AMBIENT AIR QUALITY STATUS AND TRENDS IN ODISHA (2006 – 2014)

2015

STATE POLLUTION CONTROL BOARD, ODISHA

[DEPARTMENT OF FOREST & ENVIRONMENT, GOVERNMENT OF ODISHA]
Paribesh Bhawan, A/118, Nilakanthanagar,Unit-VIII,
Bhubaneswar – 751 012

Published By :
Member Secretary, State Pollution Control Board, Orissa
September, 2015

Printed at :
Maa Kali Stationery Works
Laxmisagar, Bhubaneswar
Ph : 0674-2572233

Sri Upendra Nath Behera, IAS
CHAIRMAN

STATE POLLUTION CONTROL BOARD, ODISHA
"PARIBESH BHAWAN"
A/118, NILAKANTHA NAGAR
UNIT-VIII, BHUBANESWAR-751012
PHONE: 0674-2560973(O), FAX: 0674-2560955
e-mail:paribesh1@ospcboard.org

FOREWORD

The State Pollution Control Board, Odisha has been monitoring the Ambient Air Quality at 32 locations in 13 towns/cities, viz., Angul-Talcher, Balasore, Berhampur, Bhubaneswar, Cuttack, Kalinganagar, Keonjhar, Konark, Paradeep, Puri, Rayagada, Rourkela and Sambalpur under the National Air Quality Monitoring Programme (NAMP) and State Air Quality Monitoring Programme (SAMP). This report describes the summary of the findings over the period 2006-2014 on the trend of the air quality, seasonal variation, non-attainment areas, etc. The monitoring results indicate that at all the places concentration of Sulphur Dioxide (SO_2) and Oxide of Nitrogen (NO_X) in the ambient air remained much below the prescribed standards. However, in majority of the towns, the levels of Respirable Suspended Particulate Matter (RSPM) and Suspended Particulate Matter (SPM) are the main problems responsible for downgrading the Ambient Air Quality. Certain actions to mitigate this problem have been recommended.

Contributions of Sri Rajiv Kumar, IFS, Member Secretary, Sri B. N. Bhol, Sr. Environmental Scientist-Level-I, Dr. S.K. Mohanty, Deputy Environmental Scientist, Sri S. R. Mallick, Sr. Scientific Assistant and the project staff of NAMP in preparing this report are thankfully acknowledged.

CHAIRMAN

CONTRIBUTIONS

Report Review, Coordination and Supervision	Sri Rajiv Kumar, IFS Member secretary
	Sri B. N. Bhol Sr. Env. Scientist-I
Report Preparation	Dr. S. K. Mohanty Deputy. Env. Scientist
	Sri S. R.Mallick Sr. Scientific Asst.
Data Compilation	Sri S. Dash Jr. Scientific Asst.
	Sri S. S. Mohanty Jr. Scientific Asst.
	Sri J. Mishra Jr. Scientific Asst.
	Sri B. N. Senapati Jr. Scientific Asst.
	Sri P.K. Nayak Field Asst.
	MD A. Raheman Field Asst.
	Sri B.R.Mohanty Field Asst.
Monitoring Team	All project staffs under NAMP & SAMP
Computer Type Setting	Sri S. R. Mallick Sri P. K. Nayak Karolina

CONTENTS

LIST OF TABLES

LIST OF FIGURES AND PLATES

1.0 INTRODUCTION

Ambient air quality in terms of the concentration of air pollutants present is not only depend on the quantities of pollutants emitted from air polluting sources but also on the ability of the atmosphere to either absorb or disperse these emission. The concentration of pollutants varies spatially and temporarily due to changes in meteorological and topographical condition. The presence of air pollutants above the prescribed limit in the ambient air adversely affects the environment including health of the human being. In order to prevent and control air pollution, the Union Govt. enacted the Air (Prevention and Control of Pollution) Act in 1981. The responsibility has been further emphasized under the Environment (Protection) Act, 1986, which necessitate to address the pollution problem through air quality survey/monitoring programs. The Central Pollution Control Board has taken up a programme under the National Ambient Air Quality Monitoring programme during 1984 - 85 at national level, to assess the Ambient air quality status of the country in the important towns and cities.

The ambient air quality monitoring network involves measurement of a number of air pollutants at different locations in the country. Air quality monitoring requires proper selection of pollutants, selection of locations, frequency and duration of sampling, sampling techniques, infrastructural facilities, man power and operation & maintenance. The locations selected for monitoring are based on high traffic density, industrial growth, human population and its distribution, emission source, public complaints, the land use pattern etc. The quality of the air that we breathe affects our health and quality of life. It can also have major impacts on the ecosystem. Measuring and understanding air pollution provides a sound scientific basis for its management and control. Historically, air pollution problem has typically been high levels of smoke and sulphur dioxide arising from the combustion of sulphur-containing fossil fuels such as coal for domestic and industrial purpose. However, now the major threat to clean urban air is posed by vehicular emission. A variety of pollutants are emitted by petrol and diesel driven-engine motor vehicles. These include carbon monoxide (CO), oxides of nitrogen (NOx), volatile organic compounds (VOCs) and particulate matters (PM_{10} and PM2.5). The sources of particulate matters are mostly from biomass incineration, combustion of fuel, re-suspension of traffic dust, process emission etc. Fine particles contain microscopic solids or liquid droplets that are very small and they can penetrate deep into the lungs and cause serious health problems. Generally, coarse particles are directly emitted and fine particles can be formed in the atmosphere. Photochemical reactions resulting from the action of sunlight on nitrogen dioxide (NO_2) and VOCs from vehicles leads to the formation of ozone. Ozone is a secondary long-range pollutant, which affects areas far from the original emission site.

1.1 Composition of Natural Dry Air

Atmosphere is the protective blanket of gases, surrounding the earth, which sustains life on the earth. Pure air is a mixture of about 78% nitrogen, 21.0% oxygen, 0.03% carbon dioxide, 0.93% inert gases, traces of hydrogen and variable amount of water vapour. Composition of pure air is presented in Fig. 1.0 & Table-1.0

Fig. 1.0 Approximate Gaseous Composition of Natural Dry Air

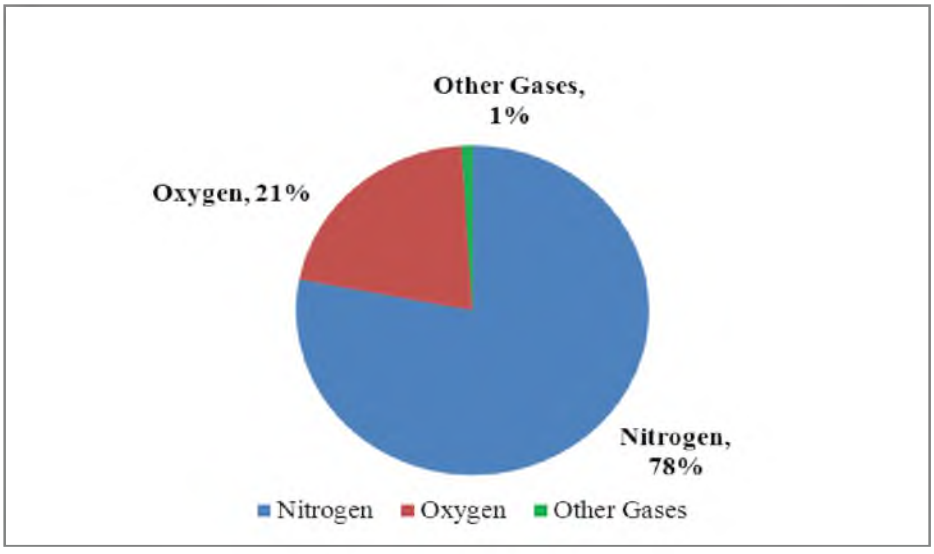


Table: 1.0 Gaseous Composition of Natural Dry Air

Gas	Concentration By Volume	
Pure air	**ppm**	**Percent**
• Nitrogen (N_2)	780,900	78.09
• Oxygen (O_2)	209,400	20.94
• Inert Gases, mostly argon, with much smaller concentrations of neon, helium, krypton and xenon	9,325	0.93
• Carbon Dioxide (CO_2)	350	0.03
• Methane (CH_4) a natural part of the carbon cycle of the biosphere	1	
• Hydrogen, (H_2)	0.5	

Gas	Concentration By Volume	
Natural Pollutants	**ppm**	**Percent**
• Oxides of Nitrogen, mostly (N_2O) and (NO_2) both produced by solar radiation and lightning	0.52 0.3	
• Carbon Monoxide (CO) from oxidation of methane and other natural sources	0.02	
• Ozone (O_3) produced by solar radiation and lightning		

1.2 Sources of Air Pollution

1.2.1 Natural Sources

Pollution of the air from the natural sources include volcanic eruptions, naturally occurring forest fires, dust stirred up by storm winds, gases produced by decay, dust from erosion and airborne pollen. About 57% of the SO_2 is produced globally from hydrogen sulphide gas from natural resources. About 7.2% of the carbon monoxide and 5.8% of nitrogen oxide emission is contributed by the forest fires. Natural sources of hydrocarbon include bacterial decomposition of organic matter which produces large amount of methane. Man made emission accounts for only 6% of the total atmosphere content of hydrocarbons. Plate 1 shows a natural source of air pollution due to forest fire.

Plate 1: Forest Fire

1.2.2 Anthropogenic Sources

Air pollution from human activity is probably as old as our ability to start fire. But large scale air pollution from industry is a relatively recent development. Furthermore, the resulting contaminants are likely to be emitted to the air in regions where many people live. Man-made sources of pollutants can be classified as stationary combustion sources, mobile combustion sources and manufacturing sources.

(i) Stationary Combustion Sources

The principal emission from stationary combustion processes that use coal or petroleum are particulate matters like fly ash, smoke and gaseous substances like oxides of sulphur and nitrogen. Sulphur oxide emission is a function of the amount of sulphur present in that fuel. Incomplete combustion of carbons and hydrocarbons produce carbon monoxide and soot particles that consist mostly of carbon.

Plate 2: Burning of Biomass Fuel

Another important source of air pollutant in developing countries is the burning of biomass fuel and coal for domestic cooking and room heating at high altitudes. Wood, crop residues, animal dung and other forms of biomass and coal are used by approximately half the world's population as cooking and/or heating fuels. Emission from biomass fuel combustion contains carbon monoxide, oxides of nitrogen and sulphur, polycyclic aromatic hydrocarbons, formaldehyde and particulate matter of

Plate 3: Woman exposed to Indoor Air Pollution of Biomass Fuel

various sizes. Cooking with bio-fuels contributes about 23% of global pollution, affecting mostly women and children (UNEP, 1999). About 200 million women in developing countries are exposed to conditions similar to smoking 2 – 20 packs of cigarettes per day. Plate 2 shows the pollution due to cooking.

(ii) Combustion of Automobile Fuels

While most of the light vehicles like two & three wheelers and cars are petrol fuelled; but the heavier vehicles used for mass transportation are diesel fuelled. Automobile exhausts from petrol and diesel engines vary with respect to the type and concentration of the pollutants. The principal pollutants emitted by petrol-fuelled vehicles are carbon monoxide, unburnt hydrocarbons, nitrogen oxides, while those from diesel vehicles are particulate matter, polycyclic aromatic hydrocarbons (PAHs) and sulphur dioxide. Plate 4 shows the pollution due to auto mobile exhaust.

Plate 4: Emission from Automobile Exhaust

(iii) Manufacturing Sources

Thousands of materials are manufactured regularly for use in industry, commerce and households. In the process, unwanted particulate matters and / or gases are generated and released into the atmosphere.
Plate 5 shows the pollution due to industrial activity.

Plate 5: Industrial Emission

1.3 Effect of Air Pollutants

Air pollutants above certain concentrations have adverse effect on health, vegetation as well as on animals. Major sources of air pollutants and its Impact are briefly described in Table 1.1

Table: 1.1 Effect of Air Pollutants

Sl No.	Pollutant	Major Sources	Impact on Human Health	Other Effects
1	Particulate Matter	Combustion of fossil fuels, Material handling, processing, Automobiles, Construction of road and buildings.	Particle size less than 10µm will affect the respiratory tracts and lungs, leads to asthma, bronchitis and pneumonia.	Affect the photosynthetic process of plants.
2	Sulphur Dioxide (SO_2)	Volcanic eruptions, Combustion of fossil fuel containing sulphur e.g., Coal, Natural gas, Petrol, Diesel, Manufacturing of sulphuric acid	Eye and nasal irritation, bronchitis, asthma, pulmonary emphysema, visibility impairment	(i) Bleaching of leaves, Necrosis, Interferences in the photosynthetic process (ii) Corrosive effect on material (iii) Cause of Acid Rain
3	Oxides of Nitrogen (NO_x)	Automobile exhaust, Industrial process like Power plant and Nitric plants, lightning & forest fires.	Eye and nasal irritation, Headache, Chest tightness and discomfort, Lung irritation, increase susceptibility to respiratory infections	Suppressed growth, leaf bleaching, epinasty, leaf abscess, Acid Rain, precursor of ozone observed in atmosphere
4	Carbon Monoxide (CO)	Automobile exhaust, combustion process, Organic Combustion	Reduce the ability of haemoglobin to carry oxygen, affect the central nervous system and responsible for heart attack and high mortality rate.	
5	Lead (Pb)	Metal processing, From batteries and paints, burning of fossil fuel wood (lead is absorbed by plants)	Gastrointestinal, liver and kidney damage, abnormality in fertility, mental development of child.	Paralysis of muscles of the larynx and difficulty in breathing, paralysis of the digestive tract in animals.

6	Ozone (O_3)	Natural process in tratosphere of the atmosphere and reaction between NO_x and VOC.	Irritation of the upper respiratory tract and can cause impaired breathing and reduced athletic performance.	(i) fleck on upper surface, suppressed growth, Necrosis and bleaching of leaf, reduction in yield of crops, (ii) Adverse effect on materials especially plastic and rubbers.
7	Volatile Organic Compound (VOC) i.e., hydrocarbons, oxygen and halogen containing species.	Automobiles, Industrial sources, burning of wood and biofuels.	Carcinogenic, genotoxic, neurotoxic, immunologic and hepatotoxic.	Carcinogenic to animals.
8	Peroxy Acetyl Nitrate (PAN)	Photochemical Smog	Eye irritant and tear inducer.	Bronzing of lower leaf surface, suppressed growth in plants.
9	Benzene (C_6H_6)	Combustion of fuel, Industrial emission, Coke oven, tobacco & wood, smoker, glues, paints, furniture wax & detergents.	Haematoxic, neurotoxic and carcinogenic effect	
10	Ammonia (NH_3)	Fertilizer Industry, Farms & Refrigerator	Irritation to skin, eye, throat, and lungs, cause coughing, lung damage and death may occur after exposure to very high concentration of ammonia.	Odor
11	Nickel (Ni)	Combustion of fuel, Nickel plating metallurgical processes	Nickel sulfide fume and dust is carcinogenic, cause allergy and dermatitis	

12	Arsenic (As)	Smelting of metals, combustion of fuel (especially low grade brown coal)coke oven emission	Epigenetic charge, multi system organ failure, Arsenic poisoning	
13	PAH [Benzo (a) payrene]	Coaltar, incomplete combustion of fuels, combustion of natural gas, Tobacco smoker, char boiled food	Mutagenic and highly carcinogenic, skin rash or eye irritation & bronchitis	

1.4 Behaviour of Air Pollutants

Concentration of air pollutants in the ambient air not only depends on the quality of pollutants released to the atmosphere but also on meteorological condition, topography and physiography of the area. Meteorological condition like inversion, stability class may build up the concentration of pollutants where as windy, rainy condition may wash out or disperse the pollutants. Valley wind effect is due to topography of the area.

Plate 6: Relative Size of Particulate Matter

The behaviour of the particles mostly depends on the size of the particulate matter. Large size particles with a diameter above 50 microns (µ) (1µ=10^{-6} meter) are collectively visible in the air and settle down quickly, so that they are not a long term pollution hazard. Particles of size ranges from 50 – 0.01µ diameter are of most significant air pollutants. Plate 6 shows relative size of Particulate Matter. They can remain in the atmosphere for varying lengths of time and undergo chemical reactions to produce secondary pollutants. Particles having a diameter of below 10µ act as nuclei for the formation of condensed water droplets in cloud formation. Particles can remain suspended in the atmosphere for days, weeks, months or years, for example, in the lower troposphere for 6 – 14 days; in upper troposphere for 2 – 4 weeks; in the lower stratosphere upto 6 months and in the upper stratosphere 1 – 3 years.

According to the behavior and concentration of the pollutants, the atmosphere can be broadly divided into 4 layers. From ground level to 100 m. the air is much polluted particularly in the urban areas. Some of the pollutants are absorbed by vegetation, buildings and water surfaces. It has been estimated that 33% of the SO_2 in this layer is removed by absorption. The next layer extends from 100m upto the cloud base at a height between 500m and 2000m altitude in the troposphere. Here the pollutants are well mixed by the turbulent air currents and are washed out by drizzle,

rain and fog. The third layer contains most of the atmospheric water vapour and extends upto the tropopause. Some pollutants may be dissolved or become nuclei in the cloud water droplets. Later, they may either be removed from the layers as rain or released again into the atmosphere when clouds evaporate. Small sized particles remain suspended in the air and undergo photochemical changes under the action of ultra violet energy. There is also movement of particles by air currents, upward into the lower stratosphere and horizontally over varying distances, depending on climatic conditions. There are well known examples of dust and SO_2 transference between Europe and Africa and Scandinavia. The last atmospheric layer stratosphere is having very less concentration of pollutants. Though the photochemical reactions occur in the stratosphere, there is very little movement of the pollutants and they remain in the layers for a very long period.

1.5 The Air (Prevention and Control of Pollution) Act, 1981

Government of India enacted the Air (Prevention and Control of Pollution) Act in 1981 to address the air pollution problem of the country. The Act prescribes various functions for the Central Pollution Control Board (CPCB) at the Central level and State Pollution Control Boards at the State level. The main functions of the Central Pollution Control Board and State Pollution Control Board are as follows:

1.5.1 Main functions of the Central Pollution Control Board

- To advise the Central Government on any matter concerning the improvement of the quality of the air and the prevention, control and abatement of air pollution.
- To plan and execute a nation-wide programme for the prevention, control and abatement of air pollution.
- To provide technical assistance and guidance to the State Pollution Control Boards.
- To carry out and sponsor investigations and research related to prevention, control and abatement of air pollution.
- To collect, compile and publish technical and statistical data related to air pollution; and
- To lay down standards for the quality of air.

1.5.2 Main functions of the State Pollution Control Boards

- To plan a comprehensive programme for prevention, control and abatement of air pollution and to secure the execution thereof.

- To advise the State Government on any matter concerning prevention, control and abatement of air pollution.

- To collect and disseminate information related to air pollution.

- To collaborate with Central Pollution Control Board in programme related to prevention, control and abatement of air pollution; and

- To inspect air pollution control areas, assess quality of air and to take steps for prevention, control and abatement of air pollution in such areas.

1.6 National Ambient Air Quality Standards (NAAQS)

The ambient air quality objectives/standards are pre-requisite for developing programme for effective management of ambient air quality and to reduce the damaging effects of air pollution. With the following objectives the ambient air quality standards are prescribed:

- To indicate the levels of air quality necessary with an adequate margin of safety to protect the public health, vegetation and property;

- To assist in establishing priorities for abatement and control of pollutant Level;

- To provide uniform yardstick for assessing air quality at national level ; and

- To indicate the need and extent of monitoring programme.

After enactment of Air (PCP) Act 1981, the Central Pollution Control Board had adopted first Ambient Air Quality Standards on November 11, 1982. Subsequently it was revised during 1994, 1998 and recently on November, 2009. The ambient air quality standards notified during 1998 and 2009 is given in Table 1.2 and Table 1.3 respectively.

Table: 1.2 National Ambient Air Quality Standards
(S.O. 935 (E), dated 14th October, 1998)

Sl. No.	Pollutants	Time Weighted Average	Industrial	Residential, Rural & Other area	Sensitive Area	Method of measurement
1.	SO_2	Annual*	80 ($\mu g/m^3$)	60 $\mu g/m^3$	15 $\mu g/m^3$	West & Gaeke method
		24 hours**	120 $\mu g/m^3$	80 $\mu g/m^3$	30 $\mu g/m^3$	
2	NO_x	Annual*	80 $\mu g/m^3$	60 $\mu g/m^3$	15 $\mu g/m^3$	Jacob & Hochheiser Modified (Na-Arsenite)
		24 hours**	120$\mu g/m^3$	80 $\mu g/m^3$	30 $\mu g/m^3$	
3	SPM	Annual*	360 $\mu g/m^3$	140 $\mu g/m^3$	70 $\mu g/m^3$	High volume sampling Flow rate 1.1 m^3 / min
		24 hours**	500 $\mu g/m^3$	200 $\mu g/m^3$	100 $\mu g/m^3$	
4	RPM	Annual*	120 $\mu g/m^3$	60 $\mu g/m^3$	50 $\mu g/m^3$	Respirable Particulate Matter Sampler
		24 hours**	150 $\mu g/m^3$	100 $\mu g/m^3$	75 $\mu g/m^3$	
5	Lead (Pb)	Annual*	1.0 $\mu g/m^3$	0.75 $\mu g/m^3$	0.50 $\mu g/m^3$	ASS method after sampling using EPM 2000
		24 hours**	1.5 $\mu g/m^3$	1.00 $\mu g/m^3$	0.75 $\mu g/m^3$	
6	NH_3	Annual*	0.1 mg/m^3	0.1 mg/m^3	0.1 mg/m^3	Indo-Phenol method
		24 hours**	0.4 mg/m^3	0.4 mg/m^3	0.4 mg/m^3	
7	CO	Annual*	5.0 mg/m^3	2.0 mg/m^3	1.0 mg/m^3	Non-Dispersive Infrared Spectroscopy
		24 hours**	10.0 mg/m^3	4.0 mg/m^3	2.0 mg/m^3	

* Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hours at uniform interval.

** 24 hours/8 hourly values should be met 98% of the time in a year. However, 2% of the time, it may exceed but not on two consecutive days.

Table: 1.3 National Ambient Air Quality Standards
(GRS 794 (E) dated 4th November, 2009)

SL. No	Pollutants	Time weighted Average	Concentration in Ambient Air		Methods of Measurement
			Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Govt.)	
1	Sulphur Dioxide (SO_2), µg/m^3	Annual *	50	20	Improved West and Gaeke Method and Ultraviolate fluorescence
		24 Hours**	80	80	
2	Nitrogen Dioxide (NO_2), µg/m^3	Annual *	40	30	Jacob & Hochheiser modified (NaOH-$NaAsO_2$) Method , Gas Phase Chemiluminescence
		24 Hours**	80	80	
3	Particulate Matter (PM_{10}), µg/m^3	Annual *	60	60	Gravimetric, TEOM and Beta attenuation
		24 Hours**	100	100	
4	Particulate Matter ($PM_{2.5}$), µg/m^3	Annual *	40	40	Gravimetric, TEOM and Beta attenuation
		24 Hours**	60	60	
5	Ozone (O_3),µg/m^3	8 Hours *	100	100	UV Photometric Chemiluminescence Chemical Method
		1 Hour**	180	180	
6	Lead (Pb), µg/m^3	Annual *	0.50	0.50	AAS / ICP Method sampling on EPM 2000 or equivalent filter paper, ED-XRF
		24 Hours**	1.0	1.0	

					using Teflon filter
7	Carbon Monoxide (CO) mg/m^3	8 Hours *	02	02	Non dispersive Infrared (NDIR) Spectroscopy
		1 Hour**	04	04	
8	Ammonia (NH_3), $\mu g/m^3$	Annual *	100	100	Chemilumines cence Indophenol blue method
		24 Hours**	400	400	
9	Benzene(C_6H_6) $\mu g/m^3$	Annual *	05	05	Gas Chromatograp hy (GC) based continuous analyzer. Adsorption and desorption followed by GC analysis
10	Benzo(a) Pyrene (BaP) particulate phase only, ng/m^3	Annual *	01	01	Solvent extraction followed by HPLC / GC analysis
11	Arsenic (As), ng/m^3	Annual *	06	06	AAS / ICP Method after sampling on EPM 2000 or equivalent filter paper
12	Nickel (Ni), ng/m^3	Annual *	20	20	AAS / ICP Method after sampling on EPM 2000 or equivalent filter paper

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

1.7 Ambient Air Quality Stations under National / State Air Quality monitoring Programme (NAMP/SAMP) in Odisha

The State Pollution Control Board has been monitoring the ambient air quality at 32 selected locations in 13 towns & cities, i.e., Angul & Talcher, Balasore Berhampur, Bhubaneswar, Cuttack, Kalinganagar, Konark, Paradeep, Puri, Rayagada, Rourkela and Sambalpur under the NAMP and Keonjhar under SAMP (Table1.4).

The four air pollutants viz., Sulphur Dioxide (SO_2), Oxides of Nitrogen (NO_x), Suspended Particulate Matter (SPM) and Respirable Suspended Particulate Matter RSPM (PM_{10}) has been identified for regular monitoring at all locations. The monitoring is carried out as per CPCB guideline i.e., 8 hour sampling for SPM and RSPM (PM_{10}), 4 hour sampling for SO_2 and NO_x in 24 hours of a day with frequency of twice a week for 104 observations in a year. The status and trend with seasonal variation and categorization on the basis of exceedence factor during monitoring period are discussed. The period of monitoring of each monitoring station is mentioned in Table-1.4 as all 32 monitoring stations of the study period were not operated from 2006 to 2014.

Table: 1.4 Ambient Air Quality Monitoring Stations

Sl. No.	City	categorisation	Name of Monitoring stations	Monitoring Period
1.	Angul & Talcher	I	1. RO, SPC Board, Industrial Estate, Angul	2006-2014
		R	2. NALCO Nagar, NALCO Township	
		I	3. TTPS Colony,	
		R	4. Coal Field Area ,MCL, Talcher	
2.	Balasore	R	5. R.O, SPCB, Sahadevkhunta	2006-2014
			6. DIC office, Angaragadia	2012-2014
		I	7. Rasalpur, Industrial Estate	2013-2014
3.	Berhampur	R	8. On the roof of Regional Office building	2006-2014
4.	Bhubaneswar	R	9. SPCB Office Building,Unit-8 , Bhubaneswar	2006-2014
			10. IRC Village, Nayapalli	2006-2014
			11. Capital Police Station, Unit-1	2006-2014
			12. Water works , Palasuni	2013
			13. Patrapada	2013-2014
			14. Chandrasekharpur	2014

5.	Cuttack	R	15. Roof of Traffic Tower, Badambadi	2006-2014
			16. Regional Office Building, Suryavihar	
			17. PHD Office, Barabati	2013-2014
6.	Kalinga nagar	I	18. On the roof of Tata steel guest House	2013-2014
			19. Roof of NINL guest house	
7.	Keonjhar	R	20. R.O, Baniapat	2006-2014
8.	Konark	R	21. Konark Police Station	2013-2014
9.	Paradeep	R	22. Roof of the PPT staff Quarters	2013-2014
			23. Roof of guest house, PPL	
		I	24. Roof of STP, IFFCO	
10.	Puri	R	25. Sadar police Station	2013-2014
			26. Town police Station	
11.	Rourkela	R	27. Regional Office Building	2006-2014
			28. IDL police Outpost	
			29. Dalmia Institute, Rajgangpur	2013-2014
12.	Rayagada	R	30. RO Building, Indiranagar	2006-2014
		I	31. LPS High School, Jaykaypur	
13.	Sambalpur	R	32. Roof of filter plant, PHD office Modipara	2006-2014

R-Residential area, I-Industrial area

1.8 Exceedence Factor

The air quality of different cities/ towns with respect to four parameters has been categorized into four broad categories, based on exceedence factor, taking in to account the 1998 and 2009 standards.

$$\text{Exceedence Factor} = \frac{\text{Observed annual mean concentration of a criterion pollutant}}{\text{Annual standard for the respective pollutant and area class}}$$

The four air quality categories are:

Critical pollution (C)	:	when EF is more than 1.5;
High pollution (H)	:	when the EF is 1.0 to 1.5;
Moderate pollution(M)	:	when the EF is 0.5 to 1.0; and
Low pollution (L)	:	where the EF is less than 0.5

Range of parameter concentrations corresponding to the Critical, High, Moderate and Low levels of air pollution are described in Table 1.5 & Table 1.6

TABLE: 1.5 CATEGORISATION OF AMBIENT AIR QUALITY PARAMETERS (As per Standard, 1998)

Pollution level	Industrial (I)			Residential (R)		
	SO_2 & NO_x ($\mu g/m^3$)	SPM ($\mu g/m^3$)	RSPM ($\mu g/m^3$)	SO_2 & NO_x ($\mu g/m^3$)	SPM ($\mu g/m^3$)	RSPM ($\mu g/m^3$)
Low (L)	0-40	0-180	0-60	0-30	0-70	0-30
Moderate (M)	40-80	180-360	60-120	30-60	70-140	30-60
High (H)	80-120	360-540	120-180	60-90	140-210	60-90
Critical (C)	>120	>540	>180	>90	>210	>90
Standard for Annual Average Value	**80**	**360**	**120**	**60**	**140**	**60**

Table: 1.6 Categorisation of Ambient Air Quality Parameters (As per Standard, 2009)

Pollution level	Residential (R),Industrial(I)		
	SO_2 ($\mu g/m^3$)	NO_x ($\mu g/m^3$)	RSPM ($\mu g/m^3$)
Low (L)	0-25	0-20	0-30
Moderate (M)	25-50	20-40	30-60
High (H)	50-75	40-60	60-90
Critical (C)	>75	>60	>90
Standard for Annual Average Value	**50**	**40**	**60**

1.9 Seasons

To access the seasonal variation of ambient air quality data the months of a year are divided in to following four seasons

Summer - M arch to June
Mon soon - July to September
Post monsoon - October & November
Winter - December to February

To calculate seasonal variation of a year during winter air quality data of December month of the year and January, February month of the next year are taken in to consideration.

2.0 AMBIENT AIR QUALITY STATUS AND TRENDS OF BHUBANESWAR CITY

The State Pollution Control Board, Odisha monitors the ambient air quality of Bhubaneswar city at five locations. The details about the location are presented in Table 2.0. The location of monitoring stations are selected as per the guideline of CPCB and are indicated in Fig.2.0

Table : 2.0 Ambient Air Quality Monitoring Locations

Place	Location	Latitude / Longitude	Category
Bhubaneswar	1. SPCB Office Building, Nayapalli	$20^0$16'48.2''N/$85^0$48'46.2''E	Residential
	2. IRC Village, Nayapalli	$20^0$17'34.4''N/$85^0$48'23.6''E	Residential
	3. Capital Police Station, Unit-1	$20^0$26'21.72''N/85^0.83'19.86 E	Residential
	4. Palasuni Water Works	$20^0$18'09.75''N/$85^0$51'52.06''E	Residential
	5. Patrapada	$20^0$13'47.30''N/$85^0$46'09.11''E	Residential
	6.Chandrrasekharpur	$20^0$20'46.4''N/$85^0$48'44.0''E	Residential

2.1 Description of Locations

2.1.1 SPCB Office Building, Nayapalli

The station is operating at the Office building at a height of 10 m. above the ground level. National Highway No. 5 is about 500 m from the station. Residential apartments, educational institutes surround the site.

2.1.2 IRC Village, Nayapalli

The station is located in one of the major residential area of Bhubaneswar and is operating at about 3 m. above the ground level. The National Highway No. 5 is about 500 m. from the station.

2.1.3 Capital Police Station, Unit – I

This is one of the major commercial areas of the city. The station is operating at about 3 m. above the ground level. The market complex is within 100 m. vicinity of the station.

2.1.4 Palasuni water works

The station is operating at the palasuni water works building at a height of 4 m. above the ground level. National Highway No. 5 is about 200 m from the station. Both residential apartments, educational institutes and commercial buildings surround the site.

2.1.5 Patrapada

The station is operating at a height of 8 m. above the ground level. National Highway No. 5 is about 200 m from the station. Residential apartments and educational institutes surround the site.

2.1.6 Chandrasekharpur

The station is operating on the roof of security room near main gate of Central laboratory, SPCB, Patia at a height of 3 m. It is 1km away from main road connecting Airport to Nandankanan. The location is situated inside institutional area. The vehicular moment near the location is less. The location is representative point for the background ambient air quality data.

Fig.2.0 Map Showing Sampling Locations in Bhubaneswar City

2.2 Ambient Air Quality of Bhubaneswar City

Ambient Air Quality status of Bhubaneswar city at SPCB office Building, IRC Village & Capital Police Station from the year 2006-2014; Palasuni water works for the year 2013, Patrapada for the year 2013 & 2014 and Chandrasekharpur for the year 2014 with respect to parameters like SPM, RSPM (PM_{10}), SO_2, and NO_x their annual average value, range value of 24 hrly average and percentage of violation from 24 hrly. Standard are presented in Table 2.1 to 2.6 and trend of each parameters are shown in Fig. 2.1 to 2.12. Seasonal variation of SPM & PM_{10} are shown in Fig. 2.13 to 2.30. Categorisation on the basis of exceedence factor of each location is shown in Table-2.7.

2.2.1 SO_2 & NO_X

The annual average value of SO_2 & NO_X at all locations are below their respective limits i.e., 50 µg/m^3 for SO_2 & 40 µg/m^3 for NO_X. Maximum annual average value for NO_X at SPCB office Building was 21.3 µg/m^3 in the year 2014,at IRC Village, Nayapalli it was 19.7 µg/m^3, in the year 2012 at Capital Police Station ,Unit-1 it was 21.3 µg/m^3 in the year 2008,at Patrapada it was 16.4 µg/m3 in the year 2013 & 2014. NO_X at SPCB office Building & IRC Village, Nayapalli was in increasing trend from the year 2006 to 2009 & from the year 2013 to 2014 and the trend decreases from the year 2010 to 2011. NO_X at Capital Police Station ,Unit-1 was in increasing trend from the year 2007 to 2008 & 2012 to 2014 and the trend decreases from the year 2009 to 2011 and at Patrapada NO_X value remain same in 2013 & 2014 . On the basis of exceedence factor both SO_2 & NO_x fall under Low category at all locations throughout the study period.

2.2.2 SPM & RSPM (PM_{10})

The annual average value of SPM at SPCB office Building, Nayapalli from the year 2008 to 2010, 2013 & 2014, at IRC Village Nayapalli from the year 2008 to 2010, at Capital Police Station, Unit-1 from the year 2006 to 2013 and Patrapada in 2013 & 2014 were above the limit i.e., 140 µg/m^3. The maximum annual average value at R.O., SPCB was 117 µg/m^3 in the year 2010, at IRC Village 157 µg/m^3 in the year 2008 at Capital Police Station 192 µg/m^3 in the year 2006 and at Patrapada 152 µg/m^3 in the year 2014. Maximum frequency of violations for SPM on 24 hrly average standard was 36.3 % at SPCB office Building in the year 2013, 20% at IRC Village in the year 2011, 44.2 % at Capital Police Station in the year 2011, 26.7 % at Patrapada in the year - 2013 and 16.7 % at Palasuni in the year 2013. The trend of SPM at SPCB office Building and IRC Village are mostly in increasing trend. At Patrapada, SPM value increases from the year 2013 i.e., 146 µg/m^3 to 152 µg/m^3 in the year 2014. Palasuni showed annual average value of 125 µg/m^3 in the year 2013 & Chandrasekharpur showed 88 µg/m^3 in the year 2014.

The exceedence factor of SPM shows Moderate at SPCB office Building, from the year 2006 to 2007 & 2011 to 2012 and High from the year 2008 to 2010 & 2013 to 2014; IRC Village shows Moderate in 2006, 2007 and 2011 to 2014, High from the year 2008 to 2010; at Capital Police Station, Unit-1 showed Moderate in the year 2007 & 2014, High in the year 2006, 2008 to 2013;

at Palasuni water works shows Moderate in the year 2013; at Patrapada, Moderate in both 2013 & 2014 and at Chandrasekharpur, Moderate in the year 2014.

The annual average of RSPM at all six locations are above the limit i.e., 60 μg/m^3 during the study period. The maximum annual average value at R.O., SPCB was 102 μg/m^3 in the year 2014, at IRC Village 84 μg/m^3 in the year 2014 at Capital Police Station 104 μg/m^3 in the year 2009 and at Patrapada 84 μg/m^3 in the year 2014. Maximum frequency of violation from 24hourly standard was 37.7 % at SPCB office Building, in the year 2014, 40.9 % at IRC Village in the year 2013, 42.1% at Capital Police Station,Unit-1 in the year 2012, 34.2 % at Patrapada in the year 2014, Palasuni 30.7% in the year 2013 and 34.2 % at Chandrasekharpur in the year 2014. The trend of RSPM mostly was in increasing trend at all locations throughout the study period.

From seasonal variation it was observed that both SPM & RSPM shows high values in winter and recorded low in monsoon in the study period at all locations.

2.2.3 $PM_{2.5}$

Ambient air quality with respect to $PM_{2.5}$ was monitored at 5 locations in the year 2014. The annual average value of $PM_{2.5}$ at all locations were within the prescribed limit i.e 40 μg/m^3, except at Capital Police Station i.e 44 μg/m^3. The maximum percentage of violation with respect to 24 hrly. standard was observed at IRC Village, Nayapalli i.e 13.5%. The maximum 24 hrly. average value of $PM_{2.5}$ was 504 μg/m^3 observed at Capital Police Station on the day of Deepawali.

Status of Ambient Air Quality at Bhubaneswar

Table: 2.1 SPCB Office Building, Nayapalli

Year	No. of Obs. (24 hrs.)	Parameters (µg/m^3) Annual Average (Range Values)					Frequency of violation of data (24 hrs. Avg.) from prescribed standard (% of violation)				
		SPM	RSPM	$PM_{2.5}$	SO_2	NO_x	SPM	RSPM	$PM_{2.5}$	SO_2	NO_x
2006	106	118 (33-427)	64 (18-227)	-	BDL (BDL- BDL)	13 (9-24)	10.4%	12.3%	-	-	-
2007	105	124 (37 – 258)	67 (20 -138)	-	BDL (BDL -16.2)	13.4 (BDL - 42.3)	9.5%	12.4%	-	-	-
2008	107	160 (82 – 262)	81 (45 -130)	-	BDL (BDL -BDL)	18.1 (11.8 -23.0)	13 %	15 %	-	-	-
2009	107	164 (63 – 359)	82 (41 -176)	-	BDL (BDL -BDL)	18.4 (14.3 -23.1)	25.2 %	24.3 %	-	-	-
2010	104	177 (65-418)	84 (32 -178)	-	BDL (BDL -BDL)	18.0 (9.7 -23.3)	30%	28 %	-	-	-
2011	99	139 (30-327)	80 (17-214)	-	BDL (BDL -BDL)	16.4 (BDL-40.9)	31.3%	30.3%	-	-	-
2012	92	140 (23-698)	76 (14-209)	-	BDL (BDL -BDL)	18.2 (BDL-45.1)	23.9%	27.2%	-	-	-
2013	91	162 (12-677)	87 (07-266)	-	BDL (BDL -BDL)	17.0 (BDL-45.8)	36.3%	37.4%	-	-	-
2014	77	141 (44-668)	102 (24-551)	39 (7-504)	BDL (BDL-BDL)	21.3 (10.8-40.0)	19.5 %	37.7%	6.4 %	-	-
Prescribed standard (R)	**24 hrly/ Annual avg.**	**200/140**	**100/60**	**-**	**80/60**	**80/60**	**As Per 1998 Standard**				
	24 hrly/ Annual avg.	**-**	**100/60**	**60/40**	**80/50**	**80/40**	**As Per 2009 Standard**				

N.B.: BDL - Below Detectable Limit, R – Residential BDL Value for SO_2 - ≤4,BDL Value for NO_X - ≤9, BDL Value for RSPM - ≤ 5

Table: 2.2 I.R.C. Village, Nayapalli

Year	No. of Obs. (24 hrs.)	Parameters (µg/m³) Annual Average (Range Values)					Frequency of violation of data (24 hrs. Avg.) from prescribed standard (% of violation)				
		SPM	RSPM	$PM_{2.5}$	SO_2	NO_x	SPM	RSPM	$PM_{2.5}$	SO_2	NO_x
2006	103	107 (55-385)	62 (29-256)	-	BDL (BDL-4.3)	12.5 (9-18)	-	-	-	-	-
2007	102	118 (46 – 265)	64 (24 -167)	-	BDL (BDL-BDL)	12.6 (BDL – 33)	12.7%	17.6%	-	-	-
2008	103	157 (59-279)	83 (34-152)	-	BDL (BDL-BDL)	17.9 (11.5-23.1)	19.4 %	22.4 %	-	-	-
2009	104	153 (78-312)	76 (38-144)	-	BDL (BDL-BDL)	17.7 (12.3-24.2)	16.4 %	16.4 %	-	-	-
2010	108	143 (42-343)	68 (23-144)	-	BDL (BDL-BDL)	16.8 (10-22.7)	15%	14 %	-	-	-
2011	100	130 (32-372)	75 (17-334)	-	BDL (BDL-BDL)	15.0 (BDL-32.7)	20%	26%	-	-	-
2012	101	121 (30-280)	76 (16-240)	-	BDL (BDL-BDL)	19.7 (BDL- 48.4)	8.9%	23.75	-	-	-
2013	93	128 (39-338)	82 (06-277)	-	BDL (BDL-BDL)	15.9 (BDL-40.9)	17.2%	40.9%	-	-	-
2014	37	130 (48-282)	84 (28-179)	37 (3-95)	BDL (BDL-BDL)	17.1 (10.7-30.8)	13.5 %	27 %	13.5 %	-	-
Prescribed standard (R)	**24 hrly/ Annual avg.**	**200/140**	**100/60**	**-**	**80/60**	**80/60**	**As Per 1998 Standard**				
	24 hrly/ Annual avg.	**-**	**100/60**	**60/40**	**80/50**	**80/40**	**As Per 2009 Standard**				

Table: 2.3 Capital Police Station, Unit-1

Year	No. of Obs. (24 hrs.)	Parameters (µg/m^3) Annual Average (Range Values					Frequency of violation of data (24 hrs. Avg.) from prescribed standard (% of violation)				
		SPM	RSPM	$PM_{2.5}$	SO_2	NO_x	SPM	RSPM	$PM_{2.5}$	SO_2	NO_x
2006	99	187 35-861	89 (21-376)	-	BDL (BDL -BDL)	16.4 (9-47)			-	-	-
2007	101	156 (26 – 315)	81 (16 -180)	-	BDL (BDL-15)	15.7 (BDL -36.8)	37%	36.6%	-	-	-
2008	102	167 (85-299)	97 (45-197)	-	BDL (BDL -BDL)	21.3 (15.1-32.4)	22.5 %	40.2 %	-	-	-
2009	105	192 (79-464)	104 (41-284)	-	BDL (BDL -BDL)	20.3 (13.9-25.5)	32.4 %	34.3 %	-	-	-
2010	105	171 (65-447)	97 (37-381)		BDL (BDL -BDL)	19.1 (13.2-24.5)	31%	40 %			
2011	104	179 (44-608)	95 (17-463)	-	BDL (BDL -BDL)	17.3 (BDL-38.1)	44.2%	41.3%	-	-	-
2012	95	166 (36-556)	101 (23-423)	-	BDL (BDL -BDL)	19.1 (9.3-35.5)	27.3%	42.1%	-	-	-
2013	92	161 (42-481)	99 (25-268)	-	BDL (BDL -7.2)	19.0 (10.2-49.1)	32.6%	39.1%	-	-	-
2014	84	135 (53-349)	99 (32-529)	44 (10-110)	BDL (BDL-9.5)	20.0 (11.1-52.1)	9.5 %	36.9 %	13.0 %	-	-
Prescribed standard (R)	**24 hrly/ Annual avg.**	**200/140**	**100/60**	**-**	**80/60**	**80/60**	**As Per 1998 Standard**				
	24 hrly/ Annual avg.	**-**	**100/60**	**60/40**	**80/50**	**80/40**	**As Per 2009 Standard**				

Table: 2.4 Palasuni water works

Year	No. of Obs. (24 hrs.)	Parameters (µg/m^3) Annual Average (Range Values)					Frequency of violation of data (24 hrs. Avg.) from prescribed standard (% of violation)				
		SPM	RSPM	$PM_{2.5}$	SO_2	NO_x	SPM	RSPM	$PM_{2.5}$	SO_2	NO_x
2013	78	125 (32-344)	75 (21-194)		BDL (BDL -BDL)	15.1 (BDL-28.7)	16.7%	30.7 %	-	-	-
Prescribed standard (R)	**24 hrly/ Annual avg.**	**200/140**	**100/60**	**-**	**80/60**	**80/60**	**As Per 1998 Standard**				
	24 hrly/ Annual avg.	**-**	**100/60**	**60/40**	**80/50**	**80/40**	**As Per 2009 Standard**				

Table: 2.5 Patrapada

Year	No. of Obs. (24 hrs.)	Parameters (µg/m^3) Annual Average (Range Values)					Frequency of violation of data (24 hrs. Avg.) from prescribed standard (% of violation)				
		SPM	RSPM	$PM_{2.5}$	SO_2	NO_x	SPM	RSPM	$PM_{2.5}$	SO_2	NO_x
		Annual Average									
2013	86	146 (32-344)	83 (15-267)		BDL (BDL -BDL)	16.4 (BDL-43.2)	26.7%	32.6%	-	-	-
2014	53	152 (58-350)	84 (28-187)	34 (6-106)	BDL (BDL-BDL)	16.4 (11.3-25.6)	26.3%	34.2%	11.3 %	-	-
Prescribed standard (R)	**24 hrly/ Annual avg.**	**200/140**	**100/60**	**-**	**80/60**	**80/60**	**As Per 1998 Standard**				
	24 hrly/ Annual avg.	**-**	**100/60**	**60/40**	**80/50**	**80/40**	**As Per 2009 Standard**				

Table: 2.6 Chandrasekharpur

Year	No. of Obs. (24 hrs.)	Parameters (µg/m^3) Annual Average (Range Values)					Frequency of violation of data (24 hrs. Avg.) from prescribed standard (% of violation)				
		SPM	RSPM	$PM_{2.5}$	SO_2	NO_x	SPM	RSPM	$PM_{2.5}$	SO_2	NO_x
2014	45	88 (33-262)	136 (56-360)	30 (23-41)	BDL (BDL -BDL)	16.4 (11.3-25.6)	26.3%	34.2 %	-	-	-
Prescribed standard (R)	**24 hrly/ Annual Avg.**	**200/140**	**100/60**	**-**	**80/60**	**80/60**	**As Per 1998 Standard,**				
	24 hrly/ Annual Avg.	**-**	**100/60**	**60/40**	**80/50**	**80/40**	**As Per 2009 Standard,**				

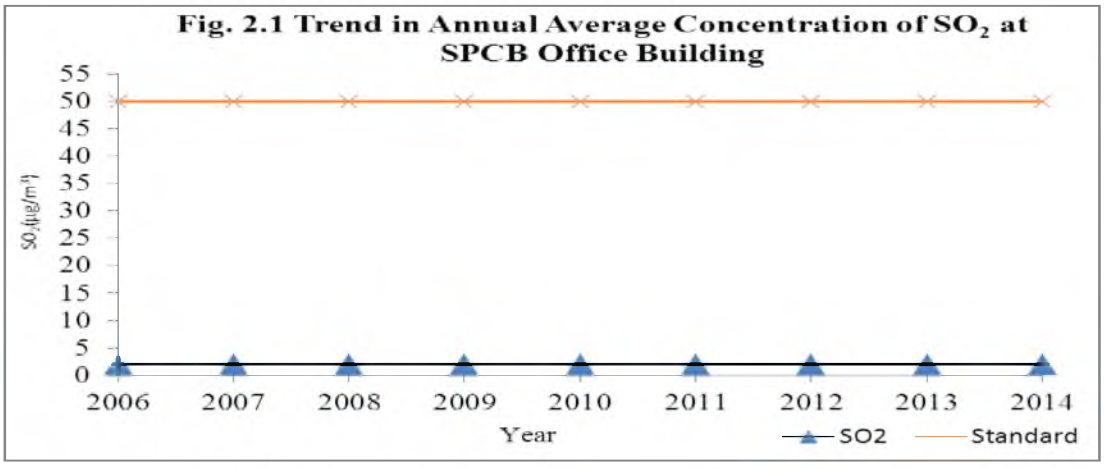


Fig. 2.1 Trend in Annual Average Concentration of SO_2 at SPCB Office Building

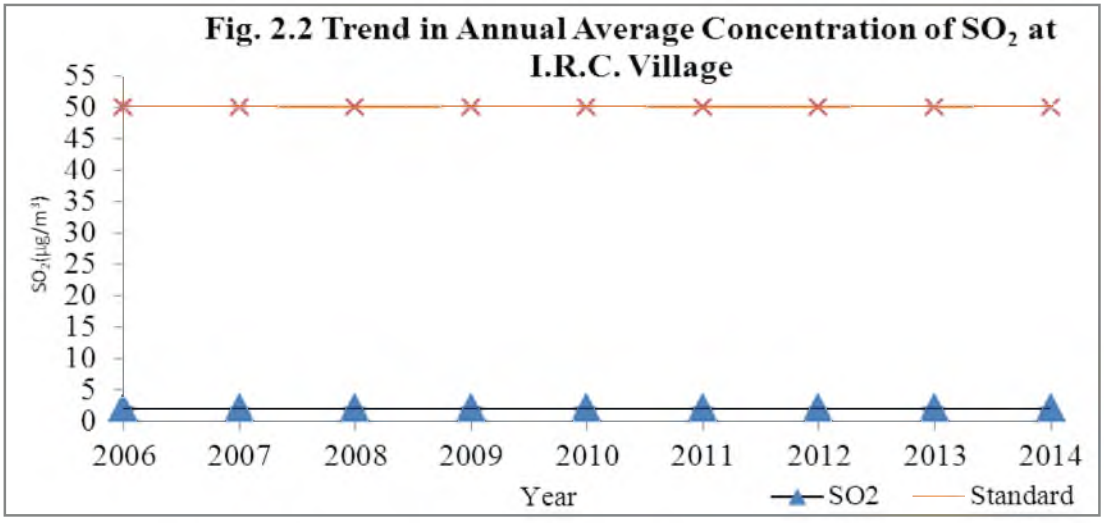


Fig. 2.2 Trend in Annual Average Concentration of SO_2 at I.R.C. Village

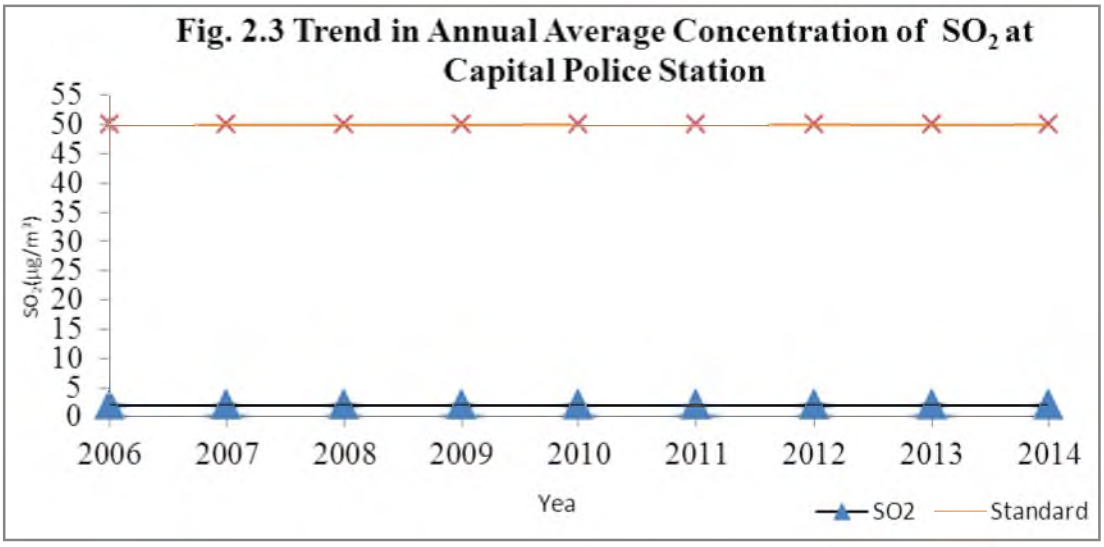


Fig. 2.3 Trend in Annual Average Concentration of SO_2 at Capital Police Station

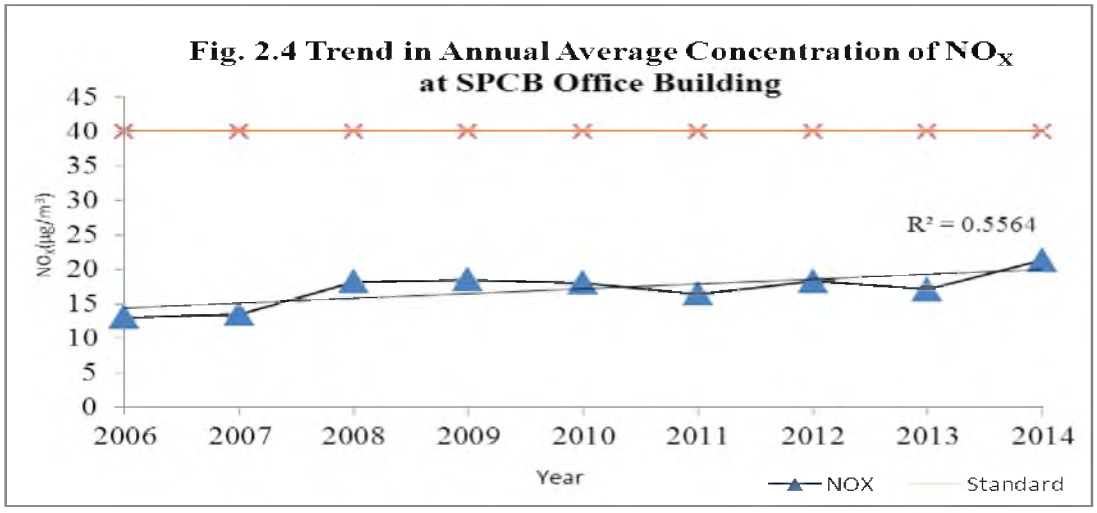


Fig. 2.4 Trend in Annual Average Concentration of NO_X at SPCB Office Building

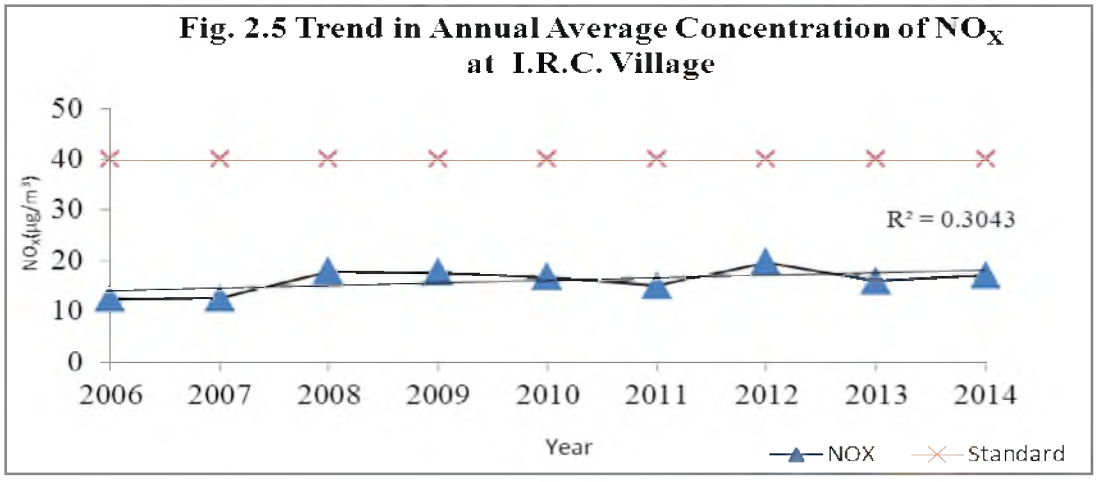


Fig. 2.5 Trend in Annual Average Concentration of NO_X at I.R.C. Village

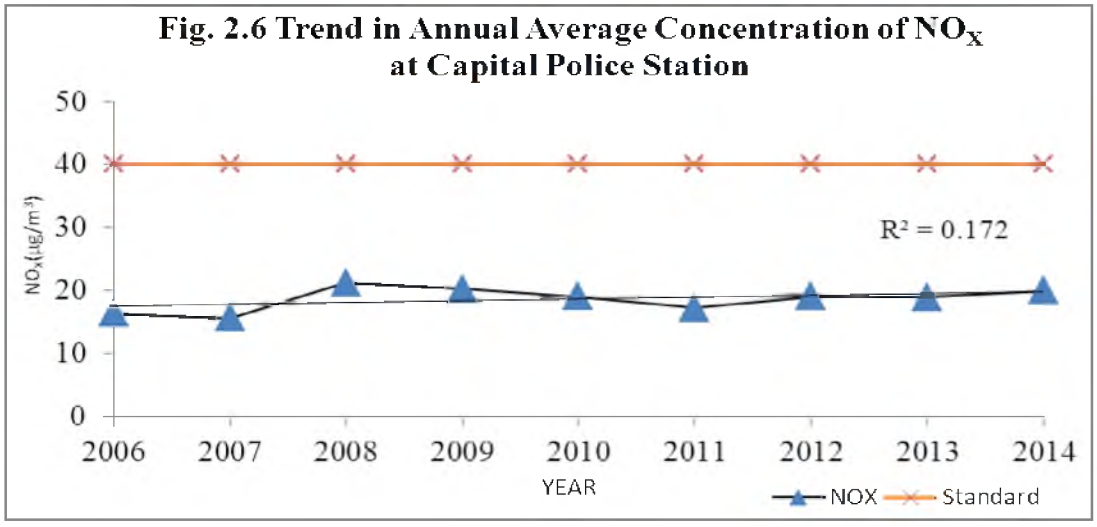


Fig. 2.6 Trend in Annual Average Concentration of NO_X at Capital Police Station

Fig. 2.7 Trend in Annual Average Concentration of SPM at SPCB Office Building

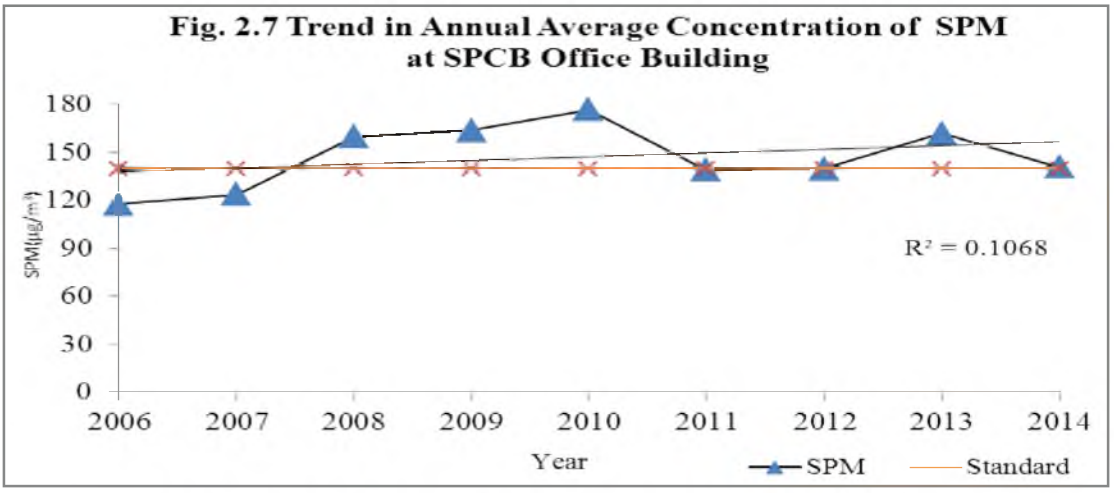


Fig. 2.8 Trend in Annual Average Concentration of SPM at I.R.C. Village

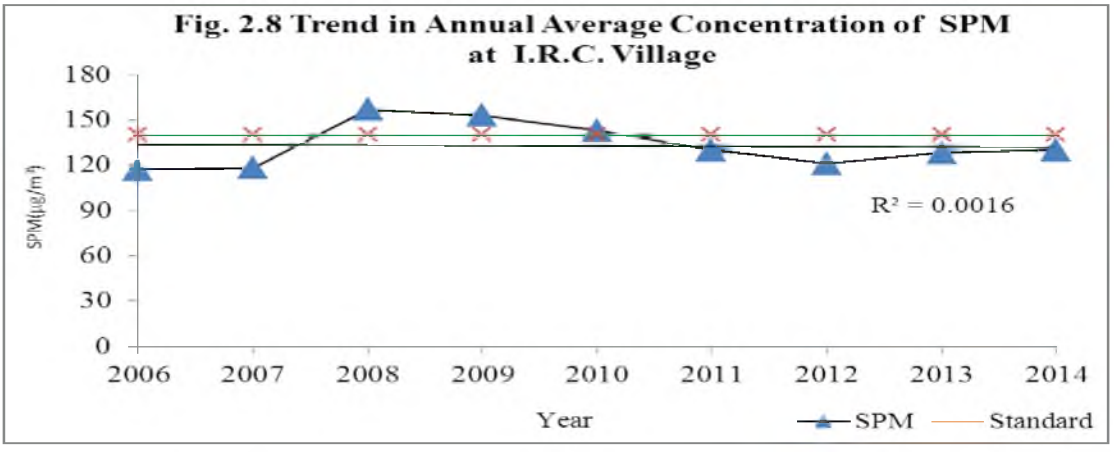
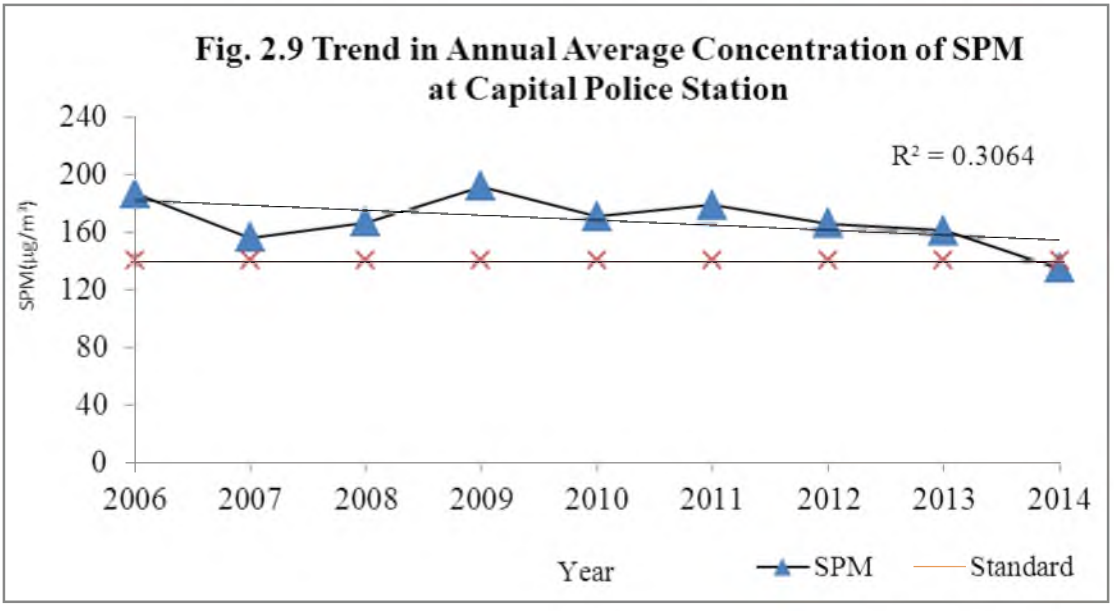


Fig. 2.9 Trend in Annual Average Concentration of SPM at Capital Police Station



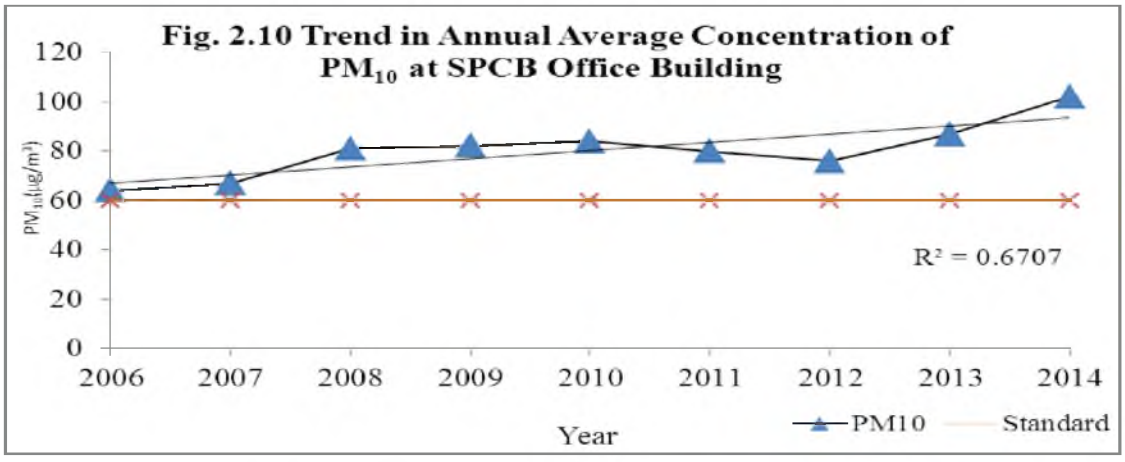


Fig. 2.10 Trend in Annual Average Concentration of PM_{10} at SPCB Office Building

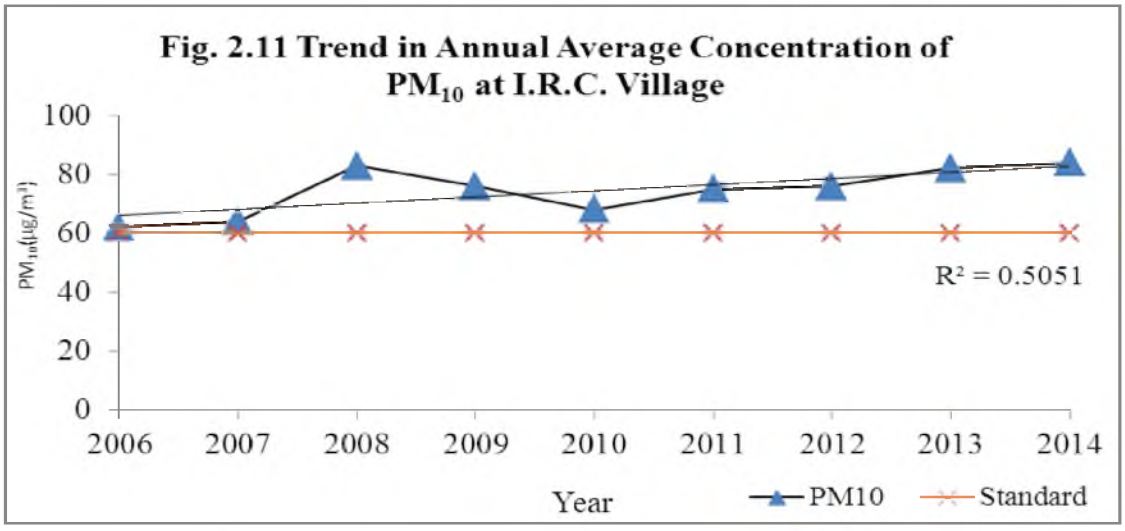


Fig. 2.11 Trend in Annual Average Concentration of PM_{10} at I.R.C. Village

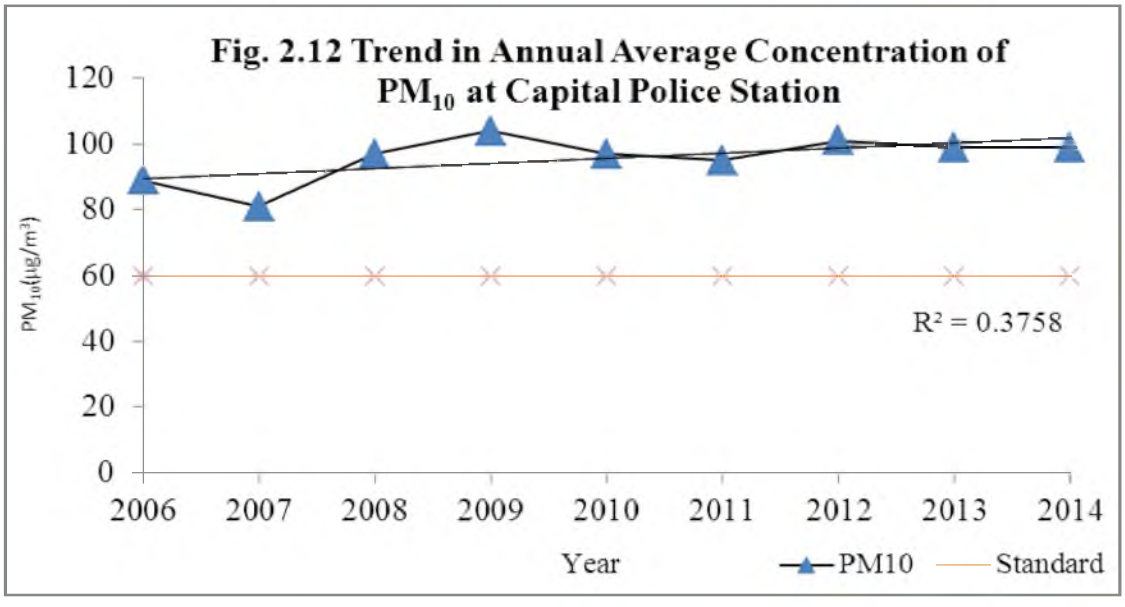


Fig. 2.12 Trend in Annual Average Concentration of PM_{10} at Capital Police Station

Fig. 2.13

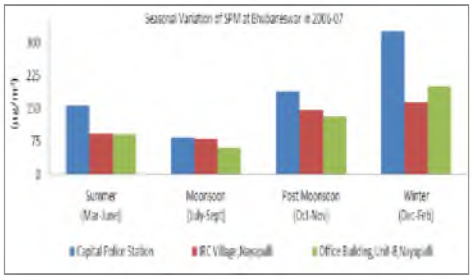


Fig.2.14

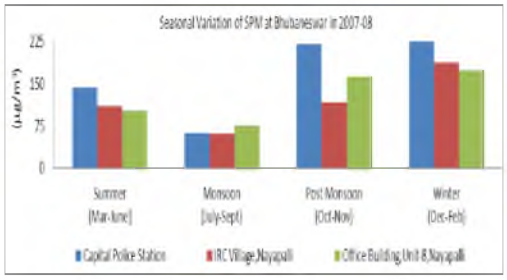


Fig. 2.15

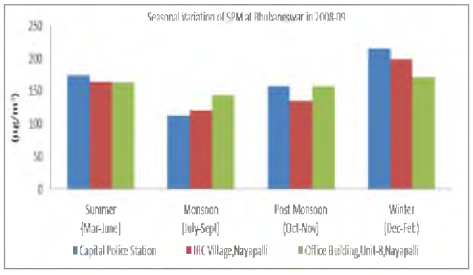


Fig. 2.16

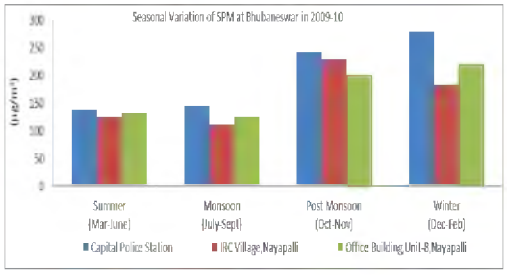


Fig. 2.17

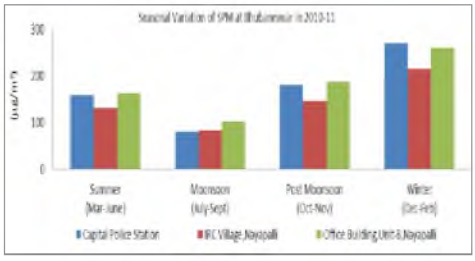


Fig. 2.18

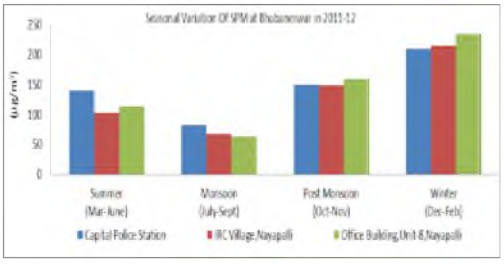


Fig. 2.19

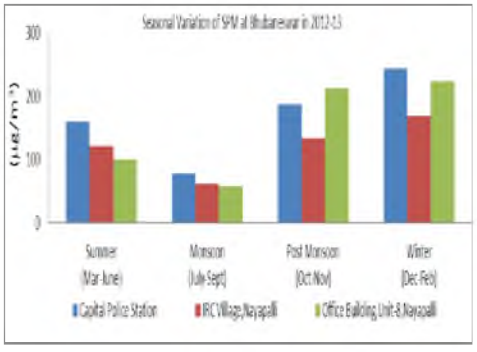


Fig. 2.20

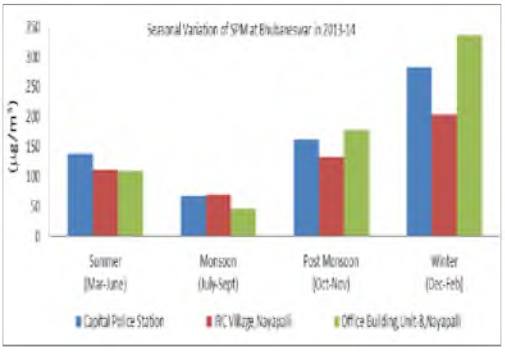


Fig. 2.21

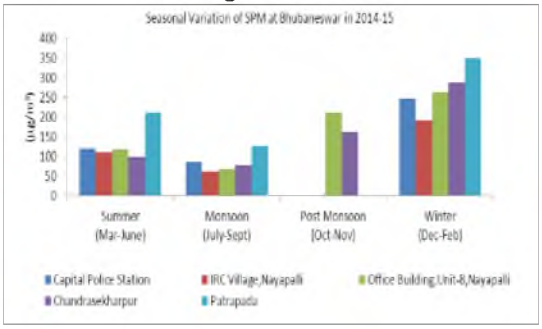


Fig.2.22

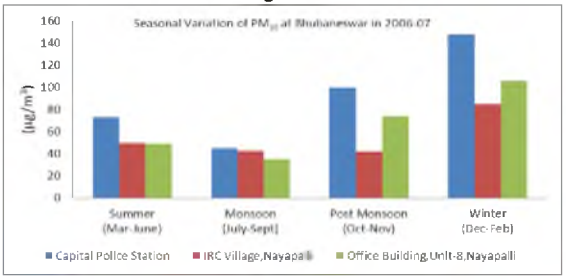


Fig.2.23

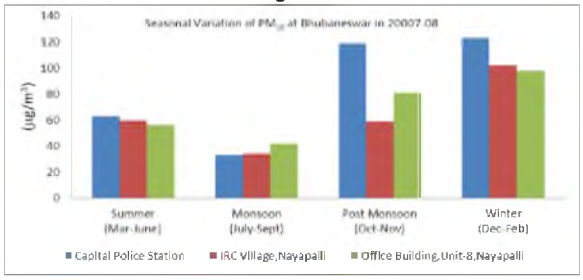


Fig.2.24

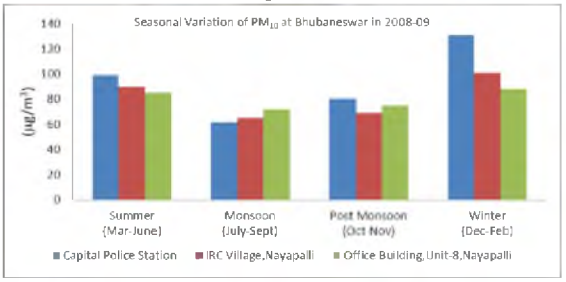


Fig.2.25

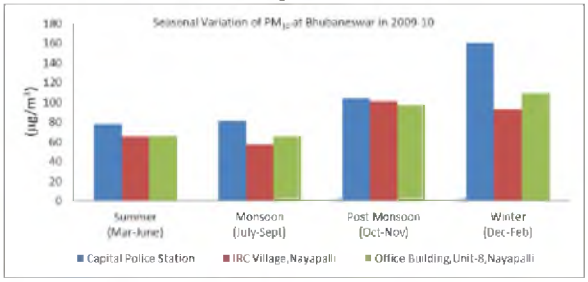


Fig.2.26

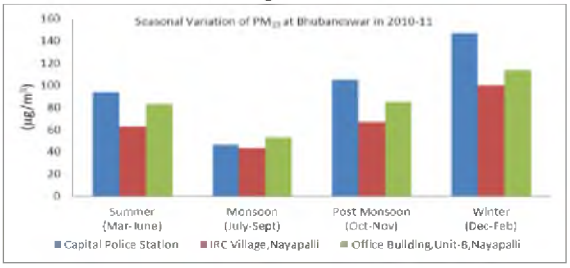


Fig.2.27

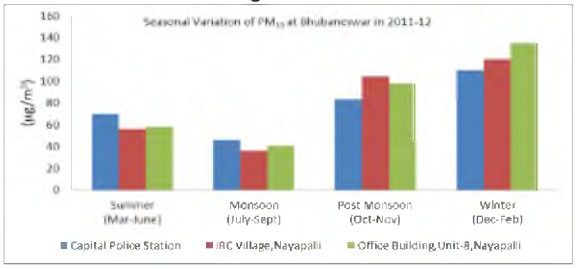


Fig.2.28

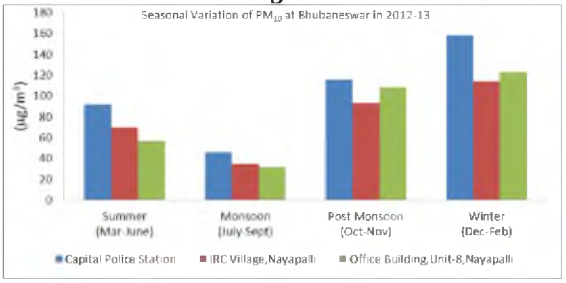


Fig.2.29

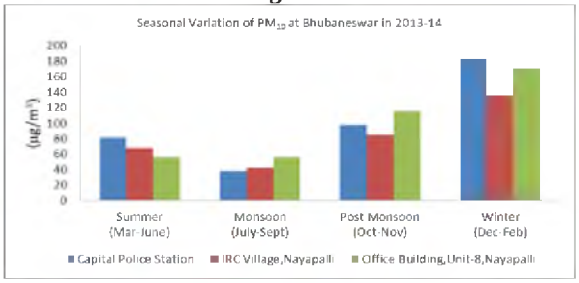


Fig.2.30

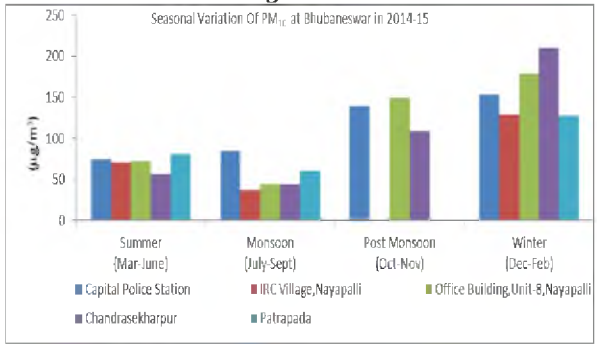


Table: 2.7 Categorisation of Ambient Air Quality on the basis of Exceedence Factor of Bhubaneswar

Location	Categorisation of Bhubaneswar (2006 to 2014)								
	SO_2								
	2006	2007	2008	2009	2010	2011	2012	2013	2014
Office Building, Nayapalli	L	L	L	L	L	L	L	L	L
I.R.C. Village	L	L	L	L	L	L	L	L	L
Capital Police Station	L	L	L	L	L	L	L	L	L
Palasuni water works								L	-
Patrapada								L	L
Chandrasekharpur								-	L

Location	NO_X								
	2006	2007	2008	2009	2010	2011	2012	2013	2014
Office Building, Nayapalli	L	L	L	L	L	L	L	L	M
I.R.C. Village	L	L	L	L	L	L	L	L	L
Capital Police Station	L	L	L	L	L	L	L	L	L
Palasuni water works								L	-
Patrapada								L	L
Chandrasekharpur								-	L

Location	SPM								
	2006	2007	2008	2009	2010	2011	2012	2013	2014
Office Building, Nayapalli	M	M	H	H	H	M	M	H	H
I.R.C. Village	M	M	H	H	H	M	M	M	M
Capital Police Station	H	M	H	H	H	H	H	H	M
Palasuni water works								M	-
Patrapada								M	M
Chandrasekharpur								-	M

Location	RSPM								
	2006	2007	2008	2009	2010	2011	2012	2013	2014
Office Building, Nayapalli	H	H	H	H	H	H	H	H	C
I.R.C. Village	H	H	H	H	H	H	H	H	H
Capital Police Station	H	H	C	C	C	C	C	C	C
Palasuni water works								H	-
Patrapada								H	H
Chandrasekharpur								-	H

NB:- L: Low, M: Moderate, H: High, C: Critical

3.0 AMBIENT AIR QUALITY STATUS AND TRENDS OF CUTTACK CITY

The State Pollution Control Board, Odisha monitors the ambient air quality of Cuttack city at three locations. The details are presented in Table 3.0. The location of monitoring stations are selected as per the guideline of CPCB and are indicated in Fig.3.0.

Table: 3.0 Ambient Air Quality Monitoring Locations

Place	Location	Latitude / Longitude	Category of Area
Cuttack	1. RO, Building, SPC Board	$20^0$01' N/$84^0$58' E	Residential
	2. Traffic Tower, Badambadi	21^0 10'N/87^0 03' E	
	3. PHD Office, Barabati	$20^0$28'43.02''N / $85^0$52'03.63''E	

3.1 Description of the Locations

3.1.1 Regional Office Building, Surya Nagar

The station is operating in the residential area. NH-5 is about 500 m. away from the monitoring station. Madhupatana Industrial Estate is situated within 1 km. from the site. The station is operating at about 6 m. above the ground level and is adjacent to one of the busiest connecting road from National Highway–5 to the main bus terminal of Cuttack city.

3.1.2 Traffic Tower, Badambadi

The station is operating on the traffic tower located besides the main bus terminal of the city. It is one of the major commercial areas of the city. The station is operating at about 10 m above the ground level.

3.1.2 PHD Office, Barabati

The station is operating on the PHD office building. The famous Barabati fort is situated nearby. It is situated both in commercial and residential areas. The station is 3m above the ground level.

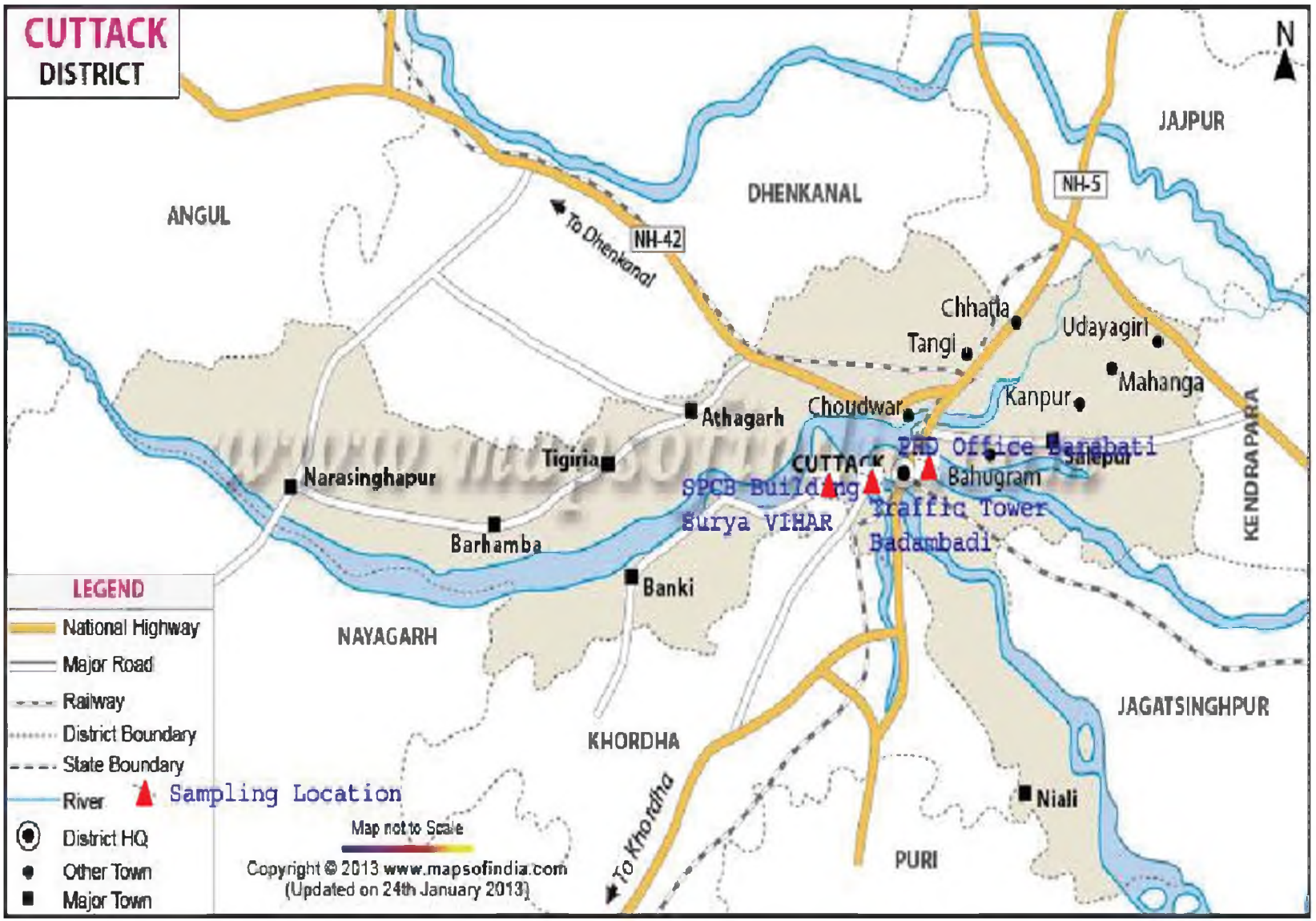


Fig.3.0 Map Showing Sampling Locations in Cuttack City

3.2 Ambient Air Quality of Cuttack City

Ambient Air Quality status of Cuttack city from the year 2006 to 2014 with respect to annual average value, range value of 24 hrly average and frequency of violation of parameters like SPM, RSPM (PM_{10}), SO_2 & NO_x at SPCB, Building, Surya vihar, Traffic Tower, Badambadi and at PHD office Barabati for the year 2013 & 2014 are presented in Table 3.1 to 3.3 and trend of the parameters are shown in Fig. 3.1 to 3.8. Seasonal variation of SPM & PM_{10} are shown in Fig. 3.9-3.26. Categorisation on the basis of exceedence factor of each location shown in Table 3.4.

3.2.1 SO_2 & NO_x

The annual average value of SO_2 & NO_X at all locations were below their respective limits i.e., 50 µg/m^3 for SO_2 & 40 µg/m3 for NO_x except NOx at Traffic Tower, Badambadi in 2006 & 2007. The trend of SO_2 at three locations remained unchanged. The maximum annual average for NO_X at RO, Building, Surya vihar was 26.5 µg/m^3 in the year 2014; Traffic tower, Badambadi was 53.6 µg/m^3 in the year 2006 & at PHD office, Barabati was 30.8 µg/m^3 in the year 2014. The trend of NO_X at all three locations decreases from the year 2006 to 2013. SO_2 falls under Low category at all three locations where as NO_X falls under Low category at most of the time at all locations, except High in the year 2006 & 2007, Moderate in the year 2010,2011 & 2014 at Traffic tower Badambadi, High in the year 2006 and Moderate in the year 2014 at RO, Building, Surya vihar and Moderate in the year 2014 at PHD office Barabati.

3.2.2 SPM & RSPM (PM_{10})

The annual average of SPM value at all three locations were above the limit i.e., 140 µg/m^3 throughout the study period. The maximum annual average value at RO, Building, Surya vihar was 186 µg/m^3 in the year 2012; Traffic tower, Badambadi was 331 µg/m^3 in the year 2007 & at PHD office, Barabati was 202 µg/m^3 in the year 2014. Maximum frequency of violation for SPM in Traffic Tower Badambadi on 24hrly average was 79.2 % in the year 2009, 40 % at RO, Building, Surya Vihar in the year 2012 & 44.3 % in the year 2013 at PHD office Barabati .The trend of SPM at Traffic tower Badambadi & PHD office Barabati are in decreasing trend and RO, Building, Surya Vihar was in increasing trend. The exceedence factor of SPM mostly falls under High category at RO, Building, Surya vihar for the year 2006 to 2014 & PHD office Barabati in the year 2013 & 2014, Critical at Traffic Tower Badambadi from the year 2006 to 2011 & 2014 and High in 2012 & 2013. The annual average of RSPM(PM_{10}) remain above the limit i.e.,60 µg/m^3 at all locations in the study period .The maximum annual average value at RO, Building, Surya vihar was 79 µg/m^3 in the year 2014 with maximum percentage of violation 31.4 % in the year 2013; at Traffic tower Badambadi maximum annual average value was 105 µg/m^3 & maximum percentage of violation was 43.6 % in the year 2014 and at PHD office Barabati maximum annual average value was 94 µg/m^3 in the year 2014 and maximum percentage of violation was 38.1 % in the year 2013. On the basis of exceedence factor RSPM mostly falls under High category throughout the study period at all locations except at Traffic Tower & PHD office where it was critical in the year 2014.

From seasonal variation it was observed that during winter season the concentration of both SPM and RSPM are maximum and it shows minimum values during monsoon in most of the years at all locations.

3.2.3 $PM_{2.5}$

Ambient air quality with respect to $PM_{2.5}$ was monitored at 3 locations in the year 2014. The annual average value of $PM_{2.5}$ at all stations were exceeded the prescribed limit i.e 40 µg/m^3. The maximum percentage of violation with respect to 24 hrly. standard observed at Traffic Tower, Badambadi i.e., 35.6%. The maximum 24 hrly. average value of $PM_{2.5}$ was observed on the day of Deepawali at Surya Vihar, Cuttack i.e., 161 µg/m^3 and at Traffic Tower, Badambadi i.e., 172 µg/m^3.

Status of Ambient Air Quality at Cuttack

Table: 3.1 R.O.Building, Surya Vihar

Year	No. of Obs. (24 hrs.)	Parameters (µg/m^3) Annual Average (Range Values)					Frequency of violation of data (24 hrs. Avg.) from prescribed standard (% of violation)				
		SPM	RSPM	$PM_{2.5}$	SO_2	NO_x	SPM	RSPM	$PM_{2.5}$	SO_2	NO_x
		Annual Average									
2006	106	157 (100-341)	68 (32-181)	-	BDL (BDL-BDL)	17.2 13.7-27.1	-	-	-	-	-
2007	104	169 (105-339)	75 (40-179)	-	BDL (BDL-BDL)	16.1 (13.2-27.6)	27%	23%	-	-	-
2008	104	164 (86-267)	74 (32-134)	-	BDL (BDL-BDL)	15.8 (10.4-25)	25%	25%	-	-	-
2009	106	154 (80-326)	69 (26-192)	-	BDL (BDL-BDL)	15.7 (13.1-24.1)	23.6%	22.7%	-	-	-
2010	104	158 (78-379)	69 (26-186)	-	BDL (BDL-BDL)	17.0 (12.5-32.6)	25%	21%	-	-	-
2011	103	153 (50-350)	73 (24-175)	-	BDL (BDL-BDL)	12.2 (BDL-21.2)	26.2%	26.2%	-	-	-
2012	105	186 (92-385)	77 (34-196)	-	BDL (BDL-BDL)	17.3 (9.6-24.8)	40%	19%	-	-	-
2013	102	161 (58-309)	77 (19-164)	-	BDL (BDL-BDL)	15.3 (BDL-32.7)	37.3%	31.4%	-	-	-
2014	102	165 (82-286)	79 (37-218)	51 (25-161)	BDL (BDL-BDL)	26.5 (21.0-37.3)	16.7%	13.7%	22.5%	-	-
Prescribed standard (R)	24 hrly/ Annual avg.	200/140	100/60	-	80/60	80/60	As Per 1998 Standard				
	24 hrly/ Annual avg.	-	100/60	60/40	80/60	80/40	As Per 2009 Standard				

BDL - Below Detectable Limit, R – Residential BDL Value for SO_2 - ≤4,BDL Value for NO_X - ≤9, BDL Value for RSPM - ≤ 5

Table:3.2 Traffic Tower Badambadi

Year	No. of Obs. (24 hrs.)	Parameters (µg/m³) Annual Average (Range Values)					Frequency of violation of data (24 hrs. Avg.) from prescribed standard (% of violation)				
		SPM	RSPM	$PM_{2.5}$	SO_2	NO_x	SPM	RSPM	$PM_{2.5}$	SO_2	NO_x
2006	110	287 (220-348)	83 (64-112)	-	BDL (BDL-BDL)	53.6 (41.6-62)	-	-	-	-	-
2007	103	331 (195-561)	89 (48-200)	-	BDL (BDL-4.5)	43 (32.6-55.3)	99%	29%	-	-	-
2008	105	277 (65-568)	86 (29-203)	-	BDL (BDL-4.7)	22.9 (9.7-41.1)	70%	31%	-	-	-
2009	106	293 (97-532)	89 (29-227)	-	BDL (BDL-BDL)	24.0 (14.4-35.5)	79.2%	39%	-	-	-
2010	105	234 (96-445)	78 (33-260)	-	BDL (BDL-BDL)	23.0 (11.2-38.3)	51%	23%	-	-	-
2011	104	222 (83-415)	79 (29-212)	-	BDL (BDL-BDL)	20.4 (10.4-40.4)	51.9%	32.6%	-	-	-
2012	105	210 (115-535)	83 (38-342)	-	BDL (BDL-BDL)	19.8 (12.9-29.7)	58%	29.5%	-	-	-
2013	101	192 (82-334)	87 (29-165)	-	BDL (BDL-BDL)	17.6 (BDL-41.2)	46.5%	42.6%	-	-	-
2014	101	217 (102-372)	105 (49-226)	54 (22-172)	BDL (BDL-BDL)	32.3 (14.9-47.2)	47.5%	43.6%	35.6%	-	-
Prescribed standard (R)	**24 hrly/ Annual avg.**	**200/140**	**100/60**	-	**80/60**	**80/60**	**As Per 1998 Standard**				
	24 hrly/ Annual avg.	-	**100/60**	**60/40**	**80/50**	**80/40**	**As Per 2009 Standard**				

Table: 3.3 PHD Office, Barabati

Year	No. of Obs. (24 hrs.)	Parameters (µg/m³) Annual Average (Range Values)					Frequency of violation of data (24 hrs. Avg.) from prescribed standard (% of violation)				
		SPM	RSPM	$PM_{2.5}$	SO_2	NO_x	SPM	RSPM	$PM_{2.5}$	SO_2	NO_x
2013	97	181 (60-344)	85 (27-174)	-	BDL (BDL-BDL)	16.8 (BDL-35.7)	44.3%	38.1%	-	-	-
2014	101	202 (95-383)	94 (43-192)	48 (21-99)	BDL (BDL-BDL)	30.8 (23.8-40.6)	36.6%	35.6%	22.8 %	-	-
Prescribed standard (R)	**24 hrly/ Annual avg.**	**200/140**	**100/60**	**60/40**	**80/60**	**80/60**	**As Per 1998 Standard**				
	24 hrly/ Annual avg.	-	**100/60**	**60/40**	**80/50**	**80/40**	**As Per 2009 Standard**				

Fig. 3.1 Trend in Annual Average Concentration of SO_2 at RO Building, Surya Vihar

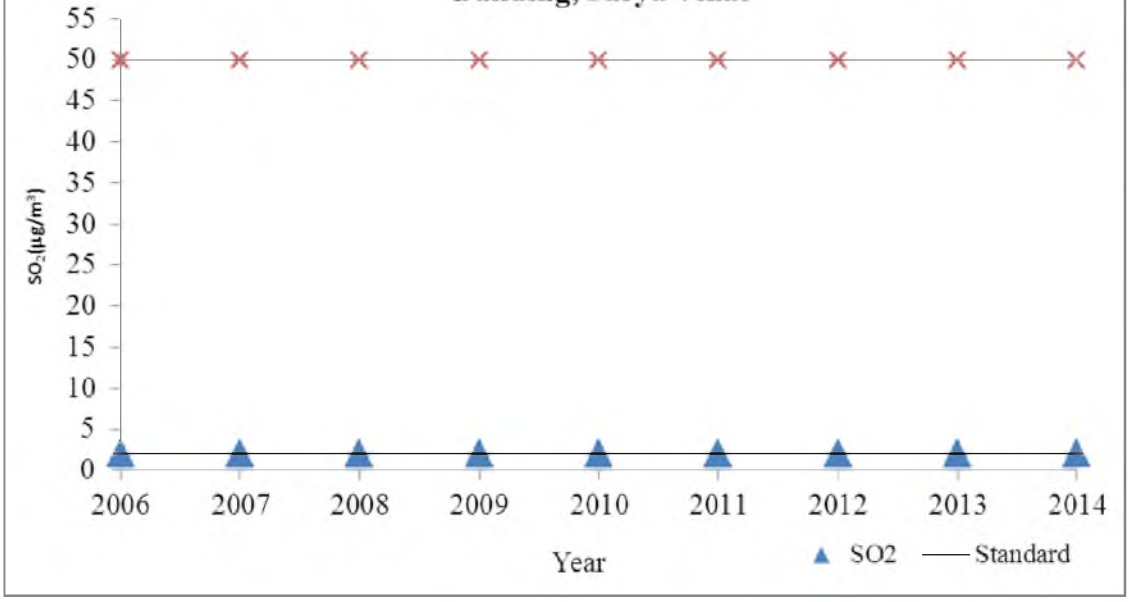


Fig. 3.2 Trend in Annual Average Concentration of SO_2 at Traffic Tower, Badambadi

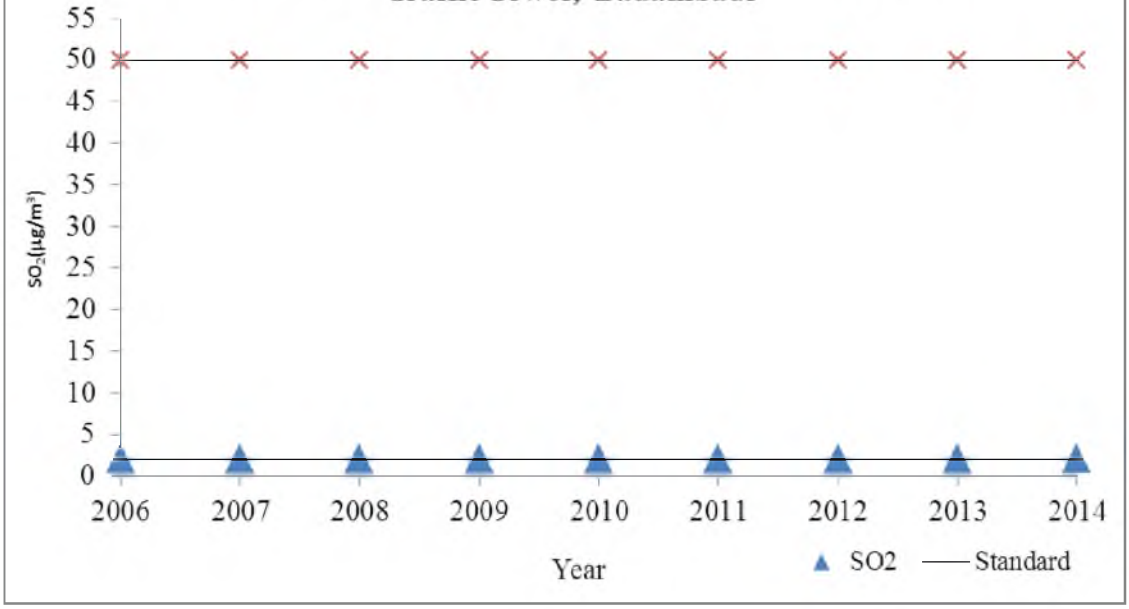


Fig. 3.3 Trend in Annual Average Concentration of NO_X at RO Building, Surya Vihar

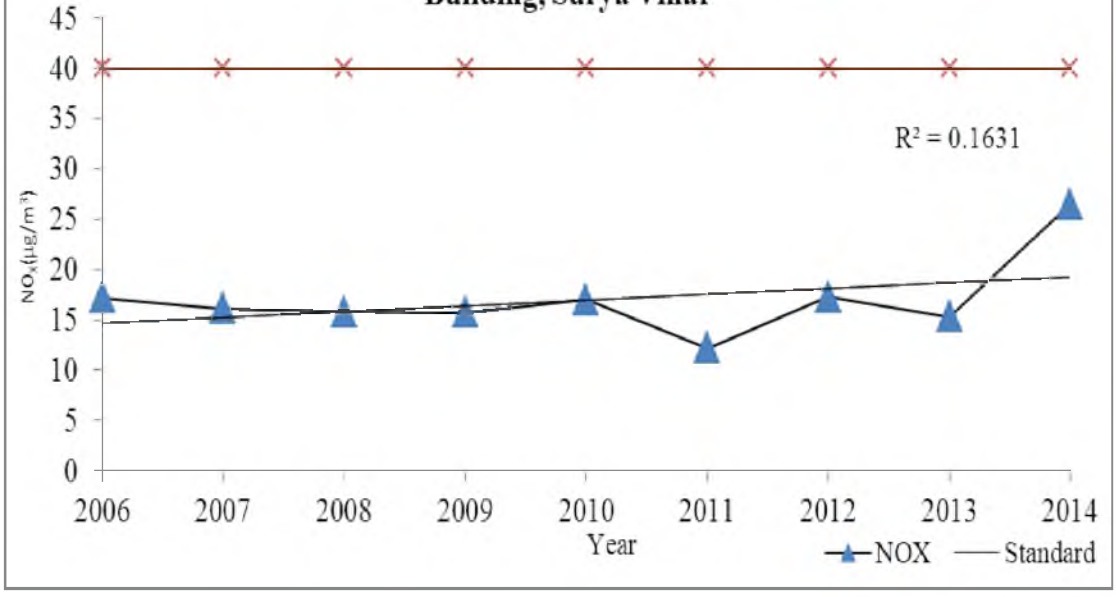


Fig. 3.4 Trend in Annual Average Concentration of NO_X at Traffic Tower, Badambadi

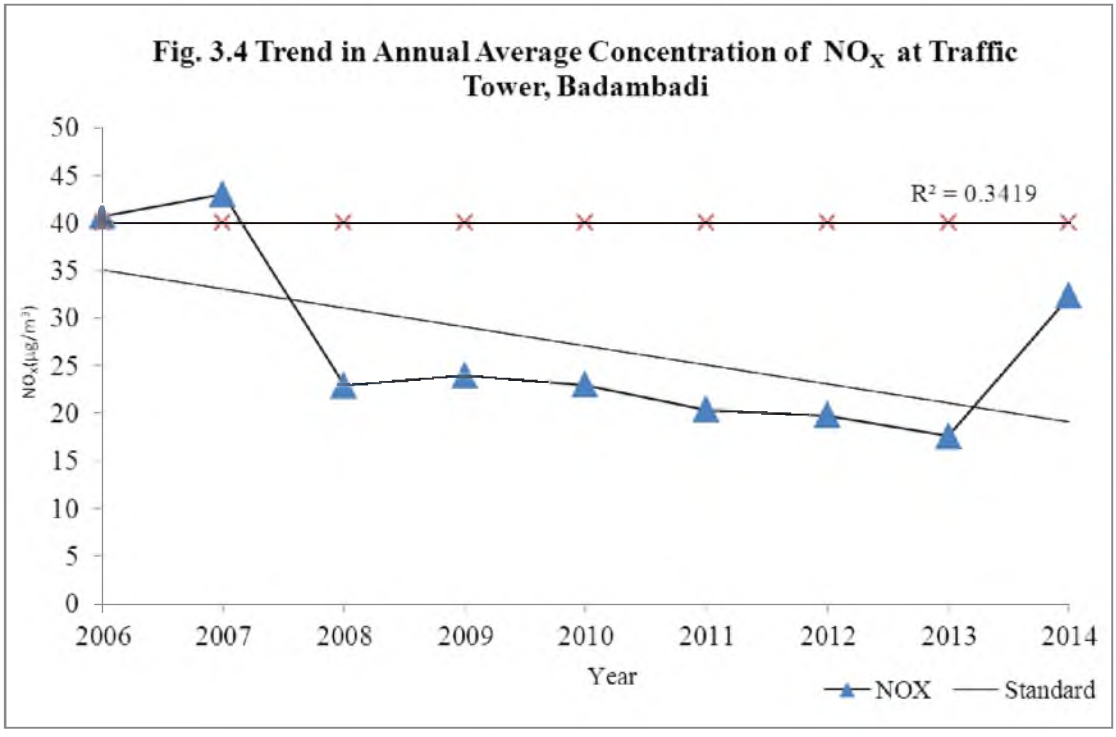


Fig. 3.5 Trend in Annual Average Concentration of SPM at RO Building, Surya Vihar

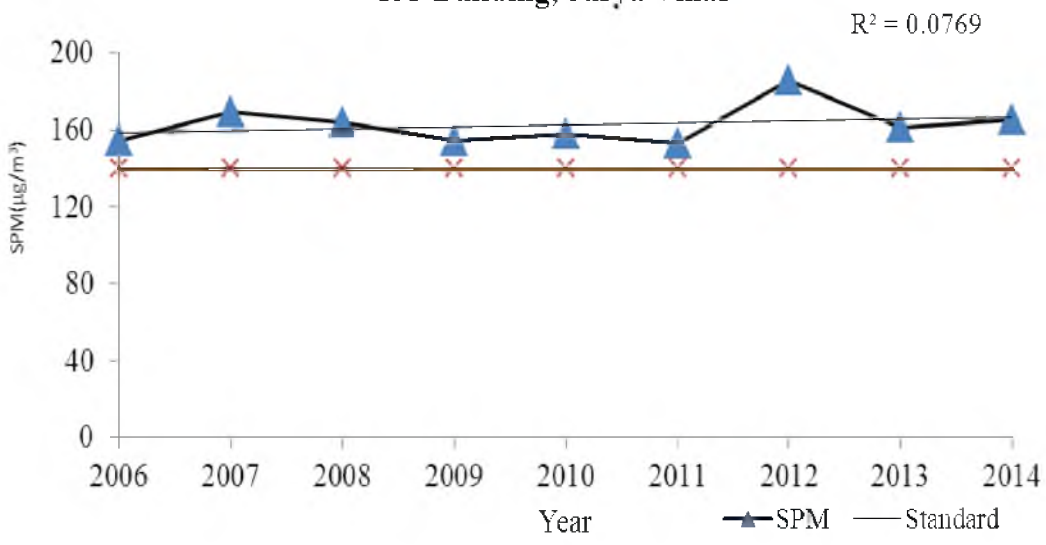


Fig. 3.6 Trend in Annual Average Concentration of SPM at Traffic Tower, Badambadi

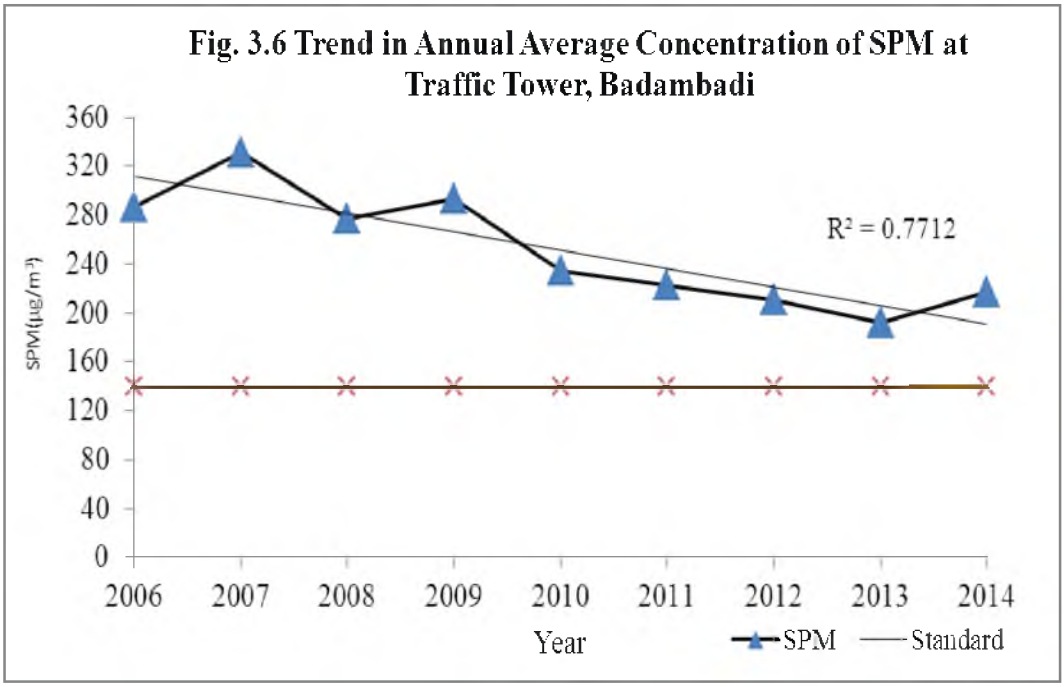


Fig. 3.7 Trend in Annual Average Concentration of PM_{10} at R.O.Building, Surya Vihar

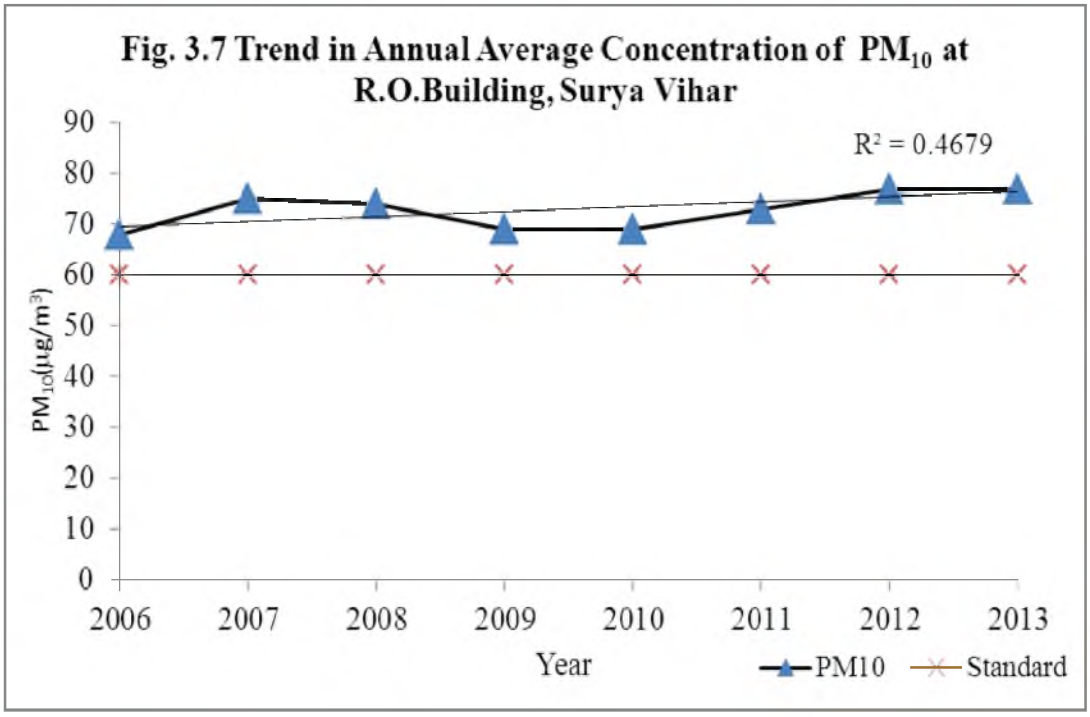


Fig. 3.8 Trend in Annual Average Concentration of PM_{10} at Traffic Tower, Badambadi

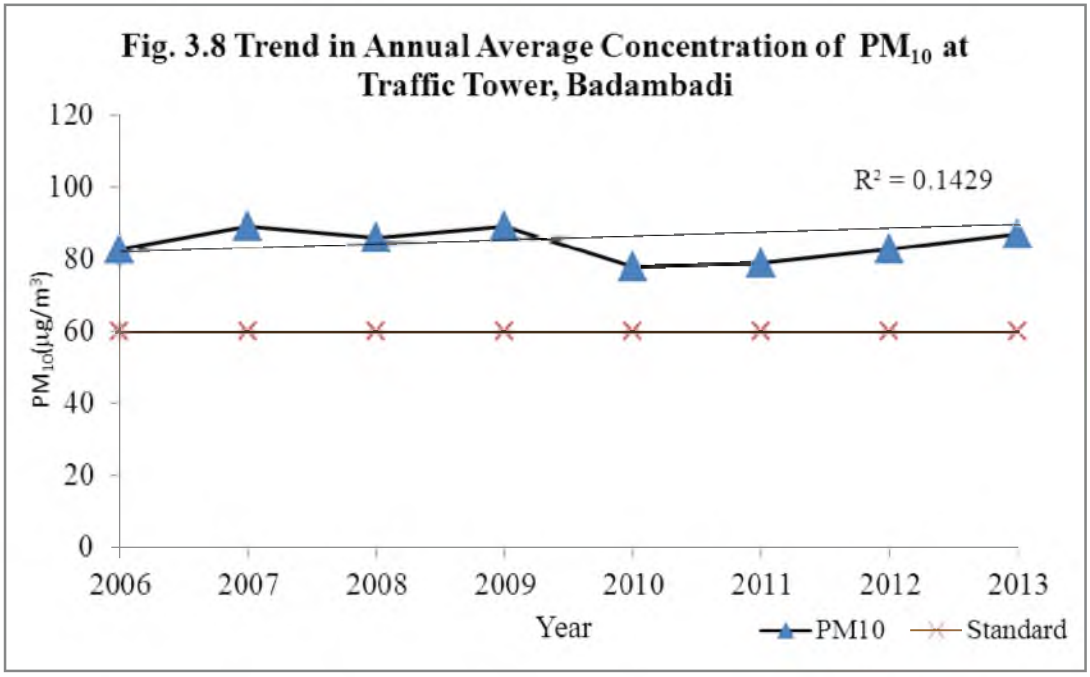


Fig.3.9

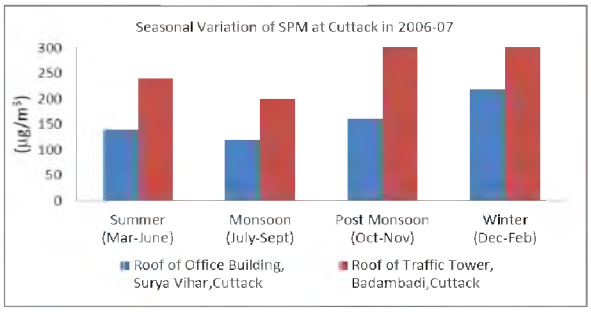


Fig.3.10

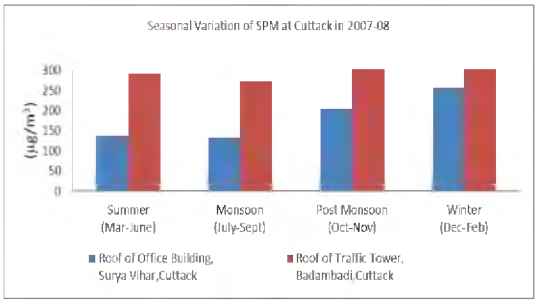


Fig.3.11

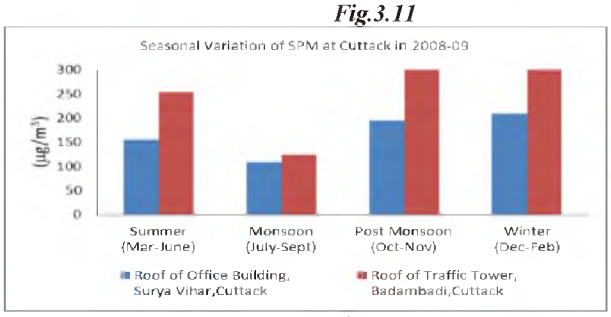


Fig.3.12

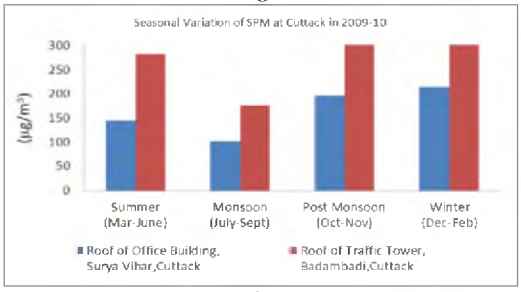


Fig.3.13

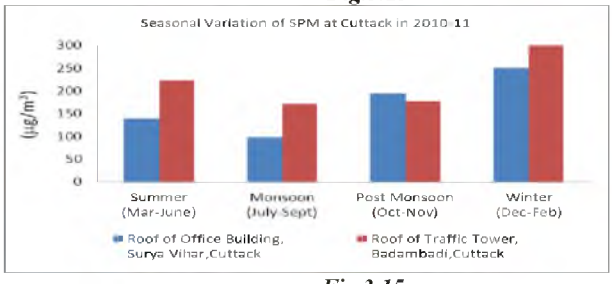


Fig.3.14

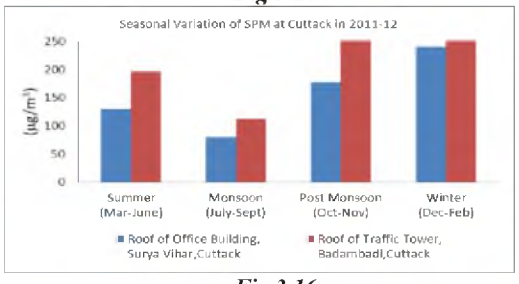


Fig.3.15

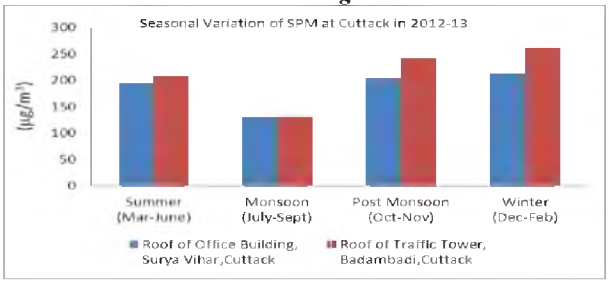


Fig.3.16

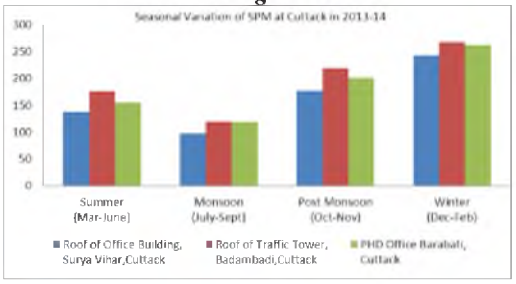


Fig.3.17

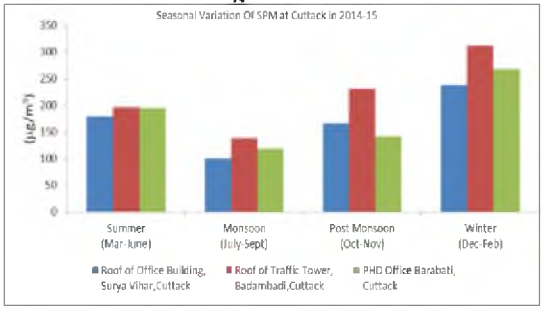


Fig.3.18

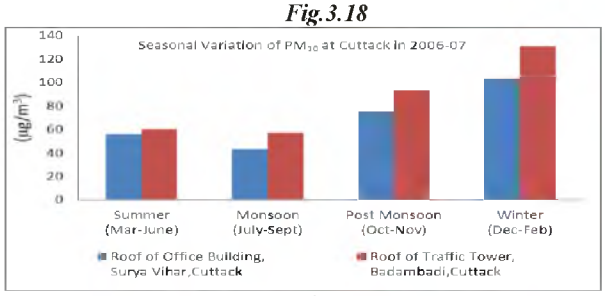


Fig.3.19

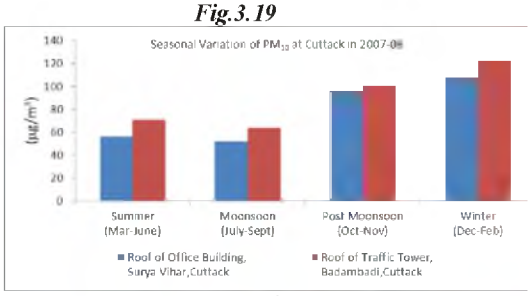


Fig.3.20

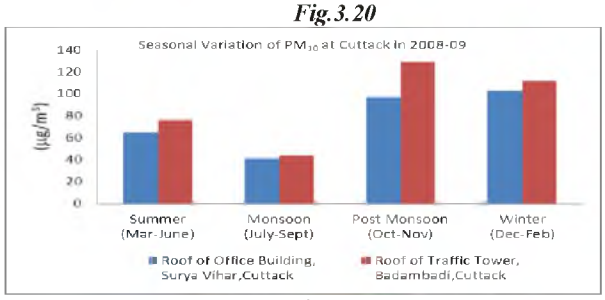


Fig.3.21

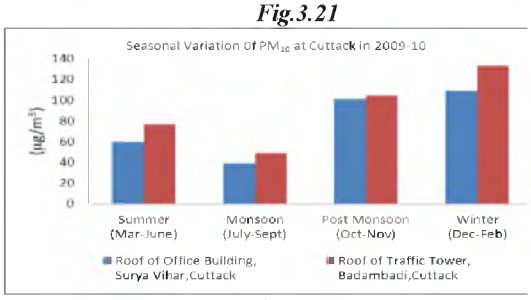


Fig.3.22

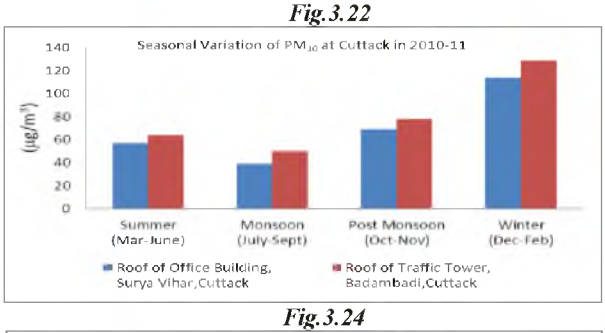


Fig.3.23

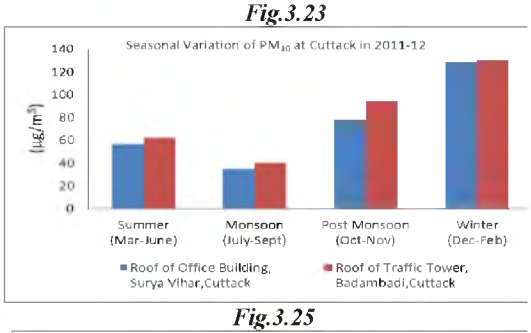


Fig.3.24

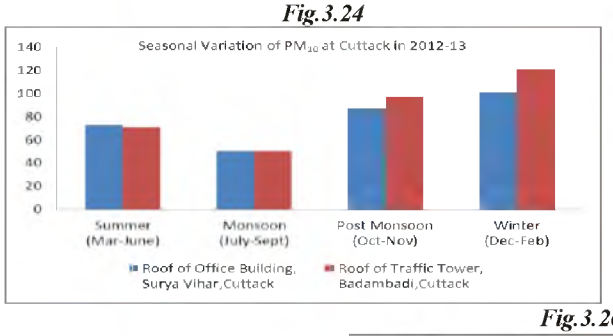


Fig.3.25

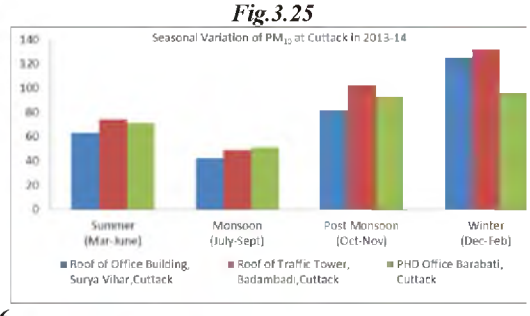


Fig.3.26

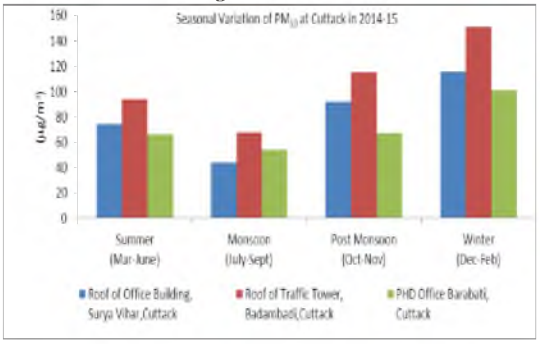


Table: 3.4 Categorisation of Ambient Air Quality on the basis of exceedence factor of Cuttack

Location	Categorisation of Cuttack, (2006 to 2014)								
	SO_2								
	2006	2007	2008	2009	2010	2011	2012	2013	2014
Traffic Tower, Badambadi	L	L	L	L	L	L	L	L	L
Regional Office, Surya Vihar	L	L	L	L	L	L	L	L	L
PHD Office, Barabati								L	L

Location	NO_x								
	2006	2007	2008	2009	2010	2011	2012	2013	2014
Traffic Tower, Badambadi	H	H	L	L	M	M	L	L	M
Regional Office, SuryaVihar	H	L	L	L	L	L	L	L	M
PHD office ,Barabati								L	M

Location	SPM								
	2006	2007	2008	2009	2010	2011	2012	2013	2014
Traffic Tower, Badambadi	C	C	C	C	C	C	H	H	C
Regional Office, Surya Vihar	H	H	H	H	H	H	H	H	H
PHD Office, Barabati								H	H

Location	RSPM								
	2006	2007	2008	2009	2010	2011	2012	2013	2014
Traffic Tower, Badambadi	H	H	H	H	H	H	H	H	C
Regional Office, Surya Vihar	H	H	H	H	H	H	H	H	H
PHD Office, Barabati								H	C

NB:- L: Low, M: Moderate, H: High, C: Critical

4.0 AMBIENT AIR QUALITY STATUS AND TRENDS OF ANGUL & TALCHER

The State Pollution Control Board, Odisha monitors the ambient air quality of Angul & Talcher area at four locations. The details are presented in Table 4.0. The location of monitoring stations are selected as per the guideline of CPCB and is indicated in Fig.4.0.

Table: 4.0 Ambient Air Quality Monitoring Location

Place	Location	Latitude/ Longitude	Category of Area
Angul & Talcher	1. R.O., SPCB Building, Angul	$20^0$49'98.3''N $85^0$06'25.4''E	Industrial
	2. NALCO Nagar, Angul	$20^0$50' 77.8''N $85^0$0918.3'' E	Residential
	3. TTPS , Talcher	$20^0$54' 086''N 85^0 12236'' E	Industrial
	4. MCL, Talcher	$20^0$55'418''N $85^0$08'399''E	Residential

4.1 Description of the locations

4.1.1 Regional Office Building, Industrial Estate, Hakimpada

The ambient air quality monitoring station at Angul is operating at the Regional Office building situated in the industrial estate. The monitoring station is 3 m. above the ground level and adjacent to the internal road of industrial estate, Angul. There are about 6 industries operating in the estate. National Highway No. - 42 is nearly 1 km. away from the monitoring station. Govt. Offices, Circuit house, inspection bungalow are situated within the vicinity of 1 Km of the monitoring station. The residential area is within 500 m. of the station.

4.1.2 NALCO Township

The station is operating at a height of 3 m above the ground level, within the premises of a water supply tank in the residential colony of NALCO. The NALCO Captive Power Plant and Smelter Units are situated at an approximate distance of 2 Km. and 1 Km. respectively from the monitoring station.

4.1.3 Talcher Thermal Power Station Township

The station is operating at a height of 5 m above the ground level, within the industrial colony of National Thermal Power Corporation, Talcher. The township is situated at a distance of 2 Km. from the site. The ash pond of TTPS is about 1 Km. away from the monitoring site, whereas, the collieries of Mahanadi Coal Field are operating within 2-10 Km distance in the northern side of the site.

4.1.4 Mahanadi Coal Field Ltd. (MCL)

The station is operating on Bharati guest house at a height of 10m from ground level. It is under Residential area.The MCL Residential colony is near the monitoring station. The station is nearer to Jagannath and Anantapur open cast mines.

Fig.4.0 Map Showing Sampling Locations in Angul & Talcher

4.2 Ambient Air Quality of Angul & Talcher Area

Ambient Air Quality status of Angul & Talcher area from the year 2006-2014 with respect to annual average value, range value of 24 hrly average and frequency of violation of parameters like SPM, RSPM (PM_{10}),SO_2 & NO_x are presented in Table 4.1 to 4.4 and trend of the parameters are shown in Fig. 4.1 to 4.16.Seasonal variation of SPM & PM_{10} are shown in Fig. 4.17 to 4.32. Categorisation on the basis of exceedence factor of the area is shown in Table 4.5

4.2.1 SO_2 & NO_x

The annual average value of SO_2 & NO_X at all locations are below their respective limits 50 µg/m^3 for SO_2 & 40 µg/m^3 for NO_X. Maximum annual average value of NO_X at Angul, Industrial Estate was 23.3 µg/m^3, at NALCO it was 21.8 µg/m^3, at TTPS, Talcher it was 23.5 µg/m^3 in the year 2014 and was 26.8 µg/m^3 in the year 2009 at MCL, Talcher. The trend of SO_2 & NO_X at three locations are mostly in increasing trend. Whereas at Mahanadi coal field location both parameters showed both fluctuating trend. SO_2 falls under Low category at all locations where as NO_X shows mostly Low from the year 2006 to 2009 and Moderate at all location in the year 2013 & 2014.In the year 2010 to 2012 show Moderate at Industrial Estate, Angul & Low in Nalco township & TTPS, Talcher.

4.2.2 SPM & RSPM (PM_{10})

The annual average of SPM value in industrial area i.e., at Angul, Industrial Estate & TTPS, Talcher are below the limit i.e., 360 µg/m^3 for industrial area throughout the study period. While SPM at NALCO, and Mahanadi coal field exceeded the limit i.e., 140 µg/m^3 for Residential area in all years except at NALCO, in the year 2006 & 2007. Maximum annual average value of SPM at Angul, Industrial Estate was 326 µg/m^3 in the year 2009, at NALCO it was 238 µg/m^3 in the year 2014, at TTPS, Talcher it was 236 µg/m^3 in the year 2011 and was 268 µg/m^3 in the year 2010 at MCL, Talcher. Maximum frequency of violation for SPM in industrial area on 24hrly average was 19.2 % in the year 2009. For Residential area the maximum percentage of violation was 72.1% at NALCO township in the year 2014 and 66.3 % at Mahanadi Coal field in the year 2009. SPM at all locations were in increasing trend except industrial Estate, Angul which was in decreasing trend.

The annual average of RSPM (PM_{10}) at all four locations were above the limit i.e., 60 µg/m^3.The maximum annual average of RSPM (PM_{10}) at Industrial Estate, Angul was 158 µg/m^3 in the year 2009 at Nalco township, Angul it was 115 µg/m^3 in the year 2014, at TTPS it was 114 µg/ m^3 in the year 2014 and at Mahanadi coal field it was 135 µg/m^3 in the year 2010 & 2014.

From seasonal variation it was observed that during monsoon the concentration of SPM & RSPM (PM_{10}) showed minimum values in most of the years at all locations. The exceedence factor for SPM showed Moderate in both the Industrial area i.e., Industrial Estate, Angul & TTPS Talcher throughout the study period except Low at TTPS, Talcher in the year 2007.While SPM at residential area i.e., Nalco Township show High for the year 2008 to 2012, showed Moderate in the year 2006 & 2007 and Critical in the year 2013 & 2014. Whereas at Mahanadi coal field it remains Moderate for the year 2007 to 2010 & Critical in the year 2013 & 2014 and Low in the year 2006.

Similarly RSPM(PM_{10}) in the Industrial area i.e., Industrial Estate Angul remained Critical from the year 2010 to 2014 & in the year 2006 & High from the year 2007 to 2009.TTPS, Talcher remained Critical in the year 2006 & from the year 2010 to 2014, Moderate in the year 2008 & 2009 and High in the year 2007 .In Residential area at Nalco township it showed High from the year 2006 to 2011 & Critical from the year 2012 to 2014.At Mahanadi coal field it showed High in the year 2006 & 2007, Moderate in the year 2008 & 2009 and Critical in the year 2010,2013 & 2014.

Status of Ambient Air Quality at Angul & Talcher

Table: 4.1 Regional Office Building, Industrial Estate

Year	No. of Obs. (24 hrs.)	Parameters (µg/m^3) Annual Average (Range Values)				Frequency of violation of data (24 hrs. Avg.) from prescribed standard (% of violation)			
		SPM	RSPM	SO_2	NO_x	SPM	RSPM	SO_2	NO_x
2006	102	226 (66-419)	107 (29-222)	6.6 (4.4-14.7)	13.8 (9.5-18.4)	-	11.8%	-	-
2007	107	260 (104 - 508)	72 (31 – 139)	6 (4.5-8.4)	17.3 (12.6-22.2)	2.8%	-	-	-
2008	104	282 (58-546)	130 (38-276)	5.8 (BDL-8.4)	21.8 (17.4-25.9)	2.0 %	33.7%	-	-
2009	104	326 (125-697)	158 (69-256)	5.8 (BDL-7.8)	21.9 (12.8-24.0)	19.2%	50%	-	-
2010	103	304 (126-446)	146 (58-215)	6 (4.4-7.3)	22.7 19.8-24.9)	-	81%	-	-
2011	101	269 (106-395)	124 (52-210)	6.4 (BDL-9.8)	20.3 (12.0-25.9)	-	75.2%	-	-
2012	103	256 (107-388)	121 (29-187)	6.5 (4.1-9.8)	20.1 (16.3-24.3)	-	74.7%	-	-
2013	103	218 (83-415)	106 (39-219)	8.3 (4.3-12.7)	21.6 (15.7-28.5)	-	52.4%	-	-
2014	104	234 (53-454)	115 (28-221)	10.0 (4.6-14.6)	23.3 (13.2-31.0)	-	59.6%	-	-
Prescribed standard	**24 hrly / Annual Avg.**	**500/360**	**150/120**	**120/80**	**120/80**	**As Per 1998 Standard**			
	24 hrly/ Annual Avg.	-	**100/60**	**80/50**	**80/40**	**As Per 2009 Standard**			

N.B.: BDL - Below Detectable Limit, R – Residential BDL Value for SO_2 - ≤4, BDL Value for NO_X - ≤9, BDL Value for RSPM - ≤ 5

Table: 4.2 NALCO Township, NALCO Nagar

Year	No. of Obs. (24 hrs.)	Parameters (µg/m^3) Annual Average (Range Values)				Frequency of violation of data (24 hrs. Avg.) from prescribed standard (% of violation)			
		SPM	RSPM	SO_2	NO_x	SPM	RSPM	SO_2	NO_x
2006	105	132 (26-261)	70 (15-167)	4.3 (BDL-6.8)	21 (BDL-24)	6.7%	17.1%	-	-
2007	97	132 (37 – 241)	64 (24 -114)	5 (BDL – 7.1)	18.5 (BDL-23.6)	11.3%	5.15%	-	-
2008	66	172 (82-237)	89 (38-143)	8.0 (BDL-12.2)	18.2 (11.1-22.5)	22.7 %	24.2%	-	-
2009	88	165 (64-229)	80 (32-112)	8.0 (4.5-11.2)	17.3 (11.8-21.6)	16%	4.5%	-	-
2010	100	147 (65-261)	75 (27-119)	7.6 (5.7-12.2)	19.3 (16-26.4)	-	14%	-	-
2011	69	176 (111-260)	89 (58-146)	6.8 (BDL-9.1)	18.8 (13.2-23.0)	26%	24.6%	-	-
2012	103	186 (76-293)	91 (36-142)	6.4 (BDL-9.3)	18.5 (13.6-24.4)	40.7%	36.8%	-	-
2013	103	217 (80-448)	108 (38-214)	8.1 (4.3-12.6)	20.3 (14.4-25.9)	51.4%	52.4%	-	-
2014	104	238 (104-376)	115 (45-191)	9.3 (4.0-13.4)	21.8 (11.6-30.6)	72.1%	66.3%	-	-
Prescribed standard (R)	**24 hrly/ Annual avg.**	**200/140**	**100/60**	**80/60**	**80/60**	**As Per 1998 Standard**			
	24 hrly/ Annual avg.	**-**	**100/60**	**80/50**	**80/40**	**As Per 2009 Standard**			

Table: 4.3 TTPS, Talcher

Year	No. of Obs. (24 hrs.)	Parameters (µg/m^3) Annual Average (Range Values)				Frequency of violation of data (24 hrs. Avg.) from prescribed standard (% of violation)			
		SPM	RSPM	SO_2	NOx	SPM	RSPM	SO2	NOx
2006	102	193 (41-449)	92 (24-179)	8.8 (BDL-29.1)	19.6 (13.5-27.8)	--	11.8%	--	--
2007	108	163 (45 – 219)	74 (23 – 132)	8 (BDL–12)	17.6 (11.4-23.2)	--	--	--	--
2008	105	196 (48 – 432)	94 (26 – 162)	10.0 (BDL-16.9)	19.2 (10.2-27.1)	--	--	--	--
2009	104	204 (87-330)	95 (53-130)	10.1 (5.3-19.6)	19.3 (13.3-28.5)	--	-	--	--
2010	103	197 (84-313)	92 (39-128)	10 (BDL-13.8)	19.8 (12-24.1)	--	40%	--	--
2011	103	236 (115-352)	106 (59-155)	8.9 (BDL-14.9)	19.1 (11.7-25.4)	--	60.1%	--	--
2012	103	234 (65-366)	110 (33-180)	7.5 (BDL-13.4)	18.6 (12-23.6)	--	69.9%	--	--
2013	105	199 (67-441)	105 (32-230)	8.5 (4.6-12.7)	21.5 (15.1-27.3)	--	52.4%	--	--
2014	103	207 (66-422)	114 (34-243)	9.3 (4.6-12.1)	23.5 (13.2-27.1)	--	55.3%	--	--
Prescribed standard	**24 hrly / Annual avg.**	**500/360**	**150/120**	**120/80**	**120/80**	**As Per 1998 Standard**			
	24 hrly/ Annual avg.	**-**	**100/60**	**80/50**	**80/40**	**As Per 2009 Standard**			

Table:4.4 Mahanadi Coal Field Area, Talcher

Year	No. of Obs. (24 hrs.)	Parameters (µg/m^3) Annual Average (Range Values)				Frequency of violation of data (24 hrs. Avg.) from prescribed standard (% of violation)			
		SPM	RSPM	SO2	NOx	SPM	RSPM	SO2	NOx
2006	64	162 (38-310)	84 (22-282)	9.0 (BDL-13.9)	19 (12.6-27.6)	10.9%	12.5%	--	--
2007	96	202 (58 - 420)	90 (25 -196)	10 (BDL–14)	15 (BDL –21.4)	--	10%	--	--
2008	103	237 (58 - 477)	102 (33 -193)	14.3 (BDL – 21.3)	24 (14.9-36.7)	--	--	--	--
2009	104	267 (102-466)	115 (53-231)	14.1 (6.8-19.3)	26.8 (18.7-33.1)	66.34%	58.65%	--	--
2010	88	268 (105-438)	135 (49-253)	13.4 (7.6-15.4)	26.0 (16.5-30.6)	--	81%	--	--
2013	105	221 (74-401)	114 (43-183)	8.2 (4.1-12.4)	20.7 (14.3-25.6)	61.0%	62.9%	--	--
2014	103	262 (110-393)	135 (51-215)	9.2 (6.6-11.9)	23.8 (20.8-26.5)	66%	69.9%	--	--
Prescribed standard	**24 hrly/ Annual avg.**	**200/140**	**100/60**	**80/60**	**80/60**	**As Per 1998 Standard**			
	24 hrly/ Annual avg.	**-**	**100/60**	**80/50**	**80/40**	**As Per 2009 Standard**			

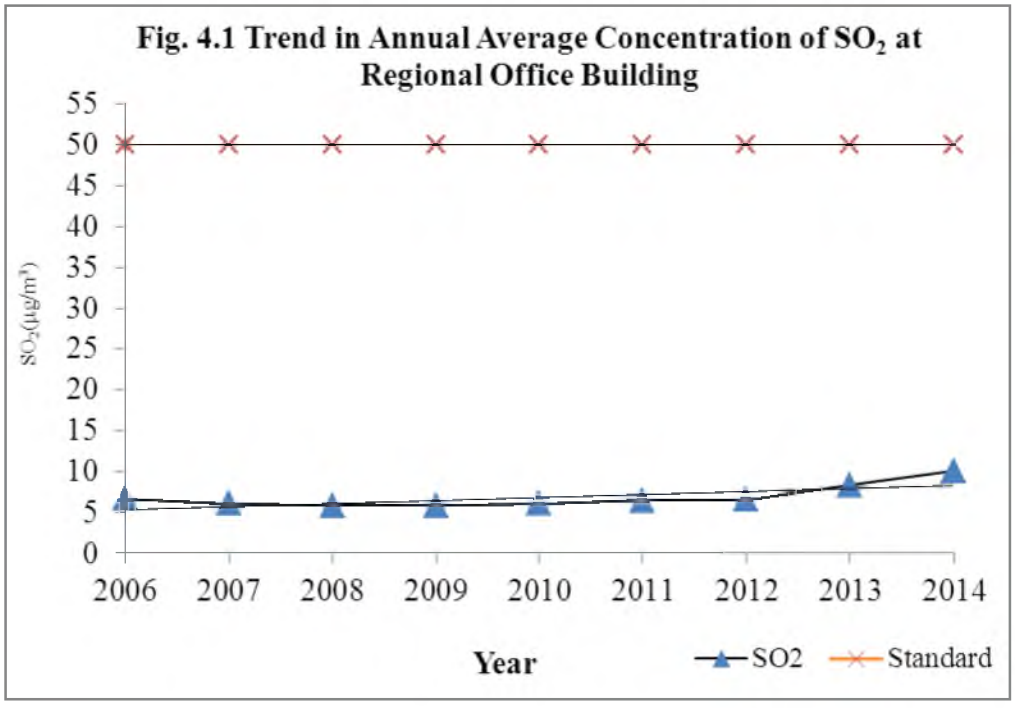


Fig. 4.1 Trend in Annual Average Concentration of SO_2 at Regional Office Building

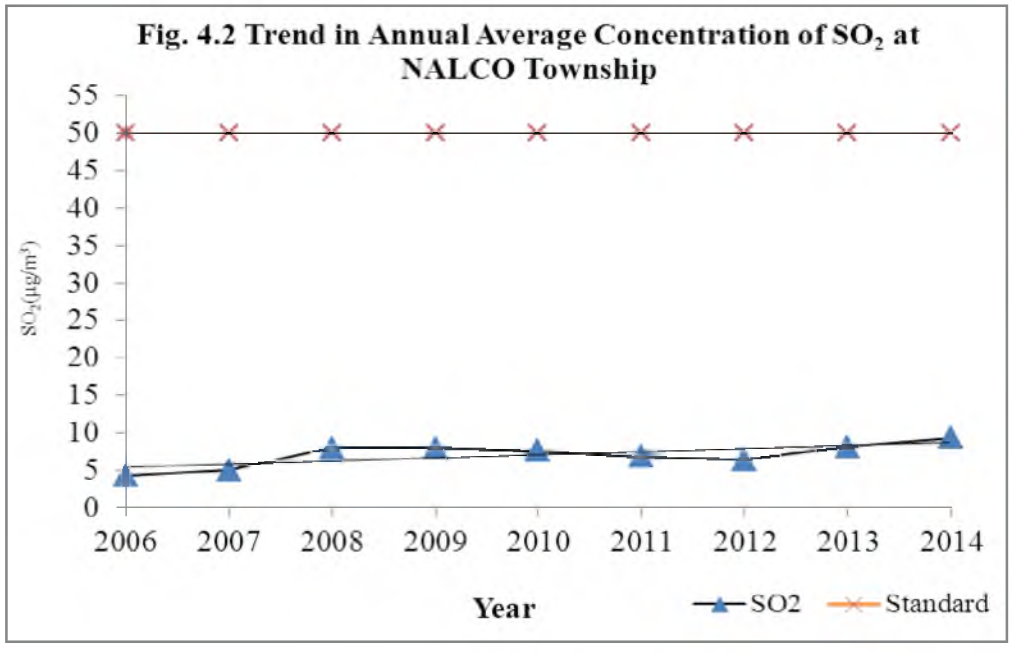


Fig. 4.2 Trend in Annual Average Concentration of SO_2 at NALCO Township

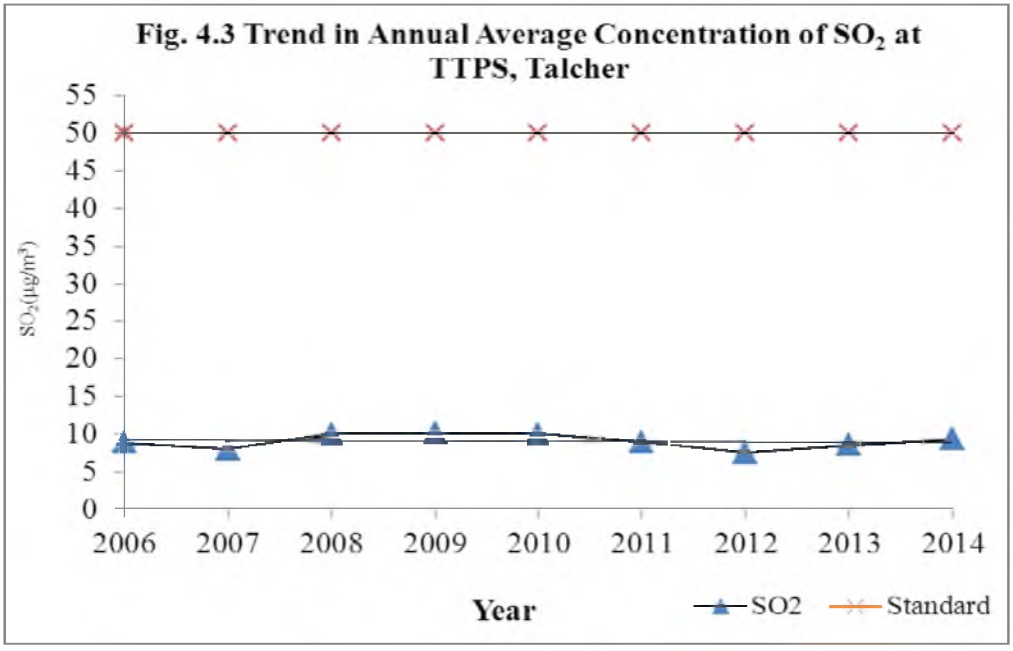


Fig. 4.3 Trend in Annual Average Concentration of SO_2 at TTPS, Talcher

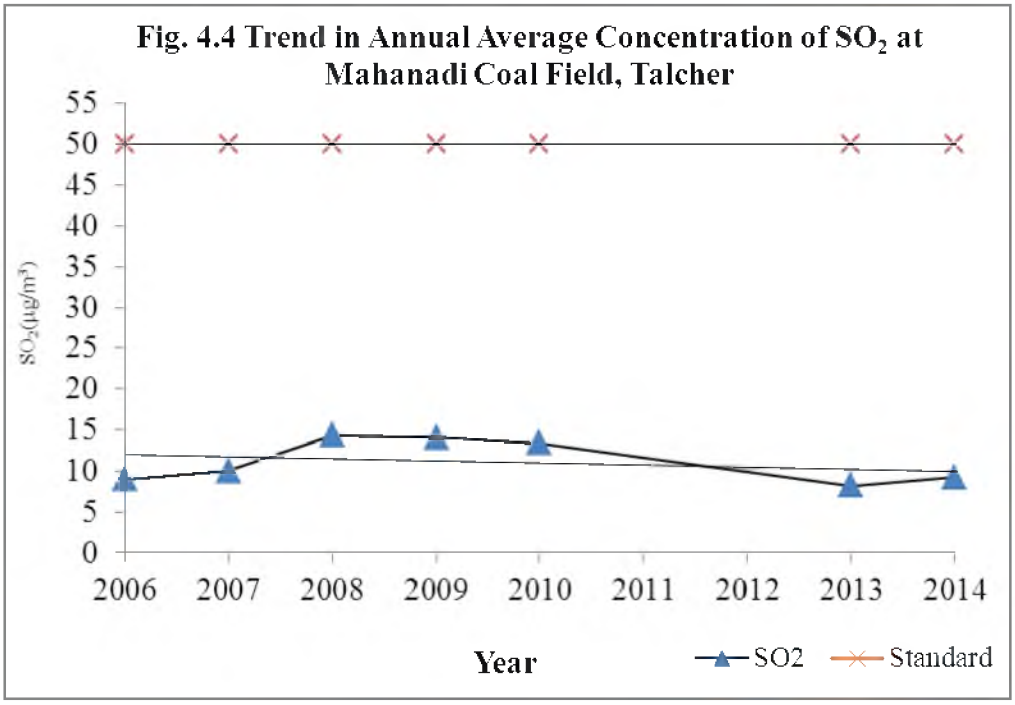


Fig. 4.4 Trend in Annual Average Concentration of SO_2 at Mahanadi Coal Field, Talcher

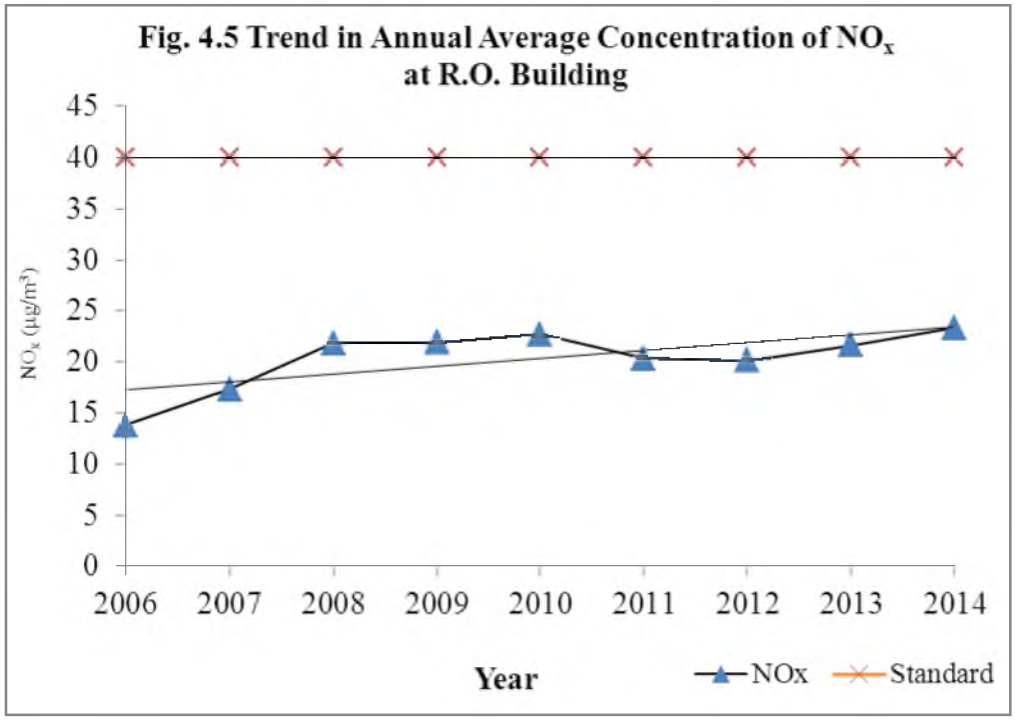


Fig. 4.5 Trend in Annual Average Concentration of NO_x at R.O. Building

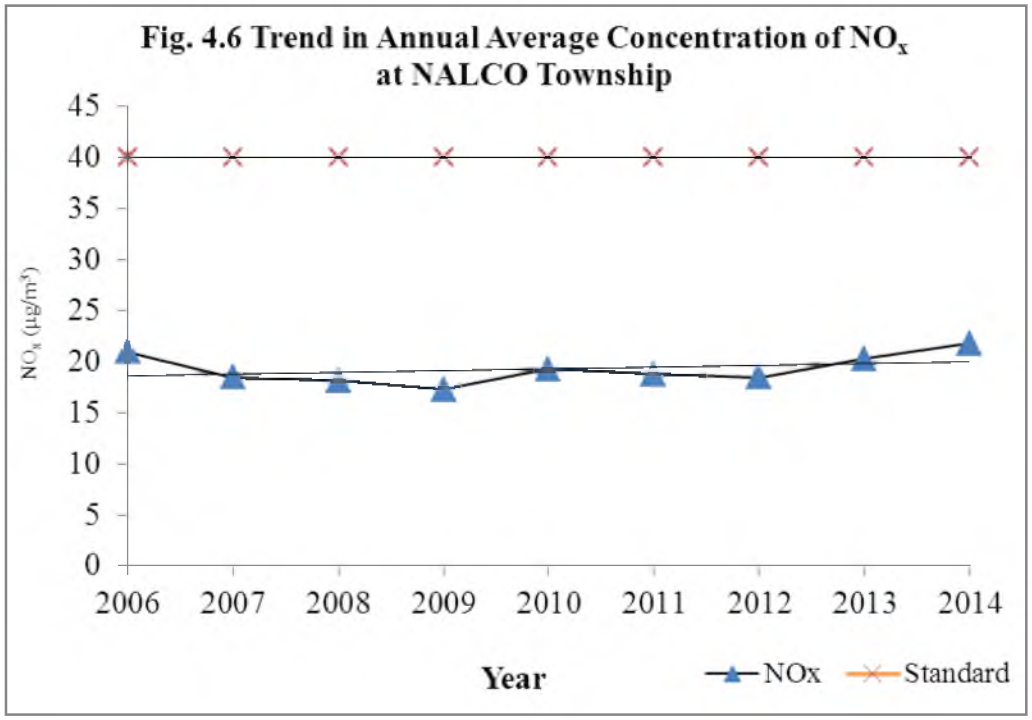


Fig. 4.6 Trend in Annual Average Concentration of NO_x at NALCO Township

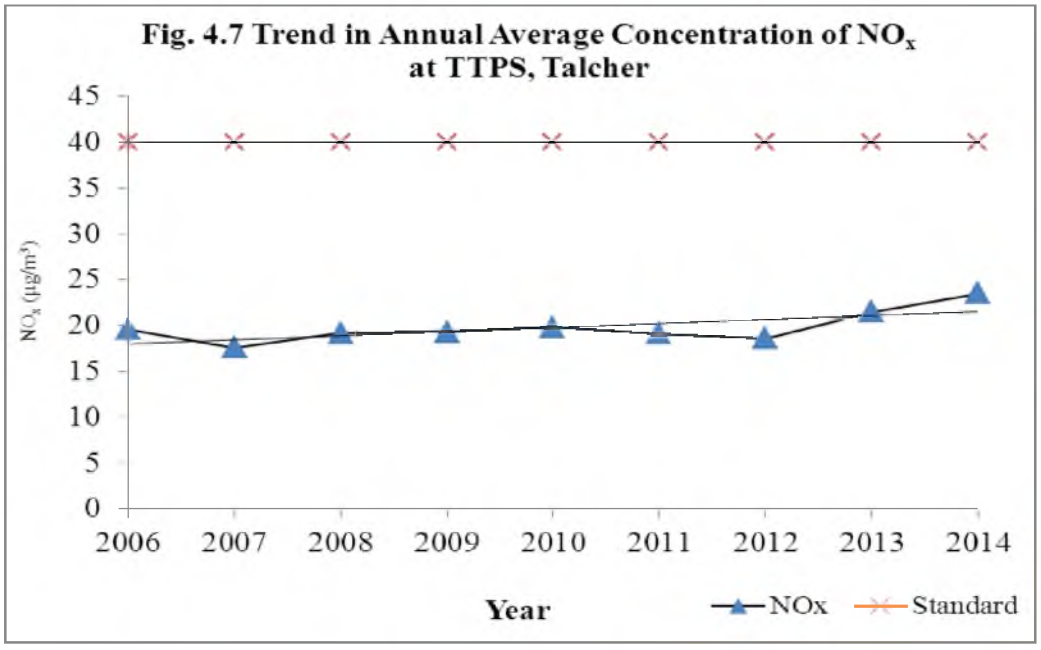


Fig. 4.7 Trend in Annual Average Concentration of NO_x at TTPS, Talcher

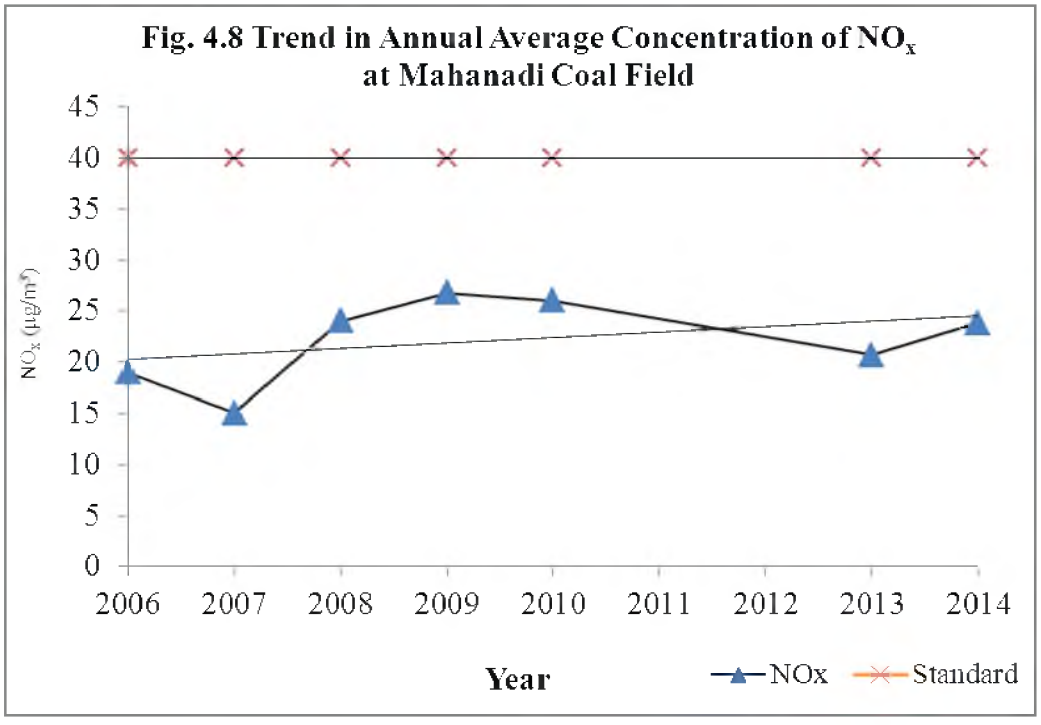


Fig. 4.8 Trend in Annual Average Concentration of NO_x at Mahanadi Coal Field

Fig. 4.9 Trend in Annual Average Concentration of SPM at R.O. Building

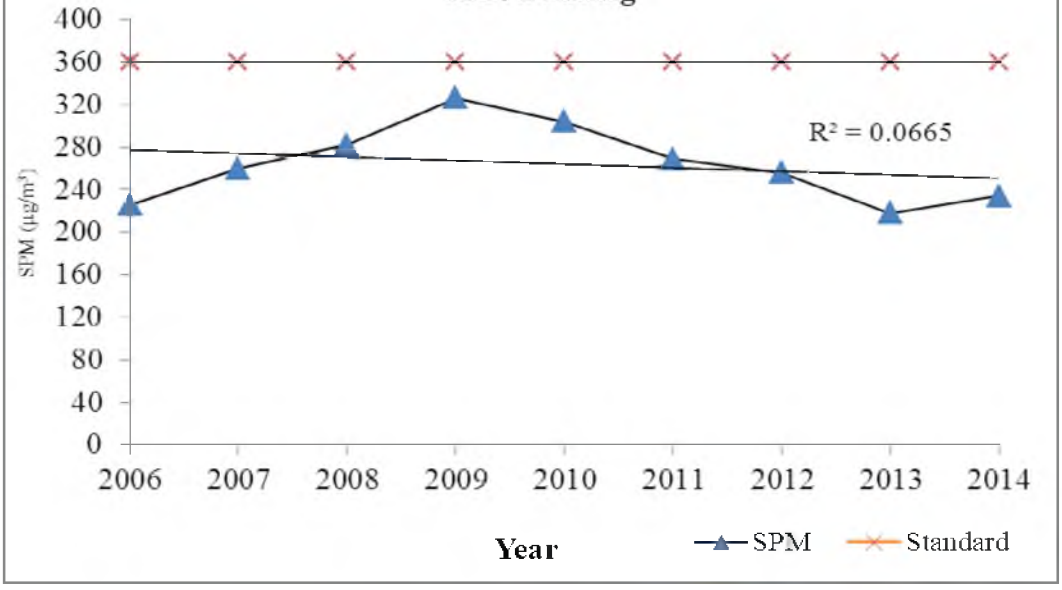


Fig. 4.10 Trend in Annual Average Concentration of SPM at NALCO Township

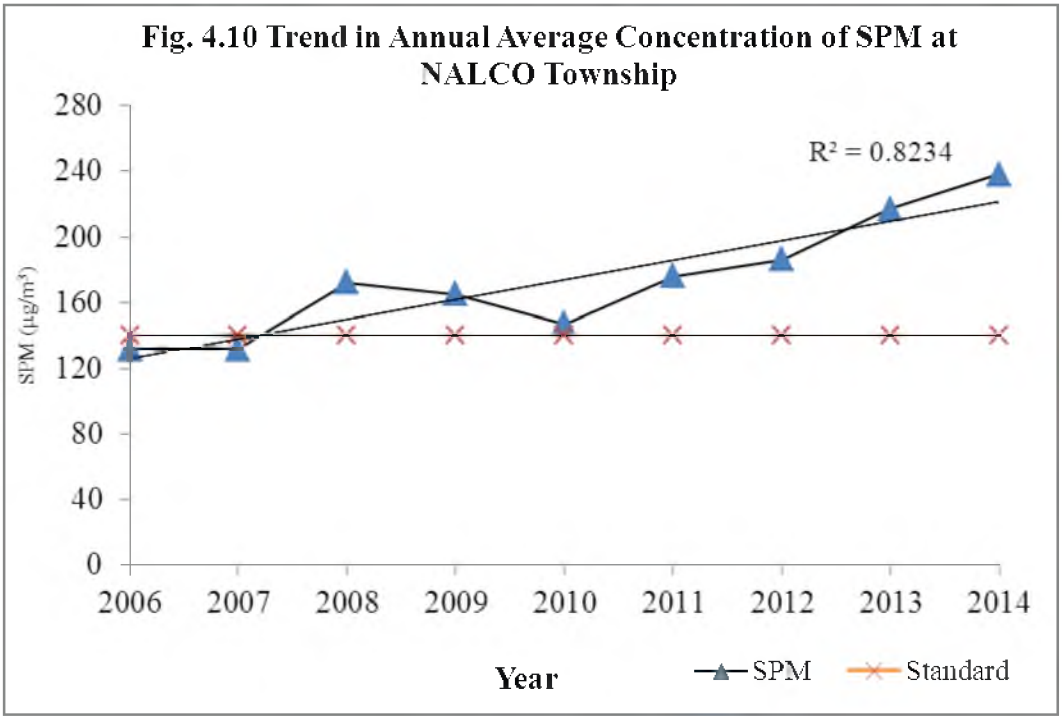


Fig. 4.11 Trend in Annual Average Concentration of SPM at TTPS, Talcher

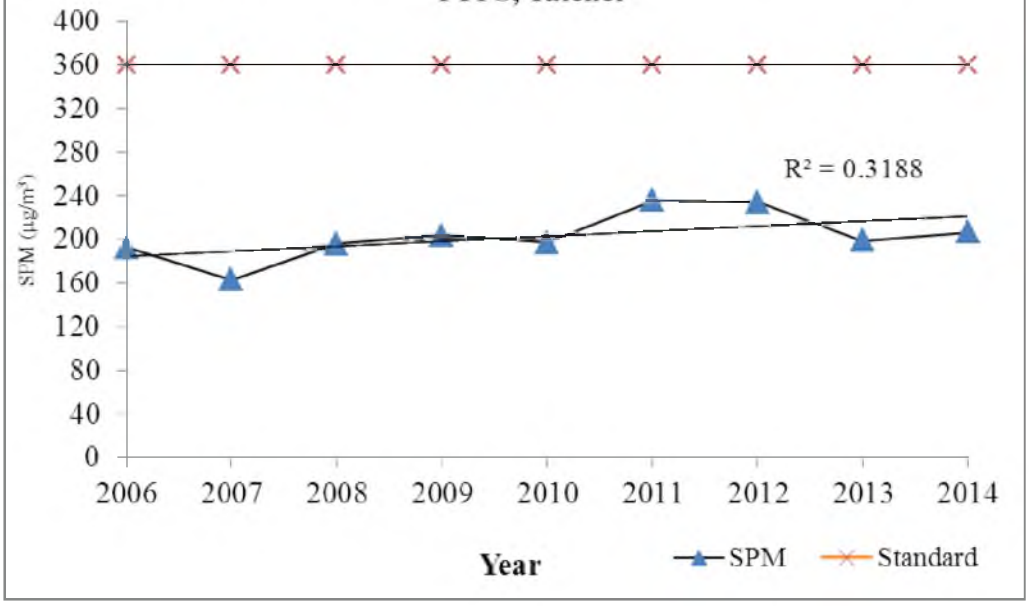
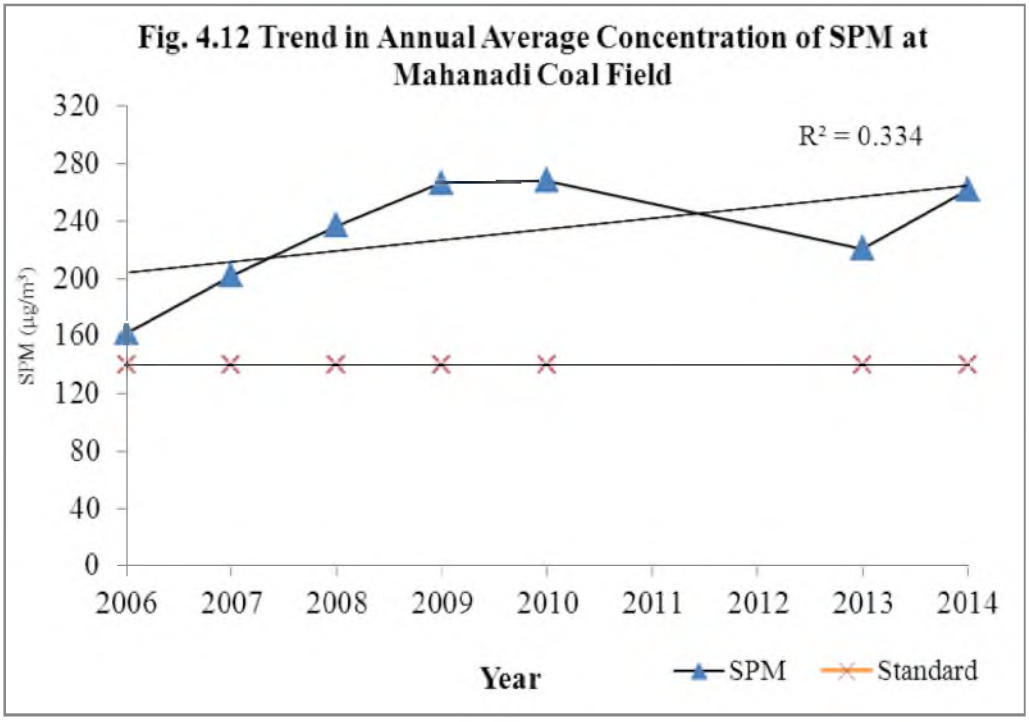


Fig. 4.12 Trend in Annual Average Concentration of SPM at Mahanadi Coal Field



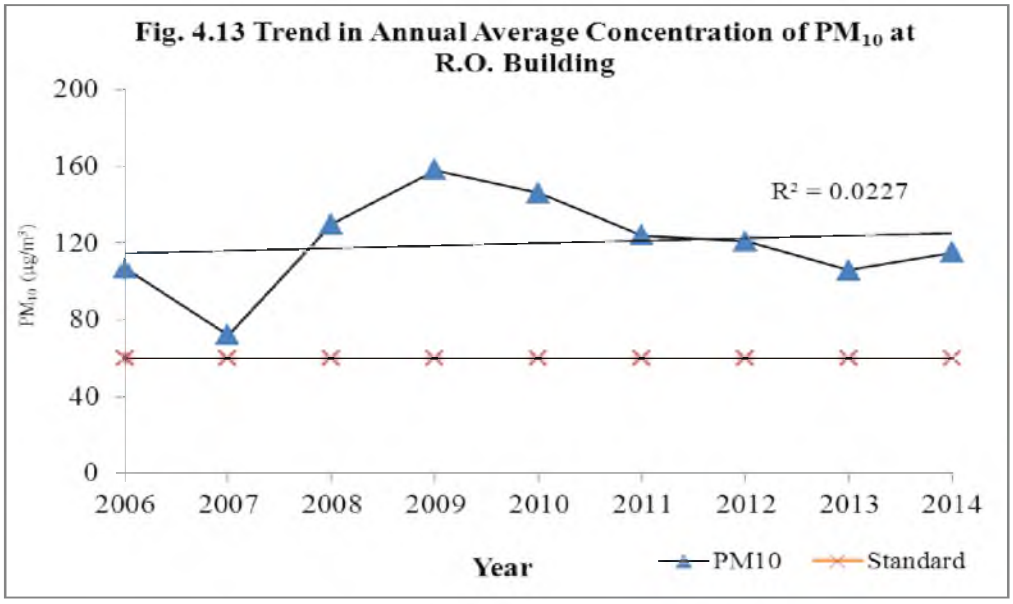


Fig. 4.13 Trend in Annual Average Concentration of PM_{10} at R.O. Building

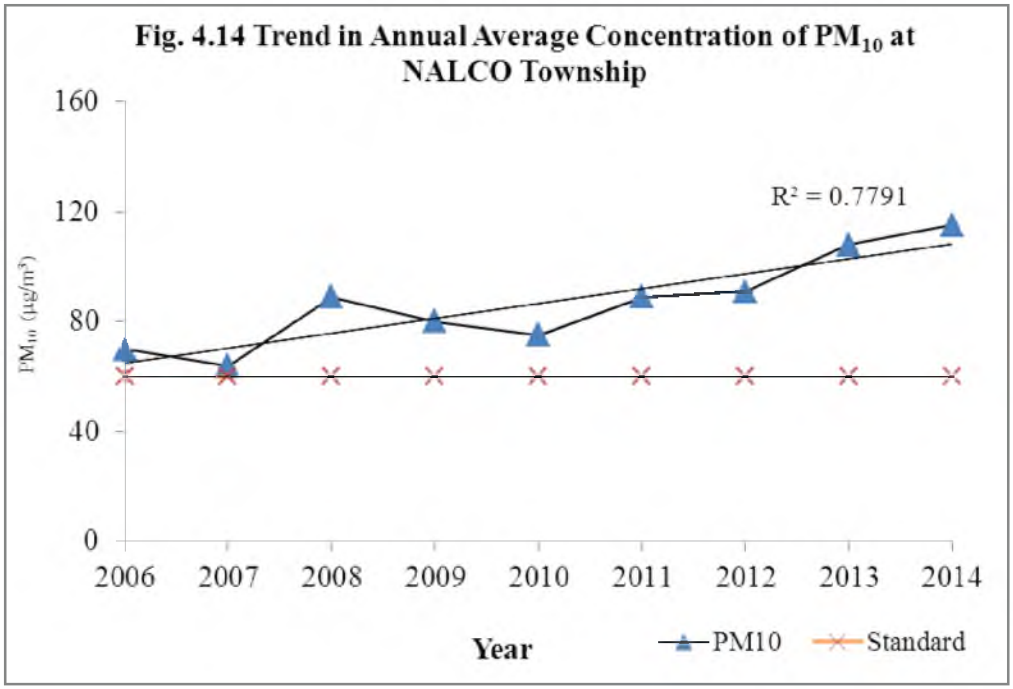


Fig. 4.14 Trend in Annual Average Concentration of PM_{10} at NALCO Township

Fig. 4.15 Trend in Annual Average Concentration of PM_{10} at TTPS, Talcher

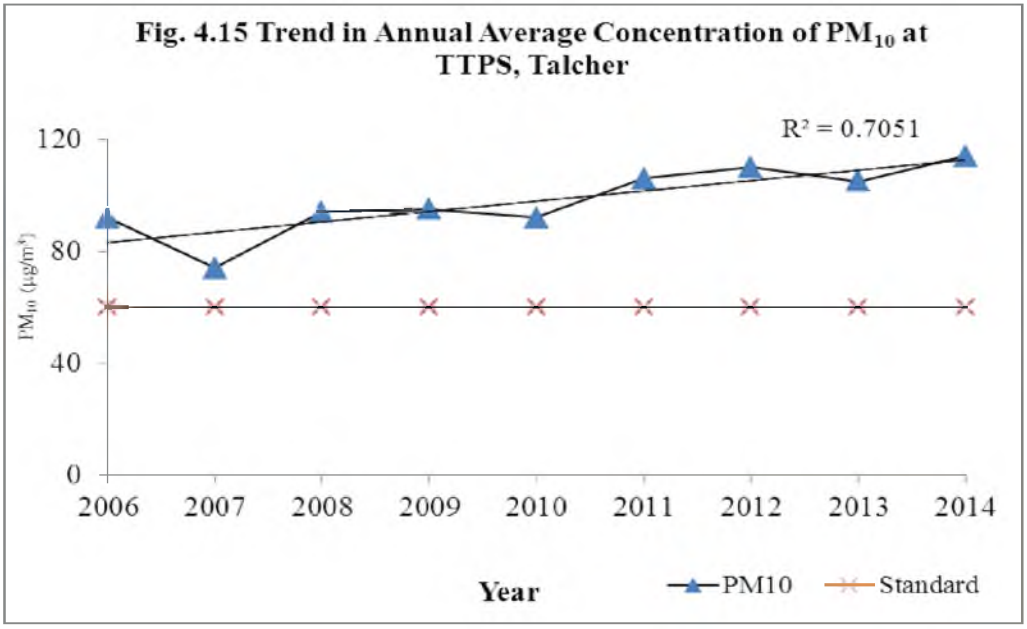


Fig. 4.16 Trend in Annual Average Concentration of PM_{10} at Mahanadi Coal Field

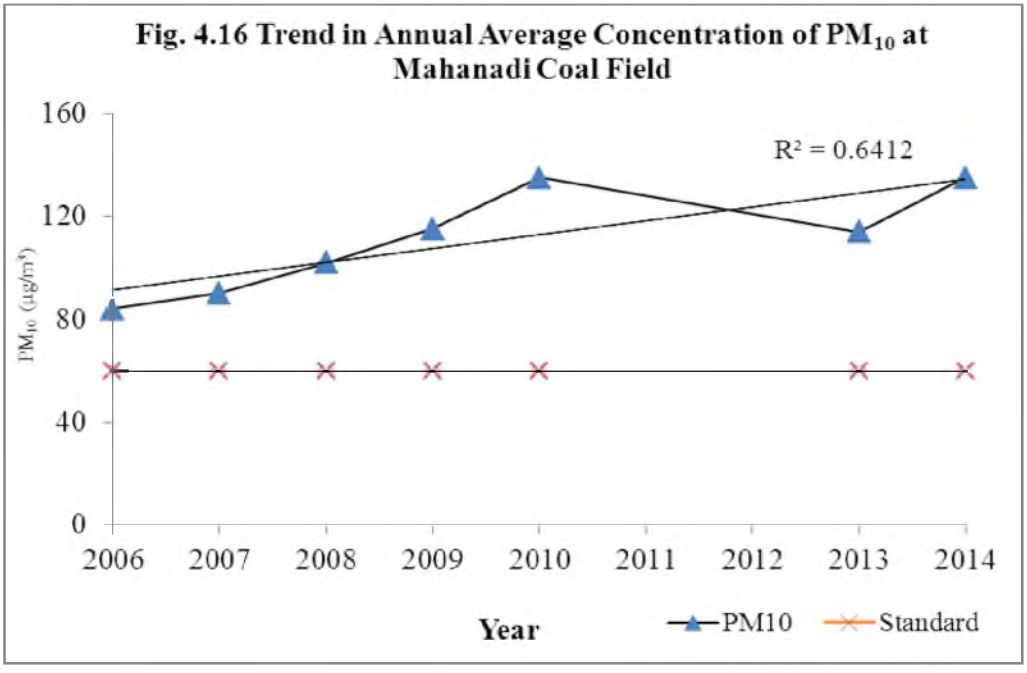


Fig. 4.17

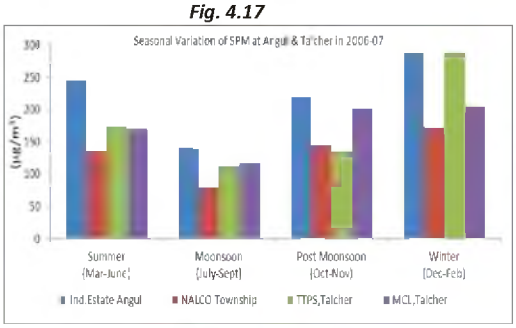


Fig. 4.18

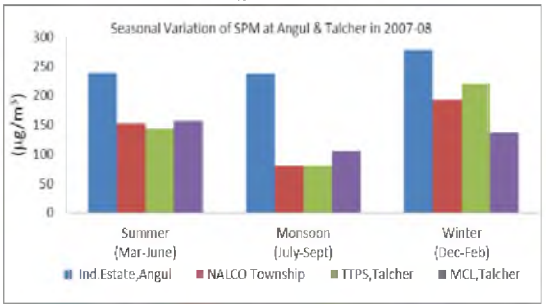


Fig. 4.19

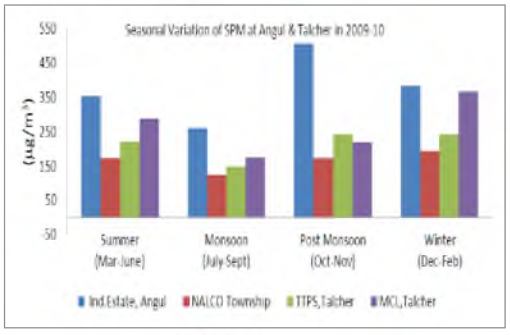


Fig. 4.20

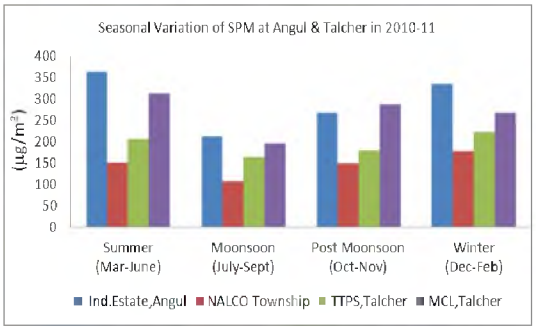


Fig. 4.21

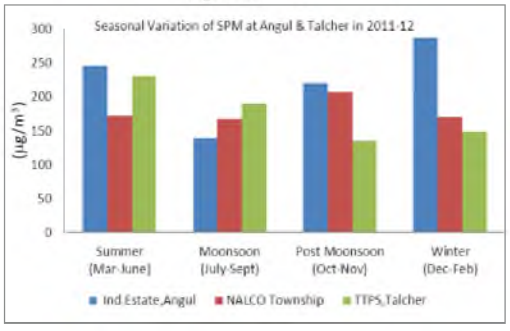


Fig.4.22

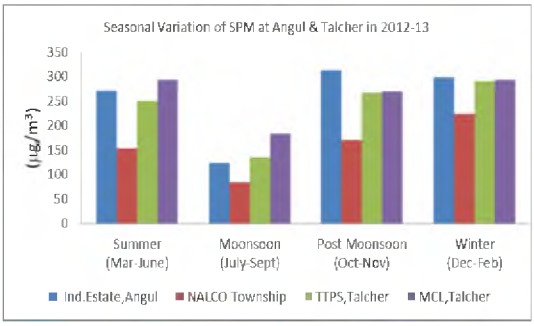


Fig.4.23

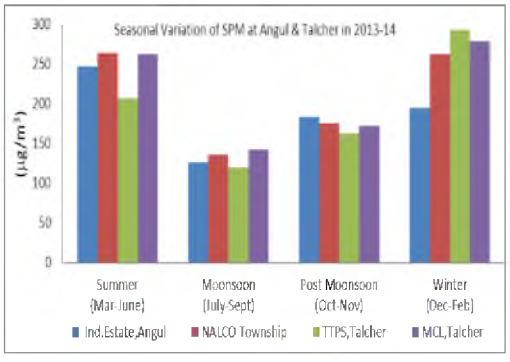


Fig.4.24

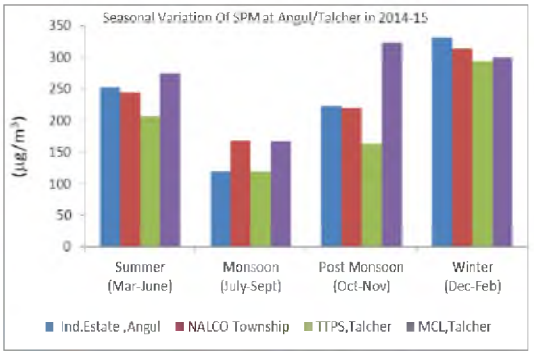


Fig.4.25

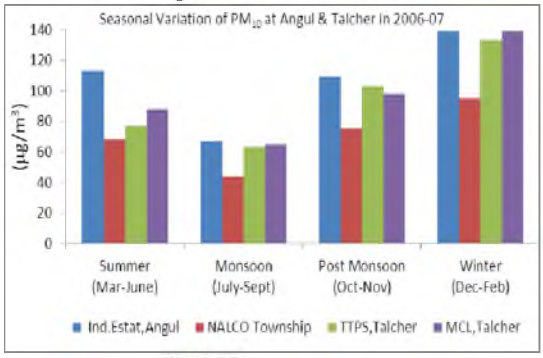


Fig.4.26

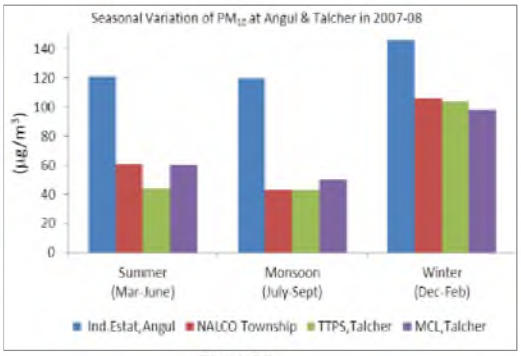


Fig.4.27

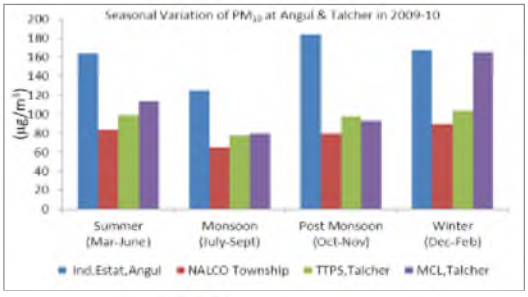


Fig.4.28

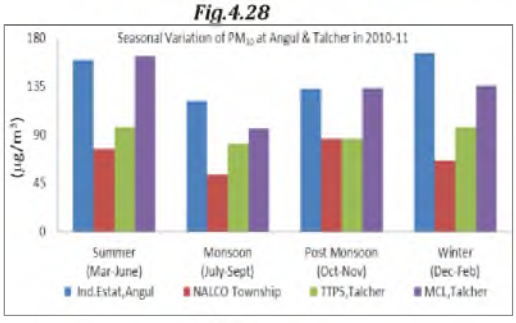


Fig.4.29

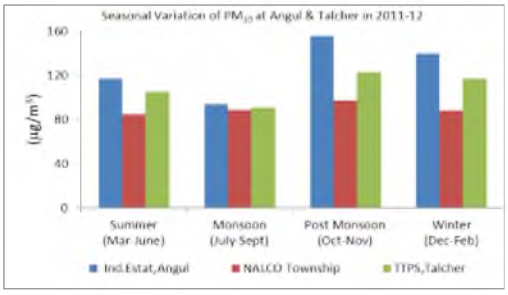


Fig.4.30

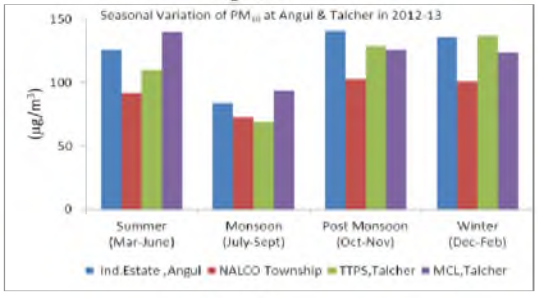


Fig.4.31

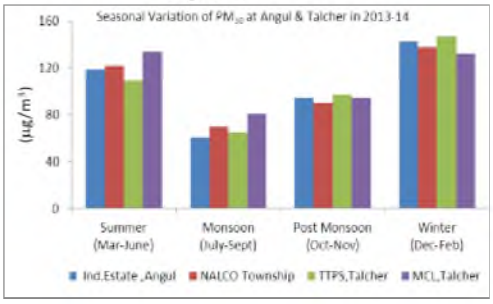


Fig.4.32

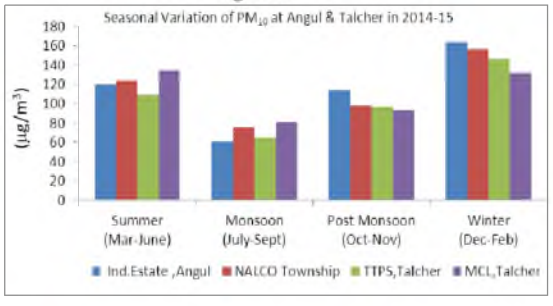


Table: 4.5 Categorisation of Ambient Air Quality on the basis of Exceedence Factor of Angul & Talcher

Location	Categorisation of Angul & Talcher, (2006 to 2014)								
	SO_2								
	2006	2007	2008	2009	2010	2011	2012	2013	2014
Industrial Estate	L	L	L	L	L	L	L	L	L
Nalco Township	L	L	L	L	L	L	L	L	L
TTPS, Talcher	L	L	L	L	L	L	L	L	L
MCL, Talcher	L	L	L	L	L	-	-	L	L

Location	NO_X								
	2006	2007	2008	2009	2010	2011	2012	2013	2014
Industrial Estate	L	L	L	L	M	M	M	M	M
Nalco Township	M	L	L	L	L	L	L	M	M
TTPS, Talcher	L	L	L	L	L	L	L	M	M
MCL, Talcher	L	L	L	L	M	-	-	M	M

Location	SPM								
	2006	2007	2008	2009	2010	2011	2012	2013	2014
Industrial Estate	M	M	M	M	M	M	M	M	M
Nalco Township	M	M	H	H	H	H	H	C	C
TTPS, Talcher	M	L	M	M	M	M	M	M	M
MCL, Talcher	L	M	M	M	M	-	-	C	C

Location	RSPM								
	2006	2007	2008	2009	2010	2011	2012	2013	2014
Industrial Estate	C	H	H	H	C	C	C	C	C
Nalco Township	H	H	H	H	H	H	C	C	C
TTPS, Talcher	C	H	M	M	C	C	C	C	C
MCL, Talcher	H	H	M	M	C	-	-	C	C

NB:- L: Low, M: Moderate, H: High, C: Critical

5.0 AMBIENT AIR QUALITY STATUS AND TRENDS OF RAYAGADA

The State Pollution Control Board, Odisha monitors the ambient air quality of Rayagada area at two locations. The details are presented in Table 5.0. The location of monitoring stations are selected as per the guideline of CPCB and are indicated in Fig. 5.0

Table: 5.0 Ambient Air Quality Monitoring Locations

Place	Location	Latitude / Longitude	Category of Area
Rayagada	1. RO Building, Indiranagar	$19^0$10'.724'' N/$83^0$25'.142'' E	Residential
	2. LPS High School, Jaykaypur	$19^0$14'.802'N/$83^0$25'.086''E	Industrial

5.1 Description of the Locations

5.1.1 Regional Office Building, Indira Nagar

The station is operating over the Regional Office building, at a height of 3 m above the ground level The station is surrounded with residential houses. The industrial area of Rayagada is about 2 Km. away from the site.

5.1.2 Jaykaypur

The station is operating over the roof of L.P.S. High School inside the residential colony of M/s J. K. Paper Mill. The factory is within 200 m from the site. The station is about 7m above the ground level. Vast vacant land with rural habitations are situated in one side of the station , whereas, residential colony of J. K. Paper Mill is situated on the other side.

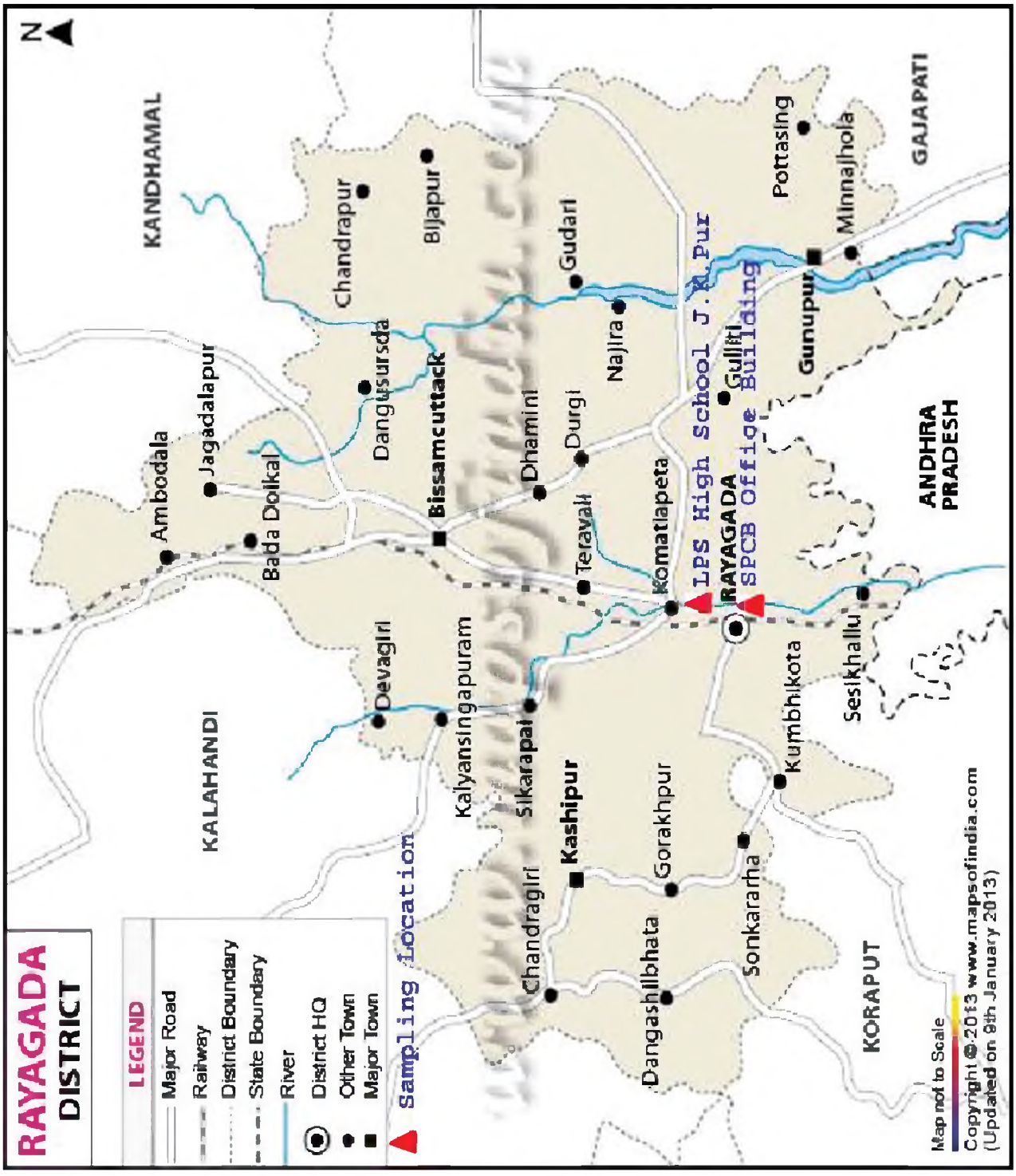


Fig. 5.0 Map Showing Sampling Locations in Rayagada

5.2 Ambient Air Quality of Rayagada

Ambient Air Quality status of Rayagada area from the year 2006 to 2014 with respect to annual average value, range value of 24 hrly average and frequency of violation of parameters like SPM, RSPM (PM_{10}), SO_2 & NO_x with respect to 24 hrly. standard are presented in Table 5.1 to 5.2 and trend of the parameters are shown in Fig. 5.1 to 5.8. Seasonal variation of SPM & PM_{10} are shown in Fig. 5.9 to 5.26. Categorisation on the basis of exceedence factor of each location is shown in Table 5.3.

5.2.1 SO_2 & NO_x

The annual average value of SO_2 & NO_x at Regional office Building, Rayagada (Residential area) & Jaykaypur (Industrial area) for the year 2006 to 2014 are below their respective limits i.e., 50 $\mu g/m^3$ for SO_2 & 40 $\mu g/m^3$ for NO_X. The maximum annual average value for NO_X at Regional office Building, Rayagada was 22.4 $\mu g/m^3$ & at Jaykaypur it was 22.8 $\mu g/m^3$ in the year 2013. NO_X at both the locations are mostly in increasing trend. The exceedence factor of SO_2 at both the locations were under Low category while NO_X at Regional Office Building, Rayagada was under Low category from the year 2006 to 2010 & 2014 and Moderate from the year 2011 to 2013 and Jaykaypur was under Low category from the year 2006 to 2009 and Moderate from 2010 to 2014.

5.2.2 SPM & RSPM (PM_{10})

The annual average of SPM value at Regional Office Building, Rayagada & Jaykaypur from the year 2006 to 2014 are below their respective limits i.e., 140 $\mu g/m^3$ for residential area and 360 $\mu g/m^3$ for industrial area. Maximum annual average value was observed at Regional office Building, Indiranagar was 121 $\mu g/m^3$ & at Jaykapur was 112 $\mu g/m^3$ in the year 2008. The trend of SPM at both locations are mostly in decreasing trend in the study period. The exceedence factor of SPM shows Moderate category at Regional Office Building, Rayagada from the year 2006 to 2011 & 2014 and Low in the year 2012 & 2013 and at Jaykaypur it was Moderate in 2008 & 2014, Low in the year 2006 & 07 and 2009 to 2013.

The annual average of RSPM at both the locations were mostly below the limit i.e., 60$\mu g/m^3$. However, during 2008 the maximum annual average value was 65 $\mu g/m^3$ at Regional Office Building, Rayagada and at Jaykaypur it was 63 $\mu g/m^3$. The trend of RSPM at both locations are in decreasing trend during study period. The exceedence factor of RSPM was under Moderate category at Regional Office Building, Rayagada from the year 2006 to 2007 2009 to 2014 and High in the year 2008 and at Jaykaypur it was under Moderate category from 2006 to 2009 & 2011 to 2014 and High in the year 2010.

From seasonal variation, it was observed that SPM & RSPM (PM_{10}) during winter season recorded maximum value and during monsoon recorded minimum value during the study period.

Status of Ambient Air Quality at Rayagada

Table: 5.1 Regional Office Building, Indiranagar

Year	No. of Obs. (24 hrs.)	Parameters (µg/m^3) Annual Average (Range Values				Frequency of violation of data (24 hrs. Avg.) from prescribed standard (% of violation)			
		SPM	RSPM	SO_2	NO_x	SPM	RSPM	SO_2	NO_x
2006	108	112 (23-247)	60 (16-122)	BDL (BDL- 5.5)	10 (BDL-20)	4.6	2.8	-	-
2007	100	103 (19 –176)	57 (12 – 99)	BDL (BDL – 4.2)	11.8 (BDL -28.8)	-	-	-	-
2008	104	121 (28-179)	65 (16-87)	BDL (BDL -BDL)	20.2 (11.4-26.5)	-	-	-	-
2009	107	96 (19-157)	60 (13-92)	BDL (BDL -BDL)	21.0 (10.9-26.7)	-	-	-	-
2010	103	85 (18-134)	54 (11-77)	BDL (BDL -BDL)	19.6 (10.8-24.8)	-	-	-	-
2011	106	78 (36-109)	54 (22-71)	BDL (BDL -BDL)	21.3 (11.5-27.1)	-	-	-	-
2012	104	65 (25-90)	49 (12-70)	BDL (BDL -BDL)	21.4 (13.7-25.5)	-	-	-	-
2013	104	62 (31--78)	44 (21-56)	BDL (BDL -BDL)	22.4 (17.2-25.8)	-	-	-	-
2014	104	70 (29-95)	49 (17-72)	BDL (BDL-8.3)	20 (13.3-28.6)	-	-	-	-
Prescribed standard (R)	**24 hrly/ Annual avg.**	**200/140**	**100/60**	**80/60**	**80/60**	**As Per 1998 Standard**			
	24 hrly/ Annual avg.	**-**	**100/60**	**80/50**	**80/40**	**As Per 2009 Standard**			

N.B.: BDL - Below Detectable Limit, R – Residential BDL Value for SO_2 - ≤4,BDL Value for NO_X - ≤9, BDL Value for RSPM - ≤ 5

Table:5.2 Jaykaypur

Year	No. of Obs. (24 hrs.)	Parameters (µg/m^3) Annual Average (Range Values				Frequency of violation of data (24 hrs. Avg.) from prescribed standard (% of violation)			
		SPM	RSPM	SO_2	NO_x	SPM	RSPM	SO_2	NO_x
2006	107	101 (21-223)	54 (10-141)	BDL (BDL- 6.2)	10.1 (BDL-28.3)	-	-	-	-
2007	100	101 (12-221)	53 (7 - 97)	BDL (BDL – 5.6)	BDL (BDL–15.6)	-	-	-	-
2008	103	112 (21-156)	63 (19-82)	BDL (BDL – BDL)	18.4 (BDL–25.3)	-	-	-	-
2009	105	95 (24-141)	61 (15-85)	BDL	21.5 (12.2–28.5)	-	-	-	-
2010	103	92 (24-139)	61 (15-80)	BDL (BDL – BDL)	20.6 (11.2–25.6)	-	-	-	-
2011	107	93 (45-159)	57 (28-76)	BDL (BDL– BDL)	22.3 (17.0-26.9)	-	-	-	-
2012	104	80 (24-109)	59 (14-84)	BDL (BDL– BDL)	22.3 (12.1-26.8)	-	-	-	-
2013	104	78 (25-102)	56 (14-75)	BDL (BDL– 7.8)	22.8 (12.6-27.4)	-	-	-	-
2014	104	78 (37-104)	55 (21-75)	BDL (BDL-6.4)	20.9 (13.6-26.3)	-	-	-	-
Prescribed standard (R)	**24 hrly / Annual Avg.**	**500/360**	**150/120**	**120/80**	**120/80**	**As Per 1998 Standard**			
	24 hrly/ Annual Avg.	-	**100/60**	**80/50**	**80/40**	**As Per 2009 Standard**			

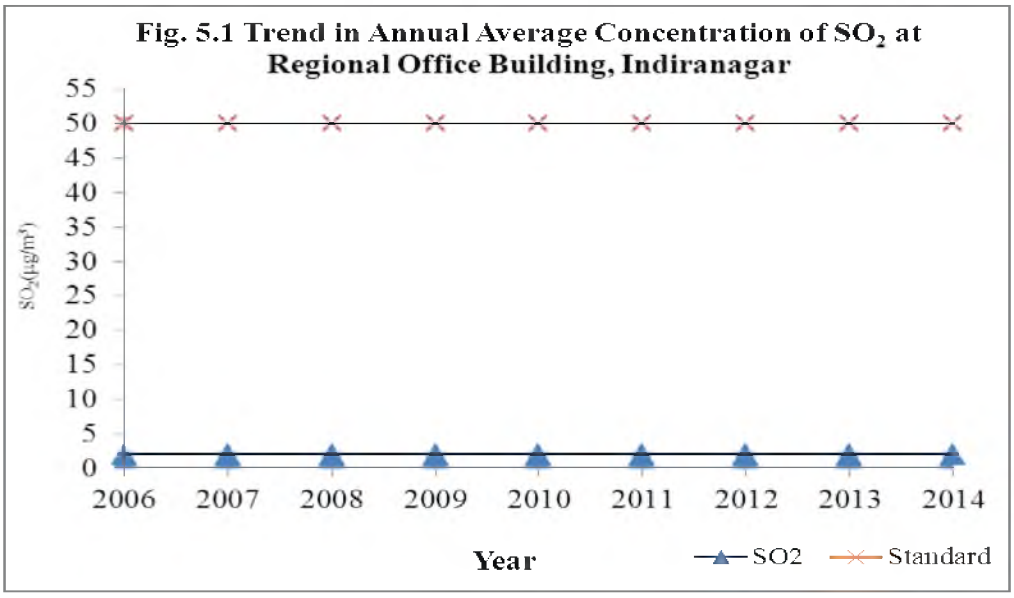


Fig. 5.1 Trend in Annual Average Concentration of SO_2 at Regional Office Building, Indiranagar

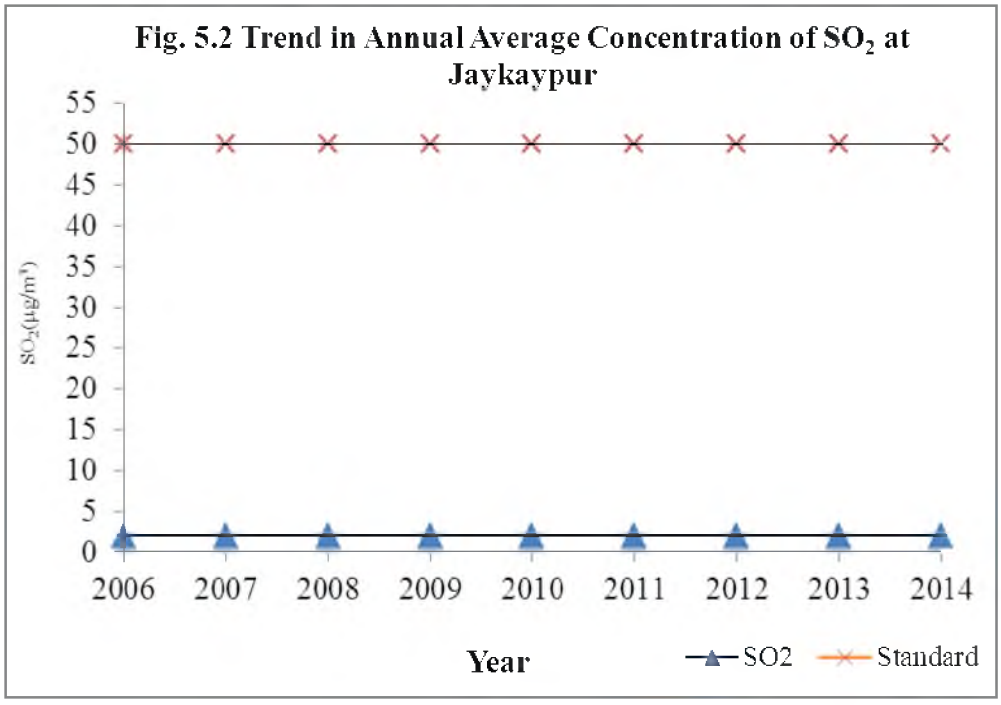


Fig. 5.2 Trend in Annual Average Concentration of SO_2 at Jaykaypur

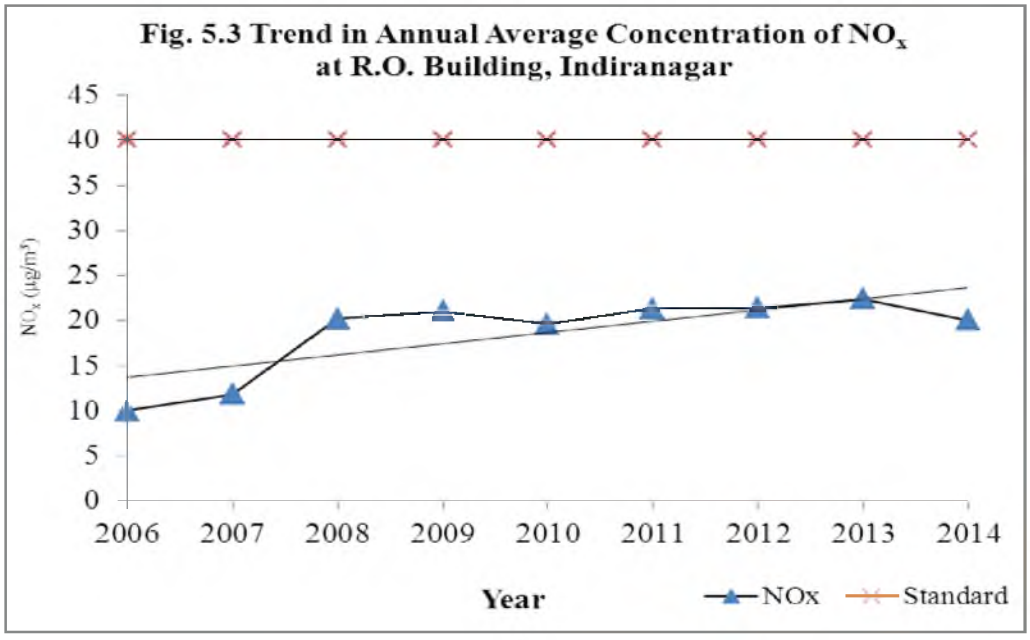


Fig. 5.3 Trend in Annual Average Concentration of NO_x at R.O. Building, Indiranagar

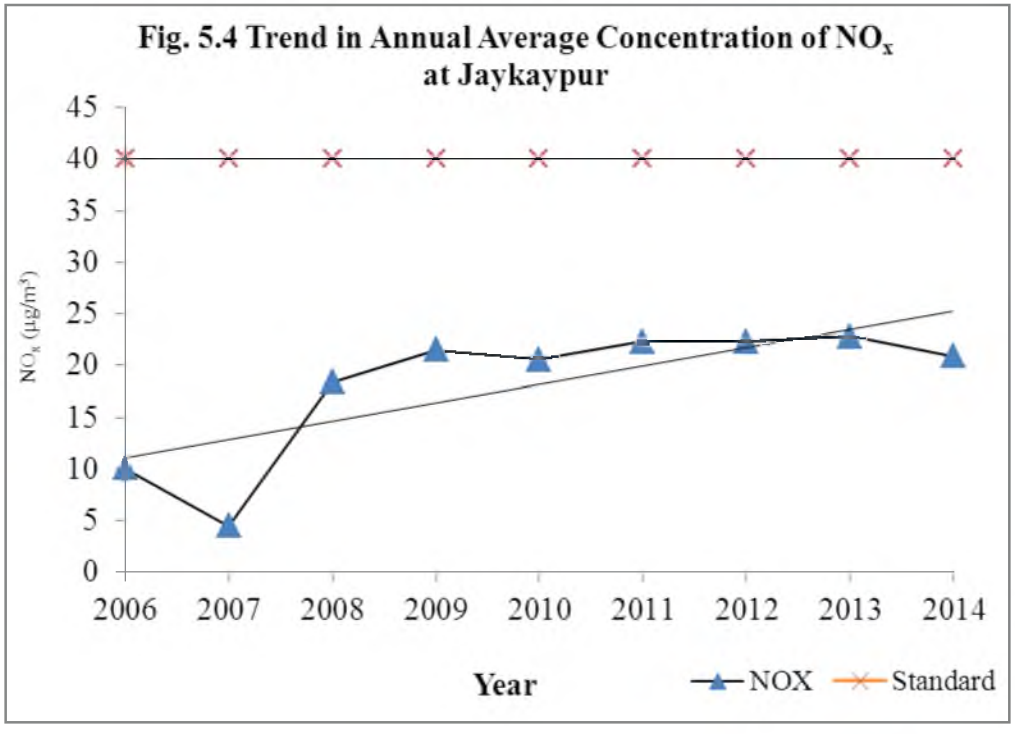


Fig. 5.4 Trend in Annual Average Concentration of NO_x at Jaykaypur

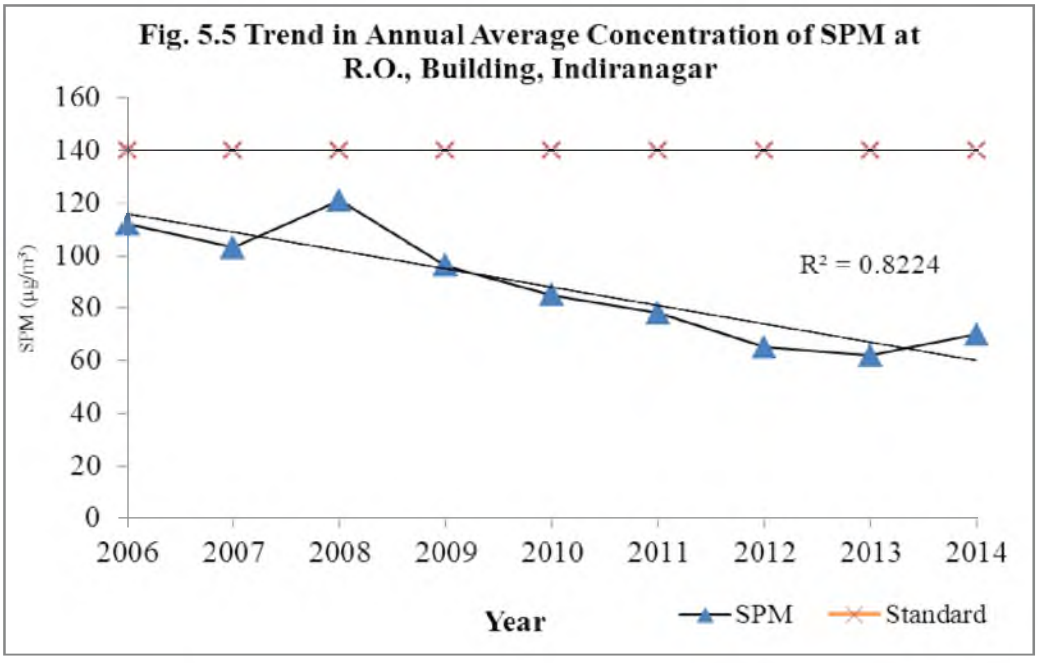


Fig. 5.5 Trend in Annual Average Concentration of SPM at R.O., Building, Indiranagar

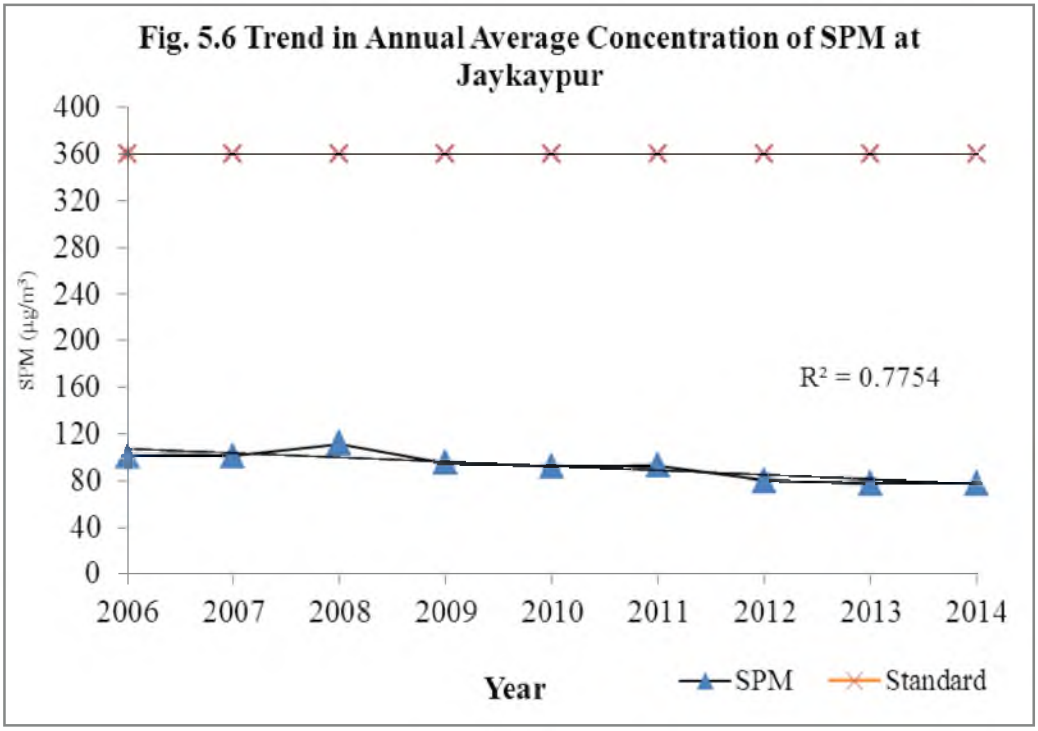


Fig. 5.6 Trend in Annual Average Concentration of SPM at Jaykaypur

Fig. 5.7 Trend in Annual Average Concentration of PM_{10} at R.O., Building, Indiranagar

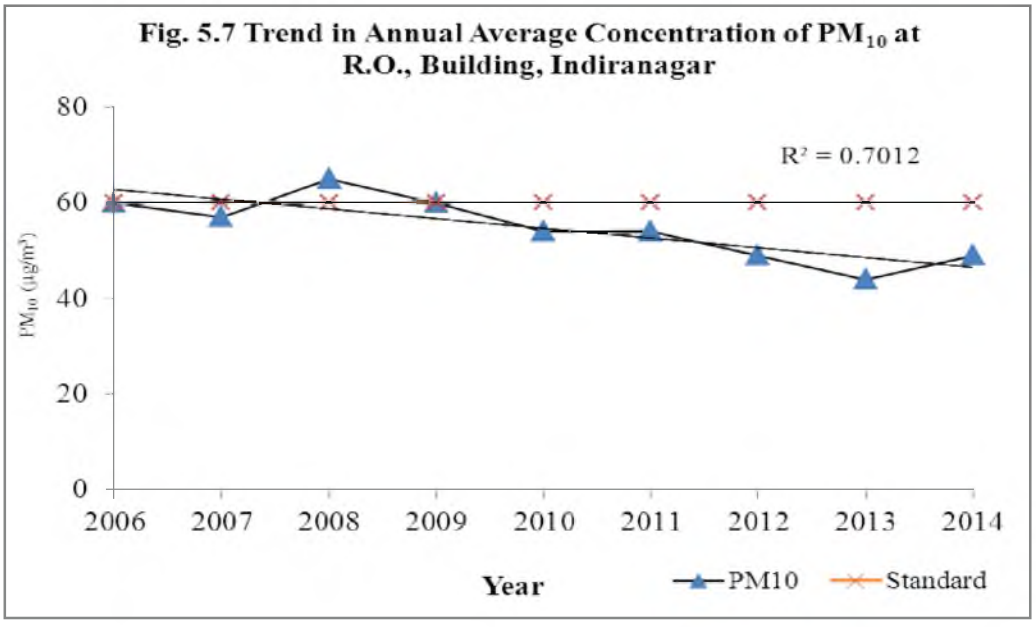


Fig. 5.8 Trend in Annual Average Concentration of PM_{10} at Jaykaypur