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ANALYSIS AND MODELING OF AIR POLLUTANTS ALONG A LINK ROAD IN MUMBAI CITY

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ABSTRACT

:*Rapid industrialization and urbanization has lead to increase in the vehicular emissions resulting in the deterioration of ambient air quality in urban areas. Present paper deals with the measurement, analysis and modeling of key pollutants along a highway corridor in Mumbai city. Air monitoring was carried out at four intersections along Bandra Worli Link Road during peak hours and results were analyzed. Prediction of the pollutants were done by using CALRoads View Model. The predicted values of the pollutants were compared with the standards prescribed by CPCB. It was found that the concentration level of the pollutants at all three locations were higher than the standard limit of CPCB. It was also observed that the CALRoads View model marginally over predicts the PM_{10} concentration and under predict the NO_X concentrations.*

Keywords : Ambient Air Quality, CalRoads View, Emission factor, Vehicular Traffic.

I. INTRODUCTION

Air pollution due to vehicular traffic is of great concern to the general public. Motor vehicles are the major source of urban air pollution, controlling strategies should be developed that minimize the environmental impacts but at the same time it should maximize the efficiency of motorized transport. Utilization of motor vehicles in turn leads to emission of solid particulate matter (SPM), oxides of Nitrogen (NO_X), oxides of Sulphur (SO_X) Hydrocarbons (Hc) etc. which are the main source of air pollution. Traffic generated air pollutants such as NO_2 and PM_{10} are of health concern; and traffic generated greenhouse gases such as carbon dioxide (CO_2) may contribute to global warming.

The emission factor based approach is widely used in Modeling of Traffic related pollutants [1], [2], [3]. The accuracy of this approach depends much on reliability of traffic data (traffic volume and speed, their temporal and spatial variations, vehicle compositions etc.)

CALINE series of model have been used extensively all over the world including India for regulatory purposes [3]. CALINE4 offers several advantages over the other previous models and has been used by many other researchers to predict pollutant concentration of vehicular pollutants along the roads/highways in Indian climatic conditions [4] [5] . [6] .Nirjar[7], [8] [9] had used CALINE4 to predict the concentrations of CO along the urban and semi-urban roads in Delhi and the study results showed under prediction and moderate r^2 correlation values between observed and predicted concentrations. Further, Gramontev . [10] used CALINE4 for the analysis aerosols of (fine and ultra fine particles) generated by vehicles on a busy road and found good agreement between observed and predicted concentrations.

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II. MATERIALS AND METHODS

2.1 Study Area

Traffic junctions are consider as hot spot of air pollution, as vehicles have to wait in idling mode of operation for signals and so the amount of pollution increases. At present the traffic from Bandra to Worli (Mumbai) travels through major signalized intersections, which leads to the increase in air pollution in nearby areas, like schools, hospitals, worship places, and playgrounds because vehicles are in idle mode at the junction. Due to the construction of Bandra – Worli Sea Link Bridge the existing traffic will be diverted from the main city land to sealink, which will avoid major signalized intersection and it will reduce the amount of pollutant in city. This study is conducted to find the amount of reduction in air pollution due to traffic diversion from main city land to sea link. . Figure 1.1 shows the locations of monitoring stations and their respective names have been given in table1.

Table1: Location of monitoring Stations

Sr. No.	Name of the Air Monitoring Stations
1	Bandra Fire Station, Bandra
2	Raja Wdri Hospital
3	Gamon House Bus Stop
4	Worli Bus Stop

Figure 1.1 Locations map of Air Quality Monitoring Stations

2.2 Methodology

The monitoring was done by standard methods as prescribed by Indian regulatory authority (MoEF Notification, 1994).Air monitoring was carried out at all the four locations for key pollutants. Nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and respirable suspended particulate matter (PM_{10}) are monitored with the help of high volume sampler. NO_2 and SO_2 were collected by aspirating ambient air through absorbent solution with a known sampling rate (1.5 liters per min). They have been measured calorimetrically by using modified Jacob and Hochheiser method for NO_2 and for SO_2 the West and Gaeke method have been used. The absorbing solution for NO_2 is sodium hydroxide plus arsenite and sodium tatracholomercurate for SO_2. Prediction of all the pollutants were done by CALRoads View model and predicted values of the pollutants were compared with the CPCB guidelines.

2.3 CALRoads View (Lakes Environments, 2008)

This model is developed by **Lakes Environmental Software**, **Canada, 2008.** CALRoads View is a dynamic and intuitive user friendly interface for the three California Department of Transportation (CALTRANS) and U.S. Environmental Protection Agency (EPA) air dispersion modeling codes i.e. CALINE4, CAL3QHC and CAL3QHCR. CALRoads View uses the original model executables without any modifications. This interface is a true, native Microsoft Windows application and runs in Windows Me/2000/XP.

The software has the following advantages;

- The CALRoads View interface has easy-to-use options that compose the CALINE4, CAL3QHC and CAL3QHCR run stream file.
- Ability to import pre-existing CALINE4, CAL3QHC and CAL3QHCR input files into the CALRoads View interface.
- Import base maps in a variety of formats for easy visualization and identification of our modeling area.
- The graphical output capabilities of CALRoads View can help you create impressive presentations of model results. We can customize our project using display options such as transparent contour shading, annotation tools, change fonts, and specify wind arrows.
- The model is built in grid receptor to find out the level of pollutant at various locations over the given map.
- Model can be developed with the help of discrete receptor to find the exact amount of pollutant at particular location.

2.3.1 Inputs for CALRoads View Model:

The various inputs data required to run the CALRoads View model are given in table 2

Table 2: Input for CALRoads View Model

Meteorological Variables	Bandra Fire Station
Averaging time (min)	60 min
Surface roughness coefficient (cm)	100 cm
Settling velocity (cm/s)	0 cm/sec
Deposition velocity (cm/s)	0 cm/sec
Wind speed (m/s)	2 m/s

Wind direction (degree)	220 – 280 degree
Wind direction increment angle (degree)	10 degree
Stability class	4D (Neutral)
Ambient atmospheric temperature	28ºC
Mixing height (m)	1000 meters
Height of receptor (m)	1.8 m

2.3.2 Comparison of Vehicular Pollution Models

Table 2.8 shows comparison of various vehicular pollution models. From the table it is clear that, CALRoads View Model is more capable for modeling. Hence, in this study we have used the same software for modeling the air quality. Various type of models and their suitability are given in table 3.

Table 3: Comparison of Vehicular Pollution Models

Name of Model	Dispersion Parameter	Plume Rise	Chemical Reaction	Dispersion of Particles	Graphical View
Simple Infinite Line Source	Ambient Turbulence	No	No	No	No
Finite Line Source	Ambient Turbulence	No	No	No	No
Stanford Research Institute Model	Traffic induce and due to building obstruction	No	No	No	No
CALINE4	Traffic induce and ambient turbulence	Yes	No	Yes	No
Simplified Methodology to estimate emission from mobile source	Traffic induce and ambient turbulence	Yes	No	Yes	No
CAL3QHC	Traffic induce and ambient turbulence	Yes	No	Yes	No
CALRoads View	Traffic induce and ambient turbulence	Yes	No	Yes	Yes

III. RESULT AND DISCUSSION

Air monitoring was carried out at four locations along Worli Bandra Link road and concentration of the pollutants were analyzed in the laboratory. Modelling of the pollutants were done by CALRoads View model. Details about the observed and predicted concentrations of the pollutants are given in table 4.

Table 4.0 Comparison of Predicted and Observed Concentration

(All the values are in $\mu g/m^3$)

Name of Pollutant	Bandra Fire Station		Rajawadi Hospital		Gamon House Bus Stop		Worli Bus Stop	
	O	P	O	P	O	P	O	P
Respirable Suspended Particulate Matter	489.16	502.76	424.17	475.16	402.18	469.77	376.05	424.76
Nitrogen Dioxide	130.72	91.24	110.77	80.04	75.17	60.49	117.91	85.32
Sulphur Dioxide	102.75	79.53	108.16	84.53	76.50	64.14	88.18	68.74

(O = Observed values, P = Predicted value)

IV. CONCLUSION

From the above study, following points have been concluded,

1. The concentration level of PM_{10}, NO_X and SO_2 at all the three monitoring stations are almost higher than the permissible limit of CPCB.
2. Predicted value of concentrations for future scenario clearly indicates that preventive measures must be taken to minimize the pollution level. in the surrounding areas..
3. It was found that CALRoads View model over predict the PM_{10} concentration and under predict the NO_X concentration.

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