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Ambient Air Quality Monitoring in Vasai Virar City Municipal Corporation Region (Maharashtra, India)

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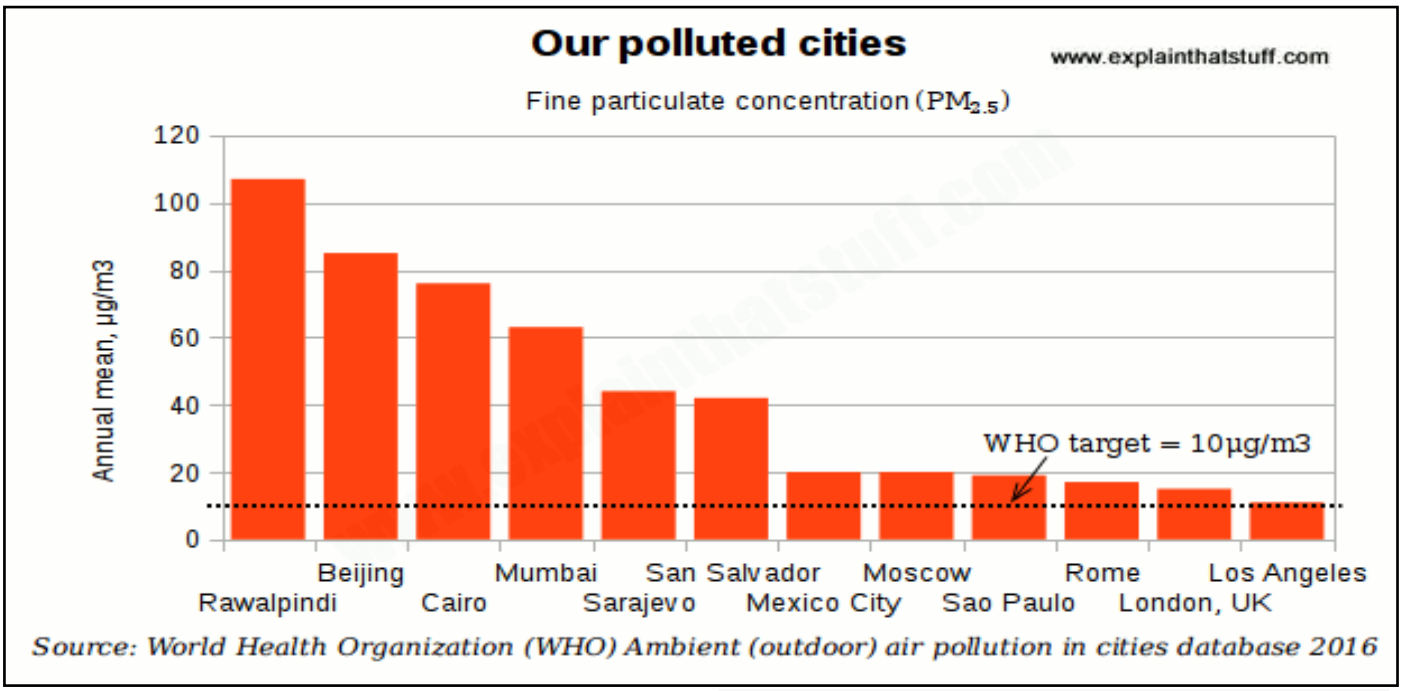
ABSTRACT

Ambient air quality criteria or standards are concentrations of pollutants in the air (usually outdoor air but sometimes indoor air) specified for a variety of reasons including for the protection of human health, buildings, crops, vegetation, ecosystems, as well as for planning and other purposes. Ambient air quality in Vasai Virar City Municipal Corporation Region was monitored during the June 2014 to May 2015. Concentrations of Oxides of nitrogen (NO_x), oxides of sulphur (SO_x), suspended particulate matter (SPM) and Ammonia (NH_3) were collected over successive periods of about 8 hour in a day. Twenty representative sites were selected over the whole stretch of the region for the study. Characteristics of the sites are mainly comprising of the residential, commercial, public places. High volume air sampler was used to measure the concentration of oxides of nitrogen (NO_x), oxides of sulphur (SO_x), suspended particulate matter (SPM) and Ammonia (NH_3). Vasai Virar city municipal corporation region is fast urbanizing city in Maharashtra, India, thereby increasing population in exponential rates. Increasing population lead to burden on the administration of the region and thereby on various services provided by the administration namely transportation, water supply, solid waste disposal, sewage disposal etc. Method used for sampling and analysis of the pollutant are standard IS methods. Results, outcome of the analysis of the collected pollutants are compared to limits as prescribed by National Ambient Air Quality Standards (NAAQS), 2009. Criteria pollutants SPM, SO2 and NO2 measured are found to have either crossed or on the average of crossing the limits or in the permissible limits of NAAQS. Reasons responsible for the pollutants were observed mainly vehicular pollution and dust suspended in the air due to heavy traffic, transport. While transport related emissions are the major sources of air contamination, increasing building construction, civil infrastructure development activities also contribute to particulates. The exponential rise in volume of vehicles, inappropriate and unplanned traffic flow pattern and human interceptions deserve due attention. The value of SPM was crossing the permissible limit at number of monitoring locations and was exceeding the National Ambient Air Quality Standard (NAAQS). The concentration of SO_2, NO_2 and NH_3 was within of National Ambient Air Quality Standard (NAAQS) at all the locations. SPM, dust concentrations are responsible for various lung diseases, respirable illness, and heart related diseases in the children as well as adult. Present study necessitating the immediate actions for controlling and efficient management of traffic in the region which is major source of dust and pollution in the region. Plantation of the trees along and sides of the road, Installation of a continuous air monitoring stations at different location in the city will be helpful to tackle pollution issue in the region.

Keywords - Ambient Air Quality, Vehicular Pollution, Pollutant, Urbanization, Construction Activities.

I. INTRODUCTION

Clean or pollution free air is need of every human and living being. However, human development and resources used for human development causes contamination of the natural resources especially air. Air pollution is nothing but contamination of the air, atmosphere with the solid, liquid, gaseous products, by products which can endanger human health and welfare of the plants and animals. Air pollution levels in cities of the developed countries is degrading continuously. These air pollutants can be mix with the air, atmosphere either through natural processes or even through anthropogenic sources. As urban air quality declines, the risk of stroke, heart disease, lung cancer, and chronic and acute respiratory diseases, including asthma, increases for the people who live in them [1]. Most of the world's major cities routinely exceed World Health Organization (WHO) air pollution guidelines. Following chart compares annual mean $PM_{2.5}$ levels in 12 representative cities around the world with the WHO guideline value of 10µg per cubic meter (dotted line). $PM_{2.5}$ particulates are those smaller than 2.5 microns and believed to be most closely linked with adverse health effects. Above chart drawn using data from Ambient air pollution in cities database 2016 courtesy of World Health Organization [2]. India's rapidly worsening air pollution is causing about 1.1 million people to die prematurely each year and is now surpassing China's as the deadliest in the world [3].



A. Adverse health Hazard of the Air Pollution:

Continuous exposure to ambient air pollution leads to adverse effects on health from affecting the functioning of the respiratory system, cardiovascular system to psychological instability and even can lead to premature death. Risk of adverse effects on health is high in young children, aged people and even pregnant females and their foetus etc. Health related issues due to pollution is seems to be more common in the developing countries than developed countries [4]. Many recent studies have shown associated relationship between significant exposure to air pollution and adverse effects on health including

mortality and morbidity [5]. Oxides of sulphur in the air may harm human lungs, respiratory system and even may lead to acid rain. Particulate matter suspended in the atmosphere are responsible for respiratory diseases and gastric cancer etc. Continuous exposure to this may lead to breathing problem, cough, and lung diseases. Coughing and wheezing are the most common complication of nitrogen oxides toxicity, but the eyes, nose or throat irritations, headache, dyspnea, chest pain, diaphoresis, fever, bronchospasm, and pulmonary edema may also occur [6]. Exposure to high concentrations of ammonia in air causes immediate burning of the nose, throat and respiratory tract. This can cause bronchiolar and alveolar edema, and airway destruction resulting in respiratory distress or failure [7].

The Study Area:

Vasai Virar City Municipal Corporation is formed 8 years back on 3rd July 2009. VVCMC is formed by merging of the Vasai, Virar, Navghar, Manikpur and Nalasopara municipalities and 53 villages of the surrounding area. VVCMC has total area of 311 sq. km and is fifth largest city in Maharashtra as per 2011 Census. Population of the VVCMC is 1.3 million as per 2011 Census. VVCMC area is bounded by Vaitarna River on the north, Vasai creek on south, Arab Sea on west and Tungar ranges on the west. Various historical monuments from B.C. 540 to 19th Century like Buddha Stupa, Portuguese forts along with religious places like Jivdani Mata Temple thereby contributing to tourism in the area. Stations which are selected for air quality survey are mainly characterized by public places, residential area, commercial as well as industrial area. Brief characteristics of the locations are as follows,

1. Vasai Railway Station: Vasai railway station is administered by Western Railway of Indian Railways. It is one of the busiest railway stations on Western Railway. Surrounding area is consists of mainly commercial as well as residential like hotels, clinics, retail shops etc.
2. Nalasopara Bus Stand: Located on the very outside of Nalasopara railway station on west side. Hundreds of buses travel through the bus stand daily. More than usual traffic on surrounding road.
3. Vitthal Rukmini Temple, Valiv: Located on Nalasopara East. Densely populated residential area. Station is mostly surrounded by chowl system.
4. Pelhar Tehasildar office: It is taluka administrative office. Station is surrounded by roads with heavy traffic. Number of vehicles, people travel daily.
5. Aamchi Shala, Zilha Parishad: Surrounded by ZP school and residential area. There is usual traffic over road. Traffic is higher in the morning and evening.
6. Vatar Village Road: Located nearby sea shore/ Navapur beach. Location is surrounded by tree cover. Traffic is usual. Location is characterized by high speed sea shore winds.
7. Sativali MIDC: Location is surrounded by the MIDC industrial area. Variety of medium and small-scale industries are located in the surrounding area. Residential area is also located nearby.
8. Gokhivare Road: Location is characterized by mix zone area i.e. residential, commercial, public service area etc. and high traffic.
9. BSNL Office, Vasai: Very densely populated residential area with usual traffic on road. Location is surrounded by residential apartments, offices, hospitals. Municipal public garden is also located nearby location.
10. Nalasopara Railway station: Busy railway station on Western Railway. Location is surrounded by heavy traffic area, roads Nalasopara bus stand is located nearby.
11. VVCMC office, Virar: Very much outside of Virar railway station. Heavy traffic is on both side of the virar railway station.
12. Hanuman Temple, Agashi: Location is mainly surrounded by Residential area. Lake is located on north east side of monitoring location.
13. Global City, Virar: Huge residential Complex with usual traffic over road. Minimum or no tree/forest cover over surrounding open area.
14. Navghar: Surrounding area of the location is densely populated. Location is surrounded by offices, retail shops, residential apt. etc.

15. Achole Road: Heavy traffic road area surrounded by residential buildings, banking offices etc.
16. Vasai Station Road, Manikpur: Location is densely populated with residential buildings, apartments etc. Traffic is usual on road surrounded by schools etc.
17. Viva Super Market, Virar: Location is nearby East side of virar railway station. Heavy traffic, traffic jams are observed on the road.
18. Arnala Beach: Located nearby sea shore/beach. Location is surrounded by tree cover. Traffic is usual. Location is characterized by high speed sea shore winds.
19. Ambadi Municipal Park: Location is surrounded by roads having heavy traffic. Park is located on the east of the monitoring location. Area is mainly surrounded by residential area.
20. Navghar Bus stand, Vasai: Location is mainly surrounded by residential area. Usual traffic on road.

II. METHODS AND MATERIAL

SPM (suspended particulate matter) concentrations were measured by finding the sample air volume (m^3) through an orifice meter and the mass (μg) of particulate matter collected in a Watt man grade 1 fiberglass filter paper. Concentrations of SO_2 and NO_2(μg /m^3or PPM) were calorimetrically determined using a spectrophotometer. 5 to 20 ml of reagent (sodium tetra chloro mercurate for West and Geake method to find SO_2 and sodium hydroxide for NO_2) filled in a train of impingers of the high-volume sampler trap specific contaminant in air. Air flows to the impingers were determined using rota meters.

Sampling of Suspended Particulate Matter (SPM):

High volume air sampler was used for the monitoring of particulates. Before sampling, the whatman filter GFA (20.3cm ×25.4cm) of the high-volume sampler was kept at 15-34 ^{0}C, 50% relative humidity for 8 hours and then weighed. The filter paper was placed into the filter holder of the high-volume sampler and air was drawn filter at the flow rate of 1.80 m^3/min. The filter was removed after sampling. The mass concentration of suspended particulates in ambient air, expressed in micrograms per cubic meter, was calculated by measuring the mass of particulates collected and the volume of air sampled.

Sampling of Nitrogen Oxides (NOx):

Ambient air was continuously drawn in 30 ml of absorbing reagent. Absorbing reagent is prepared by dissolving 4.0 gm of Sodium Hydroxide with 1.0 gm of Sodium Arsenite in 1000 ml of distilled water. Air was drawn for 8 hours at the sampling rate of 0.8 Lit/min. The nitrite ion thus formed is reacted with sulfanilamide and N-(1-naphthyl) ethylenediamine (NEDA) in phosphoric acid to form the highly colored azo dye. The absorbance of the highly colored azo-dye is measured on a spectrophotometer at a wavelength of 540 nm.

Sampling of Sulphur Oxides (SOx):

Ambient air was drawn at the in 30 ml of absorbing reagent. Absorbing reagent was prepared by dissolving 10.86 g, mercuric chloride, 0.066 g EDTA, and 6.0 g potassium chloride in distilled water. Air suction is done at the rate of 1.5 Lit/min for continuous 8 hours. Air sample is collected using high volume sampler in impinger containing absorbing solution. The amount of SO2 is then estimated by the color produced when para – rosaniline hydrochloride and formaldehyde is added to the solution. The red-violet color is shown strong absorbance at 560nm.

Sampling of Ammonia (NH_3):

Sampling for Ammonia is done using high volume sampler in impinge box containing 10 ml of absorbing solution. Absorbing solution is prepared by diluting 3.0ml of concentrated H2SO4 (18M) to 1 litre with water to obtain 0.1N H2SO4. Ammonia in the atmosphere is collected by bubbling a measured volume of air through a dilute solution of sulphuric acid to form ammonium sulphate. The ammonium sulphate formed in the sample is analyzed colorimetrically by reaction with phenol and alkaline sodium hypochlorite to produce indophenol. The reaction is accelerated by the addition of Sodium Nitroprusside as catalyst.

III. RESULTS AND DISCUSSION

It is observed from the outcomes of the study of pollutants level at 20 sites, there is remarkable correlation between activities at site and pollutant concentration observed. Locations characterized by heavy traffic of vehicles etc is observed with high concentrations of the pollutants. SPM concentration level is crossed the standard limit (200 µg/m3) at number of locations and is on the verge of crossing standard limit at almost all locations. Concentration of other pollutants i.e. SO_2, NOx, NH_3 is within the standard limit at all locations. There is also seasonable variation of the pollutant level at the locations. Concentration of the pollutants in Pre-Monsoon season is observed to be higher than in other seasons.

Table 1

Sr. No.	Pollutant	Standard Limit
1.	Suspended Particulate matter	200 µg/m3
2.	Oxide of Sulphur	80 µg/m3
3.	Oxides of Nitrogen	80 µg/m3
4.	Ammonia	400 µg/m3

Source: National Ambient Air Quality Standards [9]

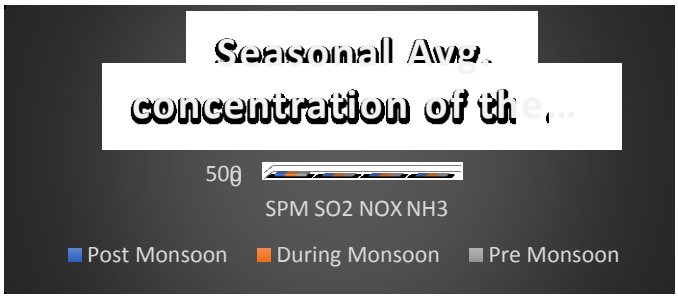


Figure 1. Seasonal Average Concentration of the pollutants

IV. CONCONCLUSION

Season wise average of the SPM is seeming to be crossing the standard limit for that parameter. Higher level of the SPM concentration at location is alarming and this situation may further get worsen in coming years. Main contributors to the increasing level of the SPM and other pollutants is mainly addition of the 2,3,4- wheelers on the roads of the urban city. Regular study of the pollutants in the city/town will help to understand the range pollutant level, cause effects, correlations, trend, pattern evaluations, preventive as well as strategic remedies to tackle the worsening air quality etc. Proper road management, better traffic regulations, controlling emission features of vehicles, proper synchronization of the office, school timings, tree plantation around the roads, creating green zones by planning gardens, encouraging citizens for use of public transport, continuously arranging awareness programmes for citizens etc. are some of the immediate remedies for upward pollution. Safety measures against poor ambient air quality should be analysed and implemented. More emphasis should be given on public places like bus stand, railway station, road junctions etc. Equal contribution of the local authorities, public administration along with active participation of the citizens is needed.

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