A STUDY OF INTEGRATED MODELING OF TRAFFIC, VEHICULAR EMISSION & AIR POLLUTANT CONCENTRATION IN AROUND VALLABH VIDYANAGAR, GUJARAT, INDIA.

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Abstract: Vehicular activities & on-road vehicles are one of the major contributors for reduction of urban air quality. Vehicular emission is the major contributor of primary and secondary pollutants to the ambient air. Health problems related with respiratory and cardiovascular systems of the human body are resulted by exposure to poor air quality. The purpose of the study is to survey the vehicular counts & flow in the study area along with ambient air quality monitoring by considering parameters such as Particulate matters PM_{10} & $PM_{2.5}$, Sulphur Dioxide as SO_2, Oxides of Nitrogen as NO_2 and carry out air dispersion modelling to predict and simulate the distribution and the behaviour of air pollutants in around Vallabh Vidyanagar, Gujarat, India.

Keywords: Air dispersion modelling, Ambient Air Monitoring, Traffic count

I. INTRODUCTION

Vallabh Vidyanagar is a town and a municipality in Anand district of Gujarat, India. It is located between Ahmedabad and Vadodara and 6 km from the town of Anand. Vallabh Vidyanagar is also known as educational centre of the state. Air pollution in Vallabh Vidyanagar originates mainly from the local sources. Local sources include local transportation, public & construction activities, etc. Fugitive emissions occurring due to the on-road transportation activity of raw-material, coal, goods, etc. for industries located around the city also affect the ambient air quality of Vallabh Vidyanagar.

Poor air quality can affect respiratory and cardiovascular systems of the human body. Countries starts to implement new polices and rules as the awareness regarding health effects of vehicular emissions rises, for reducing the human exposure to air pollutants. The policies are mostly evaluated through the use of replication tools which estimate traffic counts, vehicular emissions, ambient air concentration of pollutants, and human exposure. The accuracy of estimated ambient air concentrations would help in reducing the human exposure to such pollution. Industries, households, cars and trucks emit complex mixtures of air pollutants, many of which are harmful to health, out of which fine particulate matter has the greatest effect on human health. Fuel combustion mainly leads in emission of fine particulate matter, both from mobile sources such as vehicles and from stationary sources such as industry, households or biomass burning. Broad spectrum of acute and chronic illness is also related with the air pollution, and which leads to problems such as chronic obstructive pulmonary disease (COPD), lung cancer, and cardiovascular diseases. The purpose of the study is to estimate the spatial and temporal distributions of traffic movement & vehicle counts in the study area and evaluating the present ambient air quality by performing ambient air monitoring and considering parameters such as Particulate matters PM_{10} & $PM_{2.5}$, Sulphur Dioxide as SO_2, Oxides of Nitrogen as NO_2 in the study area. Air dispersion modelling to be carried out for evaluating the concentration of pollutant in the surrounding environment. The need of such model study would help as the early warning systems in order to have the opportunity to take promising and precautionary action to reduce pollutants when conditions that encourage high concentrations are predicted.

II. OBJECTIVE OF THE STUDY

- To estimate the spatial and temporal distributions of traffic movement & vehicle counts.
- Evaluating & monitoring the present ambient air quality of the study area.
- Determining the ambient air concentration of:
  - ✓ Particulate matters PM_{10},
  - ✓ Particulate matters $PM_{2.5}$,
  - ✓ Sulphur Dioxide as SO_2,
  - ✓ Oxides of Nitrogen as NO_2,
- To perform line source air dispersion modelling.

III. SCOPE OF THE STUDY

- Evaluating the traffic movement & vehicle counts for study area by performing the traffic survey.

- Measuring the existing ambient air quality and carry out line source air dispersion modeling by processing the collected baseline & background data.
- The scope of the study would be limited to Vallabh Vidyanagar, Anand.

IV. TRAFFIC STUDY

The vehicular movement in the study region being education hub and local transportation activity in region it majorly includes the movements of 2 & 3 wheelers, Passenger car, and Bus. Traffic count for the study was carried out for eight hours at two different locations i.e. Mota Bazaar and Bhai Kaka Circle. Traffic survey carried out at both places has shown that Mota Bazaar had more number of vehicle movements as compared to the other location. The number of vehicles evaluated per hours has been shown in below table:

Table-1 Traffic count at Mota Bazaar-Vallabh Vidyanagar

Time	Cycle	Cart	2 Wheeler	3 Wheeler	4 Wheeler	LCV	Bus	Mini Bus	Truck	Tractor	Multi Axel
9am-10am	19	0	1076	163	432	22	1	0	0	0	0
10am-11am	11	0	1287	276	509	33	0	0	0	0	0
11am-12pm	34	0	1173	315	561	41	7	4	1	1	0
12pm-1pm	23	0	1316	234	492	13	4	1	1	0	0
1pm-2pm	24	0	938	155	377	18	1	1	3	0	0
2pm-3pm	20	0	719	141	241	16	1	0	1	3	1
3pm-4pm	6	0	589	135	209	9	0	0	0	1	0
4pm-5pm	9	0	634	164	287	4	0	1	0	0	0
Total	146	0	7732	1583	3108	156	14	7	6	5	1
Avg./Hr	18.25	0	967	198	389	20	2	1	1	1	0.125

The study region for performing the ambient air baseline monitoring and line source dispersion modelling has been selected Mota Bazaar on the basis of maximum traffic count measured at Mota Bazaar.

V. AMBIENT AIR MONITORING

The monitoring period for performing baseline ambient air monitoring for determination of existing ambient air quality of study region was Feb-2019 and considering the peak hours of traffic and vehicular movements from 10 am to 2 pm, four hours monitoring twice in a week for one month had been carried out at Mota Bazaar. The analysis performed in the laboratory shown the result ranging between PM_{10} 80-94 ug/m^3, $PM_{2.5}$ 25-39 ug/m^3, SO_2 11-18 ug/m^3, NO_2 22-34 ug/m^3 for the study region.

Figure 1: Image of the study area (Mota Bazaar)

The local and daily activities of street vendors, Construction, road swiping, vehicular movement etc. contributed for the occurrence of particulate matters in the ambient air.

VI. LINE SOURCE DISPERSION MODELING

The software-graphical user interface "ISC-AERMOD View" developed by Lakes Environment, Canada, using the ISCST3 model was used for performing the line source dispersion modeling of Mota Bazaar. Pollutant type considered for the modeling were TSP (Particulate emission) and NO_X emission for averaging time period of 8 hours and 24 hours.

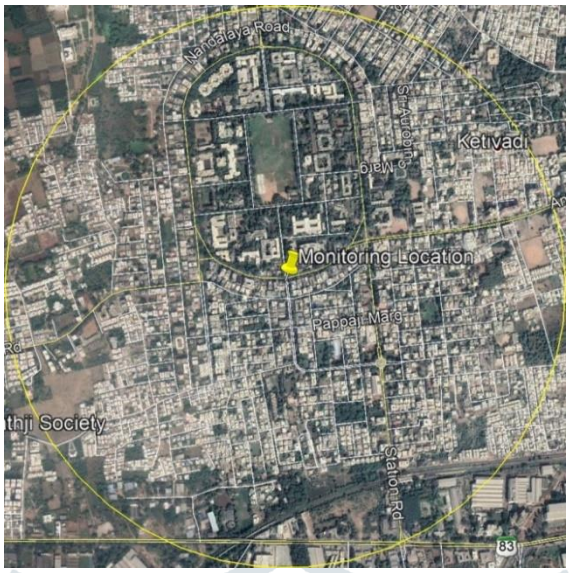

Figure 2: Satellite image of Monitoring Location

Meteorological data for the month of Feb-2019 was used for dispersion modeling. Length and width of the roads i.e. Mota Bazaar to Bhai Kaka Circle and Mota- Bazaar to Sastri Medan was measured manually. The emission factors considered for the calculation of emission rate were as prescribed by the Central Pollution Control Board for the vehicular exhaust.

Emission rate calculated for Truck, Bus, 2 & 3 Wheelers, Passenger cars of both the roads are shown in the below table:

Table-2 Emission Rate

ROAD	PM (g/s)	PM (g/s.m^2)	NO_X (g/s)	NO_X (g/s.m^2)
Mota Bazaar to Bhai Kaka Circle	0.0001051	1.0269E-08	0.008019	7.83483E-07
Mota- Bazaar to Sastri Medan	8.2648E-05	1.1628E-08	0.004608	6.48334E-07

VII. RESULTS

Discrete Cartesian Receptors were used for the dispersion modeling and the results derived after the successful run of the model for 8 and 24 hours of Pollutant type NO_X are as follows:

Table-3 Results for pollutant type NO_X

Number of Receptors	X-Direction (m)	Y- Direction (m)	Concentration NO_X (Average conc.) [ug/m^3]	
			8 Hours	24 Hours
1	3.27	29.9	27.296	15.951
2	287.21	167.83	7.936	3.947
3	-21.39	284.06	8.877	3.050
4	-319.47	212.9	10.115	3.371
5	39.25	-278.17	13.693	8.730

Similarly the result for the successful run of the model for Pollutant type TSP (Particulate emission) for 8 and 24 hours are as follows:

Table-4 Results for pollutant type TSP

Number of Receptors	X-Direction (m)	Y- Direction (m)	Concentration TSP (Average conc.) [ug/m^3]	
			8 Hours	24 Hours
1	3.27	29.9	0.425	0.250
2	287.21	167.83	0.104	0.051
3	-21.39	284.06	0.158	0.054
4	-319.47	212.9	0.132	0.044
5	39.25	-278.17	0.244	0.155

VIII. CONCLUSION

As per the study, it can be concluded that the results derived by the line source dispersion modeling for area Mota Bazaar,

Vallabh Vidyanagar shown the concentrations are well within the prescribed limit and the effect to the surrounding environment and human health would not be harmful. The reason behind getting low concentrations for TSP (Particulate emission) is because the movements of heavy diesel vehicles such as Trucks, Buses etc. are less in the study region. The analysis results of the ambient air quality of the region are also within the limits as prescribed by the Central Pollution Control Board.

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