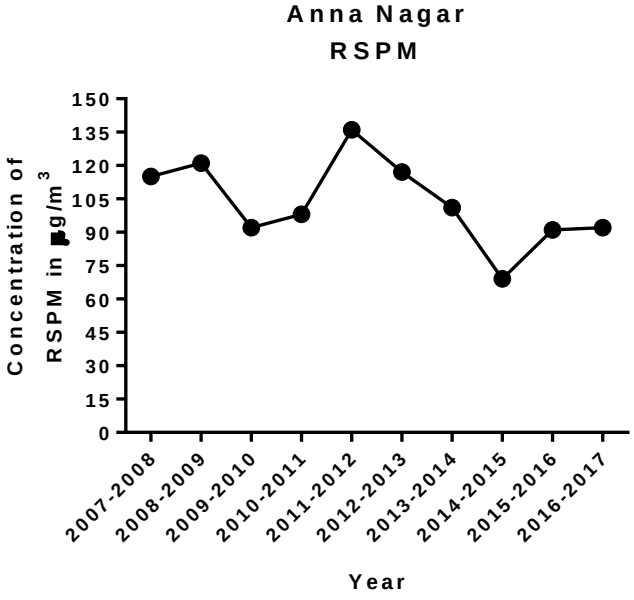


Table 5: Anna nagar RSPM

Years	Conc. Of RSPM in $\mu g/m^3$
2007 – 2008	115
2008 – 2009	121
2009 – 2010	92
2010 – 2011	98
2011 – 2012	136
2012 – 2013	117
2013 – 2014	101
2014 – 2015	69
2015 – 2016	91
2016 – 2017	92

Graph 4: Anna Nagar RSPM Graph



(iii) THYAGARAYA NAGAR

The values obtained from TNPCB are tabulated and plotted for Thyagaraya Nagar from 2007 to 2017

Table 6: Thayagaraya Nagar NO_2 and SO_2

Years	Concentration of SO_2 in $\mu g/m^3$	Concentration of NO_2 in $\mu g/m^3$
2007 – 2008	9	21
2008 – 2009	11	29
2009 – 2010	12	30
2010 – 2011	11	30
2011 – 2012	11	21
2012 – 2013	12	28
2013 – 2014	16	29
2014 – 2015	19	30
2015 – 2016	15	23
2016 – 2017	10	18

Graph 5: Thyagaraya Nagar Graph

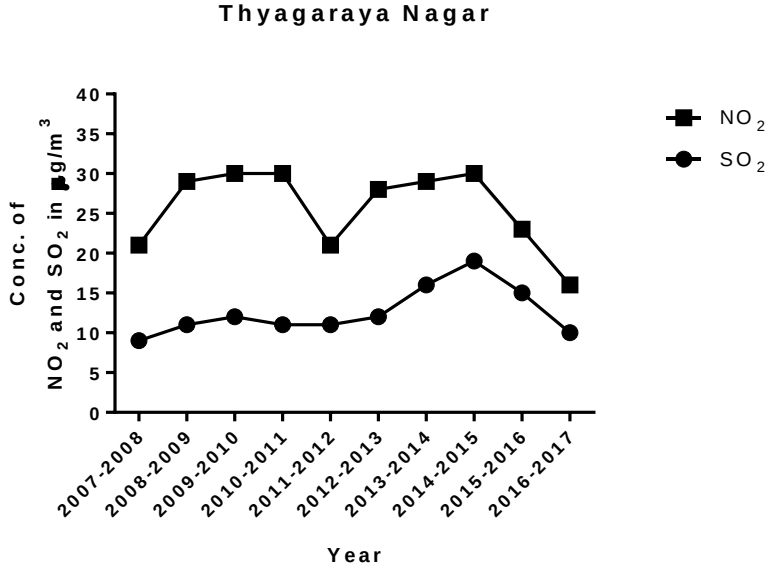
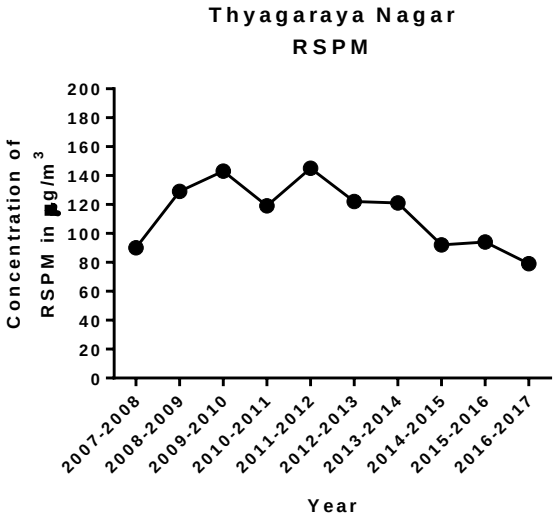


Table 7: Thyagaraya Nagar RSPM

Years	Conc. Of RSPM in $\mu g/m^3$
2007 – 2008	90
2008 – 2009	129
2009 – 2010	143
2010 – 2011	119
2011 – 2012	145
2012 – 2013	122
2013 – 2014	121
2014 – 2015	92
2015 – 2016	94
2016 – 2017	80

Graph 6: Thyagaraya Nagar RSPM Graph



IV. Discussion

(i) MANALI

The graphs 1 and 2 depict the concentration on air pollutants in manali, an industrial area from 2007 to 2016. Manali is located in north of Chennai .Manali includes industries such as Chennai petroleum corporation limited (CPCL), Madras fertilizers limited (MFL) and other plastic companies etc. so more amount of toxic waste and pollutants are expected from this region. So these are completely man made pollutants.

From the graph, we could see a sharp rise in SO_2 and NO_2 level on the year 2011-2012 and the minimum amount concentration is observed on the year 2010-2011, which is previous year. For the years, Manali has maintained the pollution level below the permissible limit which is a positive.

The source of pollution not only includes industries, it also includes emission from vehicle and other man-made activities too. There are stints of residential area too, nearby.Similarly, the level of RSPM has reached is maximum on the years 2008-2009 and 2010-2011 and has minimum in the year 2015 – 2016.During the floods on 2015 , a sharp decline is seen in both RSPM and nitrous oxide and sulphur di-oxide levels, indicating that the heavy pour of rainfall has cleared the sky from pollutants. Since 2011 the concentration of RSPM has declined. There is drastic decrease in the year 2012-2013 to 2013-2014.

(ii) ANNA NAGAR

The graphs 3 and 4 show the concentration of air pollutants in Anna Nagar, which is residential area in span for ten years, that is from 2007 to 2017. Anna nagar is located in the northern-western part of Chennai and it is one the prime residential areas in Chennai. We can find many schools and housing boards here.

One of the main reasons for pollution in Anna Nagar is due to the metro railway work that is being going on for several years. Traffic is also considered to be a reason. Huge traffics are created during the peak hours of the city that is during the school dropping or leaving time etc.From the graph obtained we can see sharp rise in the level of nitrous oxide, sulphur dioxide and RSPM during the year 2008 to 2009. It has the least value during the years 2007 to 2008 and 2011 to 2012.The RSPM level was the maximum of 136 $\mu g/m^3$ during 2011 to 2012.

The levels of RSPM are always above the permissible level, which is very bad condition. But during the flood on the year 2015 there we can observe sharp decline the levels of air pollutants. The lowest of 69 $\mu g/m^3$ was obsereved during 2014 to 2015. Since 2015 the levels of both the air pollutants have been reduced and have reached the minimum values on the year 2014 to 2015.

(iii) THYAGARAYA NAGAR

Graph 5 and 6 depicts the level of air pollutants in Thyagaraya Nagar .Thaygaraya Nagar , also known as T.Nagar is one of the busiest markets of the Asia, lots of small kiosks and vendors are seen. Vis-à-vis traffic is also observed there; it's huge and is always a problem. T. Nagar is located in south of Chennai and is one the busiest roads in Chennai. From the graph 5, we can see that it has the minimum value of 80 $\mu g/m^3$ during the year 2016 to 2017 and the highest value of 145 $\mu g/m^3$ recorded is from the year 2011 to 2012. The main reason for rise in the pollutants levels is due to the traffic created and due to the constructional sites also.

From the graph 6, we can observe the RSPM values are high during the year 2011 to 2012 are lower during the year 2016 to 2017 and during the year 2007 to 2008. The effect flood has been seen during the year 2015, where all the levels of all the air pollutants have been drastically declined, proving the fact that the rain has washed away all the air pollutants, suspended in the atmosphere.

V. Effect Of Air Pollutants On Human Health And Environment

(i) Sulfur dioxide (SO_2)

Sulfur dioxide, a chemical compound with the formula SO_2 is produced by Volcanoes and various industrial process. Coal and Petroleum often contain sulfur compounds and their combustion releases sulfur di oxide. Further oxidation of SO_2, usually in the presence of catalyst such as NO_2, forms H_2SO_4, and leads to the formation of acid rain.

Table 9: Effects of sulfur dioxide

Range of SO_2 in ppm	Condition	Effects
0 – 0.1	Good	No cautionary statement
0.1 – 0.2	Moderate	Usually sensitive people should consider reducing prolong or heavy exertion outdoor
0.2 – 1.0	Unhealthy for sensitive groups	Usually sensitive people , active children and adult with lung disease should reduce prolong or heavy exertion outdoor
1.0 – 3.0	Unhealthy	Usually sensitive people , active children and adult should reduce outdoor exertion
3.0 – 5.0	Very Unhealthy	Usually sensitive people , active children and adult should avoid all outdoor exertion
>5.0	Hazardous	It triggers health warning of emergency condition .Entire population is more likely to be affected and remains indoor

Effects of SO_2 on Human Health

The SO_2 content in air irritates the nose, throat, hand and cause coughing, wheezing, shortness of breath, tight feeling around chest. It also worsens asthma attack and also worsens heart diseases in sensitive group.

Table 10: Effects of sulfur dioxide

People with lung diseases	Children	Active people
Asthma , chronic bronchitis and emphysema will have more serious effects at higher SO_2 level	Children are at higher risk from SO_2 exposure because their lungs are still developing	They have higher exposure to So_2 than people with less active while exercise and outdoor work

Effects of SO_2 on Environment

The SO_2 content in air will combine with catalyst to for acid rain which will corrode the surface of the building. This will also decreases the strength of the building. The acid rain formed from SO_2 affects the plant species and animals. It also decreases the soil fertility and decrease the crop yield.

(ii) Nitrogen Oxide (NO_x)

Nitrogen oxides, particularly nitrogen dioxide , are expelled from high temperature combustion and are also produced during thunderstorms by electric discharge . It is a chemical compound with the formula NO_2 . It is one of the most prominent air pollutants.

Effects of NO_2 on Human Health

The long term exposure to NO_2 can decrease the lung function. This also increases the risk of respiratory condition. This will lead to increase in response to allergens. The NO_2 content will also reduces the efficiency of oxygen and disrupt cellular enzyme system.

Table 10: range of nitrous oxide

Range of NO_2 in ppm	Effects
0.06 – 0.1	Cause acute respiratory diseases when exposed to 2 – 3 years
500 - 600	Cause pulmonary hemorrhage , lung cancer and gum inflammation when exposed more than 2 – 10 days
330 - 1500	Present in cigarette smokers and lower the resistance to influenza and bronchitis

Effects of NO_2 on Environment

High NO_2 content in air will reduce the yields of Citrus plant. The 10- 50 ppm of NO_2 retards the metabolic activities and photosynthesis in plants. High level of NO_2 can have negative effect on vegetation including leaf damage and reduced growth. Vegetation become more susceptible to diseases and frost damage. It also leads to loss of fiber strength in cotton. The NO_2 react with other pollutants like hydrocarbon to gives peroxide and ozone which will crack rubbers and vegetation at higher concentration. The NO_2 react with ozone and hydrocarbon in the presence of sunlight to form Pan (Peroxy Acetyl Nitrate) which implies photochemical smog

(iii). Respirable Suspended Particle Matter (RSPM)

Respirable Suspended Particle Matter (RSPM) include variety of particles and droplets (aerosols), they can be suspended in atmosphere for short periods to long periods.

Table 11: range of RSPM

µm of atmospheric particle matter	**Types**	**Contaminants**
$10^{-4} – 10^{-2}$	Gaseous contaminant	Gaseous contaminant
$10^{-2} – 0.15$	Soot	Particle contaminant
0.01 - 1	Tobacco smoke	
0.01 – 2	Smog	
0.5 – 7	Oil smoke	
1 – 100	Fly ash	
5 – 100	Cement dust	
0.05 – 1	Suspended atmospheric dust	Dust types
1 – 100	Settling dust	
100-1000	Heavy dust	

Effects of RSPM on Human Health

Higher RSPM level will cause nose and throat irritation. It may cause lung damage and leads to asthma and bronchitis, reproductive problem and cancer.

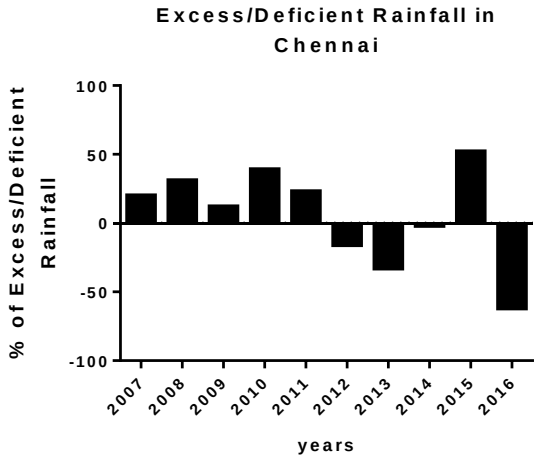
Effects of RSPM on Environment

Higher level of RSPM will reduce visibility, acid decomposition and H_2SO_4 damage on trees, plants and aquatic life in water bodies.

I. EFFECT OF AIR POLLUTANTS ON RAINFALL

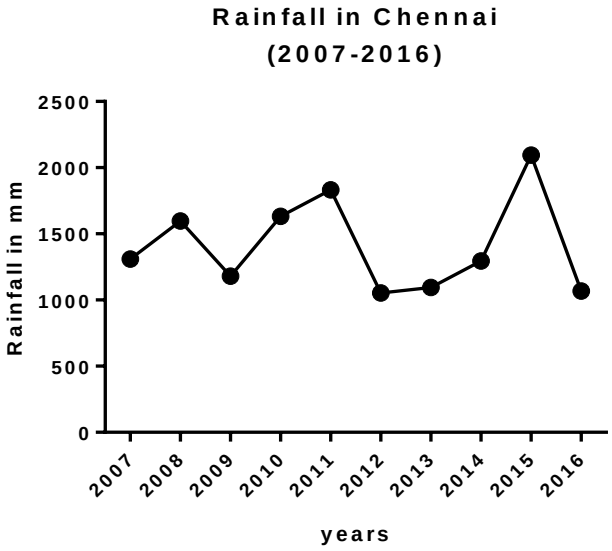
As the city get hotter, it also getting wetter. Chennai receive excessive monsoon rainfall between 2004 – 2011.The rainfall during 2012 to 2016 was low.The least rainfall is during the year of 2016.The highest rainfall was recorded in 2015 which caused flood.The burning of coal , diesel and petrol increases carbon level in the atmosphere , which in term raises the temperature of sea surface , say scientists. Increase in carbon emission is directly responsible for increase in sea surface temperature. While land reflects the heat, the sea absorbs it. When more carbon is released to the atmosphere, the sea traps more heat, says professor A.Ramachandran , Anna University's Centre for Climate Change and Adaptation Research . Rise in sea surface temperature leads to accumulation of more moisture above the sea , the source for monsoon clouds.

Graph 7: Excess/ Deficient rainfall



The rainfall in Chennai from 2007 to 2016 is shown in the graph 8.

Graph 8: Rainfall in Chennai



VI. Recommendation

1. Forest cover should be protected

Adequate forest cover is essential for maintaining the quality of air because trees absorb CO_2 and release O_2.

2. Implementation of Green belts

Densely populated cities should be covered by trees and there should be strict restriction for establishment of large buildings and industries.

3. Design of eco-friendly Engine

They should be design in such a way that there emission cause minimum pollution. Old automobile engine should be replaced by new one.

4. Design of Furnaces

Some pollution free furnaces should be designed and implemented.

5. Emission Rate

Emission rates of vehicles and industries should be check regularly and should be below the permissible limit.

6. Ban usage of pollution causing materials or substances.

CFC's and Methyl Bromide which is crop fumigant and other harmful gases should be banned.

7. Crackers during festival seasons

Uses of crackers should be avoided.

VII. conclusion

Data collected from TNPCB reveals that there is pollution in environment in various parts of Chennai. Population explosion, urbanization and industrialization in the recent past have lead to complex environmental pollution in Tamil Nadu. The real solution for avoiding the source of pollution is by adopting measures like resource recovery and cleaner technological process for the effective way of tacking the environmental issues and problems. Air pollutants releasing from industrial areas, commercial and non - commercial vehicles and other anthropogenic activities does not only affect the human health but also causes the climate change adversely such as rainfall discussed earlier. We conclude that there is direct relationship among the air pollutants itself, as it is pretty clear that during a heavy pour all the suspended matters are washed away, subsequently the level is brought down. We have also concluded that as the amount of pollutants increase, the pollutants obviously induce heat to the environment which causes irregular and drastic rainfalls. The levels of RSPM is beyond the permissible limit, standardized by the government and these areas are in a alarming state and further actions needs to be taken as soon as possible.

Acknowledgement

We express our sincere thanks to our Secretary and Correspondent Dr. P. Chinnadurai and Principal Dr.K. Mani for providing us a good opportunity. We would also like to thank our HOD Dr. L. Karthikeyan , Department of Mechanical Engineering, Panimalar Engineering College.

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