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Study on Air Quality in the near field of MMA –A case study

Braj Mohan, Kafeel Ahmed, Shakil Afsar
Department of Civil Engineering, Jamia Millia Islamia, New Delhi, India

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Abstract

Study on Air quality in the near field of MMA JauharMarg, JamiaUniversity Campus, New Delhihas been carried out by using airmonitoring data and traffic volume data which is collectedmanually up to 8 hrs on the MMA JauharMarg for 3 consecutive working days i.e 07.10.2014 to 09.10.2014. Concentration of pollutants ispredicted by air quality prediction model i.e CALINE-4/2.1 model.The main objective of this study is to find out air pollutants (CO, SOx, NOx, & PM10) concentration at near field of MMA JauharMarg, Jamia University Campus. Traffic volume passing in a day (8 hrs) is used for this purpose.The air quality prediction modelis used to predict CO concentration by using collected data of transported vehicles. Air qualitymonitoring data is collected through airsampler upto 8 hrs for verification of predicted results of caline-4 model.

The monitored value of CO is 1.4 mg/m^3(maximum) between 1000 hrs.-1100 hrs. and 0.85 mg/m^3 (Min) between 1400 hrs to 1500 hrs. 8 hrs monitored average concentration of CO is 1.14 mg/m^3.The predicted value from Caline-4 model indicates that the CO concentration near the receptor location is1.5mg/$m^3$and 200 meter away from receptor is 0.75mg/m^3.

1. Introduction

Air pollution is one of the major problems faced by many areas across Delhi. Delhi being the highest air polluted city in the world needs a comprehensive research on its air quality. To find out the air pollutants concentration a study on Air Quality in the near field of MMA Jauhar marg has been carried out. Jamia Millia Islamia, University Campus, New Delhi, has been selected for this purpose.

Vehicular transportation is Delhi's highest pollution source, which is responsible for almost 70% of the total air pollution of the city. In Delhi, vehicular population has been increased up to 4.2 million by 2004, which has been estimated 7.2 million by 2016 on the basis of transport data obtained from Transport Department, 2004 (P.Goyal et al.). Carbon Monoxide (CO), Oxides of Sulphur (SOx) Oxides of Nitrogen (NOx), Particulate Matter (PM), and Hydrocarbon (HCs) are the pollutants of vehicular transportation.

Other sources such as construction dust, Generator sets emission, and bio mass refuse burning and other unregulated sources are becoming major inputs in this area, that are responsible for high pollution levels. In the present urban setting, the ever growing increase of motor vehicle emissions, as well as other anthropogenic sources gives rise to gaseous pollutants and smaller fractions of particulate matter along with carbonaceous and volatile organic compounds. According to urban air database, released by the World Health Organization (WHO) in Sept. 2011, Delhi has exceeded the maximum PM10 (Annually) limit upto198µg/m3. (SaRizwan et al. 2011).

The Population near around of Jamia university campus increased very rapidly. This risingpopulation has increased in the elevated levels of vehicular population in this region, resulting in deterioration of air quality.

Corresponding Author,
E-mail address: bmsain@gmail.com

The net effect of this increase in population and cars is the drastic increase in environmental pollution including air pollution. Air pollution is clearly visible during the day in the dry season in Jamia University area.

2. Methodology

The study has been divided into two stages for finding pollutants concentration on air quality in the near field of MMA Jauhar Marg, Jamia university campus. The first stage is, collection of traffic vehicles data on hourly and 8 hourly basis, plying on the MMA Jauhar Marg and monitoring of air pollutants concentration with the help of desirable dust sampler (RDS).

The second stage is prediction of air pollutant 'CO' concentration by using air quality Prediction model and avg. weighted emission factors. Avg. weighted emission factors are calculated with the help of data collected of transported vehicles and emission factors. Caline-4/2.1model has been used for prediction of Carbon Monoxide (CO) concentration.

Air pollutant (CO) concentration, predicted by Caline-4/2.1 model then analyzed and compared with monitoring values of pollutants& National Ambient Air Quality Standard 2009 (NAAQS).

2.1 Study Area

Jamia University Campus has been selected as the research area for this study. It is situated in the North part of the Country between 28 º 33' 39" and 28 º 33' 44" N longitudes and between 77 º 16' 40" and 77 º 17' 9" E latitude. Length and width of this area is 1000mt. X 600 mt. The main sources of air pollution in this particular area are automobiles vehicles, generators sets, and Delhi Metro Rail construction activity going on and around the university

campus. Air pollutants like CO, SOx, NOx, and PM10 are emitted from various sources of pollution. In this study, we only consider emission of automobiles vehicles, plying on the MMA Jauhar Marg, Jamia University.

The study area map of Jamia University Campus is shown in fig.1.

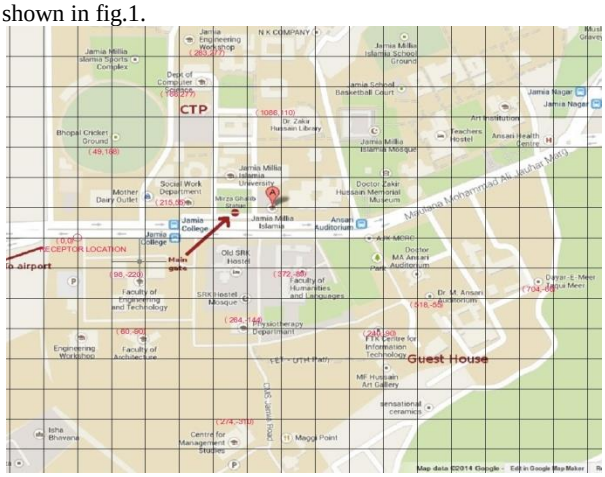

Fig: 1. Study area map of Jamia University Campus, New Delhi, India

2.2 Sampling Site

The sampling site was located in the centre of Jamia University Campus on MMA Jauhar Marg. Air Sampler of "Spectro Lab Equipment Pvt. Ltd." was installed at different location of Jamia University Campus for ambient air monitoring up to 8 hrs between 1000hrs to 1800hrs.The ambient air quality monitoring has been done for CO, SOx, NOx, PM10& HC in the month of October, 2014.

2.3 Traffic Inventory

Rapid development of this area has resulted in increase of vehicular emissions leading to insignificant deteriorating ambient air quality. In this study, the numbers of vehicles plying on the MMA Jauhar Marg (Jamia university road) have been recorded manually up to 8 hrs at two locations for different types of vehicles like, two wheeler, three wheeler ,Car, Light Commercial Vehicles (LCV) and Heavy Commercial Vehicles (HCV). Locations selected for vehicle data collection are, one at Tikona Park and other location was F/O Engg. GateNo.1. Vehicles crossing the MMA Jauhar Marg at peak hours (Morning 7-10 A.M, Afternoon 12-2 P.M & Evening 6-9 P.M) were counted for automobiles exhaust. Three days continuous monitoring in 8 hrs a day at two location sites has been recorded.

2.3.1 Traffic Volume

Traffic volume of vehicles has been recorded manually on hourly basis. Nearly 13000 vehicles crossed the road in 8 hours, at day time. Two wheelers, three wheelers& Cars were found in large number. Two wheelers counted as the highest in number among the vehicles passing through this road .The number of these vehicles have doubled in peak hours at the morning (0800 hrs. to 1000 hrs.) and evening (1800 hrs. to 2000 hrs.) 3 days continuously recording of traffic vehicles have been done in hourly basis up to8 hrs a day at 2 sites .8 hrs Traffic volume has been recorded from morning to evening shown in table 'A 'and Fig 2 to Fig 4.

Dated	Traffic Volume during day time (8 hrs)					
	2W	3W	Car	LCV	HCV	Total
07.10.2014	5417	3440	3500	159	359	12,875
08.10.2014	4910	3190	3150	142	348	11,740
09.10.2014	4756	3070	2964	129	337	11,256

Table: A: Traffic Volume during day time (8 hrs)

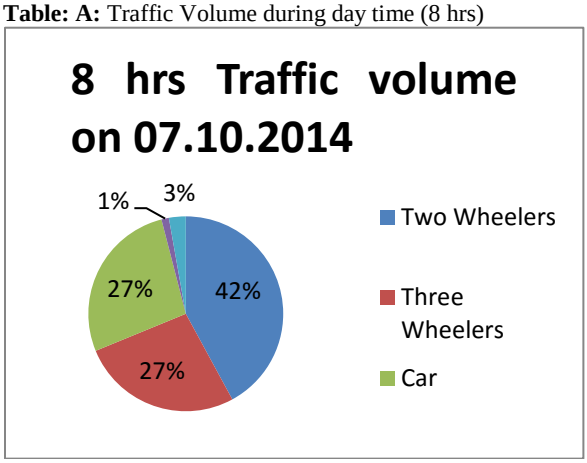

Fig: 2: 8 hrs Traffic volumes on 07.10.2014

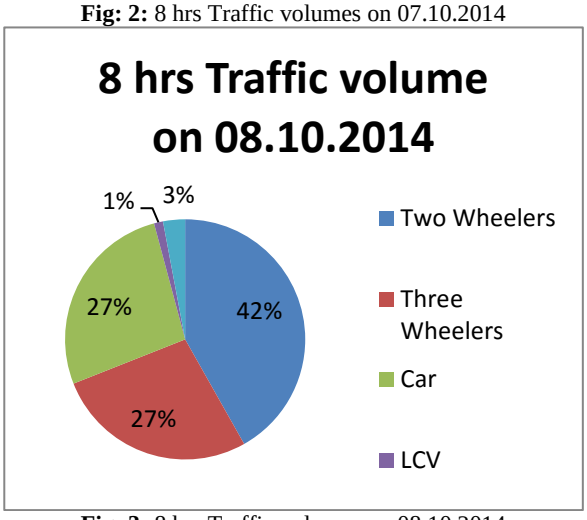

Fig: 3: 8 hrs Traffic volumes on 08.10.2014

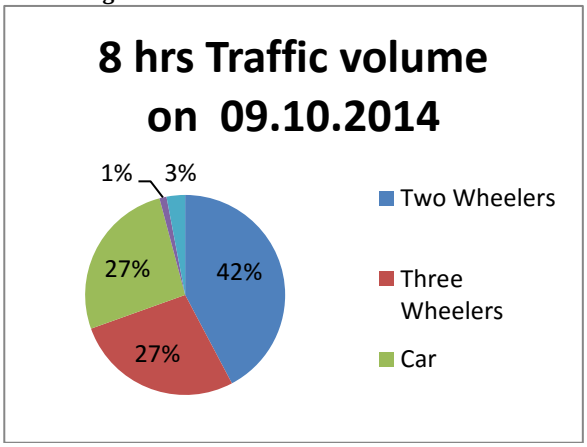

Fig: 4: 8 hrs Traffic volumes on 09.10.2014

2.4 Average Weighted Emission Factor

The avg. weighted Emission Factor can be calculated by using emission factors for specific pollutant (g/Km) and corresponding deterioration factors due to ageing of vehicles. Weighted emission factors have been calculated with the help of traffic volume and emission factor of vehicles (Source: "Emission Factor Development for Indian Vehicles" ARAI Pune, 2008)

Average weighted emission factors were calculated in gm/km/vehicles by emerging all categories of vehicles for pollution loads of CO, NOx, HC and PM10of 8 hrs. in a day.

The average weighted emission factor of specified pollutant (gm/km/vehicles) can be calculated from following formula:

EFW = { Number of vehicles of 15-20 yrs of age X deteriorated Factor X Emission factor of specified pollutant (gm/km) + Number of vehicles of 10-15 yrs of age X deteriorated Factor X Emission factor of specified pollutant (gm/km) + Number of vehicles of 5-10 yrs of age X deteriorated Factor X Emission factor of specified pollutant (gm/km) + Number of vehicles of 0-5 yrs of age X deteriorated Factor X Emission factor of specified pollutant (gm/km) / Total number of vehicles

CO is the main air pollutant from traffic vehicles. After calculation Average weighted emission factor of CO is 2.2 gm/km/vehicle. It is used for predicting Carbon-monoxide (CO) pollutant concentration with the help of CALINE-4/2.1 model.

Average weighted emission factor (g/km/vehicle) of all pollutant is shown in Fig.5.

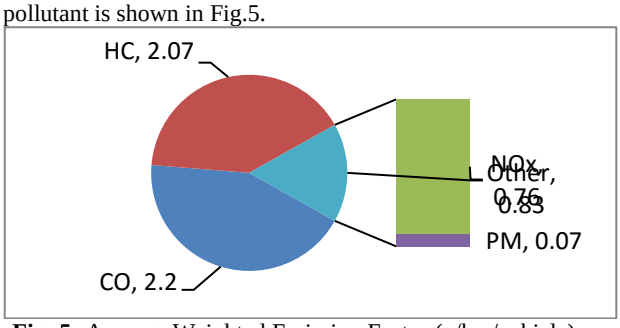

Fig: 5: Average Weighted Emission Factor (g/km/vehicle)

3.0 Air Quality Modeling

Air quality modeling is based on hourly vehicular counts, road type and its length. The Caline-4/v2.1, Dispersion Model was used for this research work to predict Air Pollutant Concentrations near roadways.

3.1 Description of CALINE 4/2.1 Model

CALINE-4 California LINE Source Dispersion Model developed by STI (Sonoma Technology Inc.), California Department of Transportation (Caltrans).

CALINE-4 is the standard modeling program to assess Carbon Monoxide (CO) impacts near roadway. It is based on the Gaussian Plume Dispersion Model and employs a mixing zone concept to characterize pollutant dispersion over the roadways. It can predict air pollutant concentrations of Carbon Monoxide (CO), Nitrogen Dioxide (NO2), and suspended particles near roadways.CALINE-4 model can be run as a command-line program rather than through the CL4 user interface, after preparing an input file. The latest CL-4 user interface (version 2.1) supports very basic modeling of PM and NO2. Like other dispersion models, CALINE-4 requires input of traffic characteristics (volumes, speeds, etc.) and emission factors.

3.2 Preparation of CALINE-4 Input File

Caline-4, dispersion model requires the parameters like, wind speed, wind direction, stability class, mixing height, ambient temperature and background concentration. Link geometry of study area is also required for receptor coordinates. Links are defined as straight lines segments. The entire length of each link should deviate no further than 3meters from the centre line of actual roadway. The endpoint coordinates (x1, y1) and (x2, y2) define the positions of link endpoints.

Traffic volume and CO emission factor of vehicles (gm/mile) has been used for calculating CO concentration. Receptor position shows the location of receptor with reference to link geometry. Receptor coordinates were taken from Google earth.

Receptors coordinates and location are shown in fig. 6 & 7.

	Receptor Name	X	Y	Z
▶	Recpt 1	98	-220	1.8
	Recpt 2	49	188	1.8
	Recpt 3	215	55	1.8
	Recpt 4	166	277	1.8
	Recpt 5	274	-310	1.8
	Recpt 6	283	277	1.8
	Recpt 7	264	-144	1.8
	Recpt 8	1086	110	1.8
	Recpt 9	372	-88	1.8
	Recpt 10	518	-55	1.8
	Recpt 11	704	-66	1.8

Fig: 6: Coordinates of Receptors

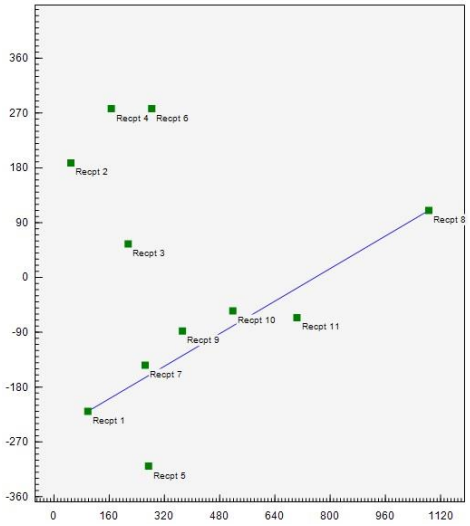

Fig: 7: Location of Receptors

Hourly frequencies distribution of wind speed, Wind direction, mixing height, stability class and ambient

temperature were used in this model.8 hrs averaged ground level concentration of 'CO' was predicted for vehicular sources. Maximum concentration due to vehicular movement was found at the receptor location.

The predicted value indicates that the max. 'CO' concentrationis1.5mg/m3near the receptor location and minimum 'CO' concentration0.75 mg/m3200 meter away from receptor.

4.0 Air Quality Monitoring

Air Quality monitoring was conducted by ITL Labs Pvt. Ltd. Delhi, with Respirable Dust Sampler (RDS) having model No. SLE RDS 103.It is manufactured by Spectro Lab Equipment Pvt. Ltd. Delhi. The filter paper used for this monitoring was "Glass micro fibre filter" and the size was 20.3X25.4 cm. Sampler was installed at the Gate No. 1 of Faculty of Engg. & Technology (Jamia University). Sampling was done for the pollutants CO, SOx, NOx, & PM10 on hourly basis, from 1000 hrs. to 1800 hrs. Air sampler is shown in fig.8.

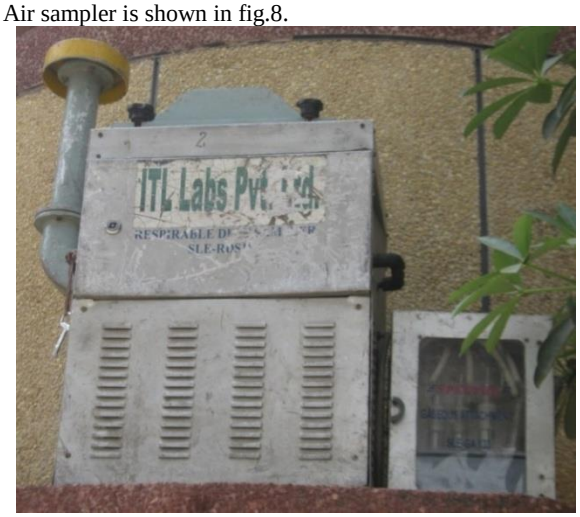

Fig: 8: Respirable Dust Sampler (RDS)

Monitored value from Respirable Dust Sampler (RDS) are given in table B

Sr No.	Parameters	Unit	Permissible Limit as per NAAQ 2009 Standard	Monitored Value
1	CO	mg/m^3	02 (8 hr.)	1.14
2	SO_x	µg/m^3	80	18.7
3	NO_x	µg/m^3	80	57.8
4	PM_{10}	µg/m^3	100	392

Table: B: 8 hrs monitored value from RDS

The Table shows that results of all parameters are within range of NAAQ standard whereas the value of PM10 is nearly 4 times the std. value. It is due to the Metro Rail construction activities that are going on the MMA Jauhar Marg. After the construction work completion, it could come in the permissible limit.

5.0 Result

Resulting 8 hrs monitored concentration of CO remained well below 1.14 mg/m3 to the National Ambient Air Quality Standard (NAAQS) 2009 of 2 mg/m3. Particulates matter (PM10) was observed 392µg/m3 much more then NAAQS value of 100µg/m3.Hourly results indicate that the concentration of CO is nearly equal to predicted values of CALINE-4 model and much less to permissible limit of NAAQ Std, shown in table 'C'

8 hrs. Avg.Predicted CO concentration by Caline-4/2.1 Model, (mg/m^3)			Monitored Concentration (mg/m^3)	8 Hourly Standard limits as per NAAQ 2009 (mg/m^3)
7.10.2014	8.10.2014	9.10.2014		
1.5	1.37	1.37	1.14	2.0

Table: C :8 hrs Avg. CO concentration Vs Standard limit

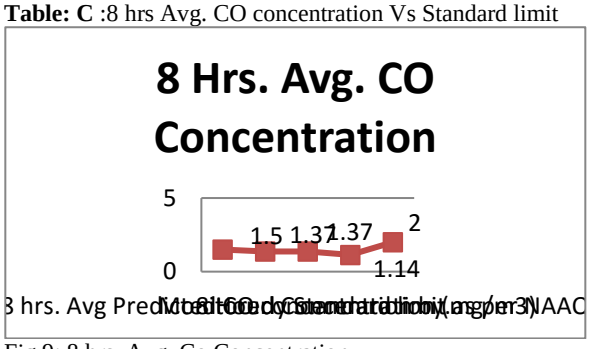

Fig.9: 8 hrs. Avg. Co Concentration

Hourly monitored values for CO concentration are compared with National Ambient Air Quality Standard (NAAQS) and hourly predicted value by CALIN-4/2.1 model, shown in table 'D'.

Time (hrs.)	Hourly Predicted value by Caline-4 Model(mg/m^3)			Hourly Monitored Con. (mg/m^3)	Hourly Standard limits as per NAAQ 2009 (mg/m^3)
	(7.10.2014)	(8.10.2014)	(9.10.2014)		
1000 – 1100	1.25	1.12	1.00	1.4	04
1100 – 1200	1.87	1.75	1.62	1.3	04
1200 – 1300	2.00	1.62	1.62	1.1	04
1300 – 1400	1.12	1.00	1.00	0.97	04
1400 – 1500	1.12	1.00	1.12	0.85	04
1500 – 1600	1.50	1.37	1.37	1.0	04
1600 – 1700	1.62	1.62	1.50	1.2	04
1700 – 1800	1.50	1.37	1.37	1.3	04

Table: D: Hourly CO concentration from morning to evening

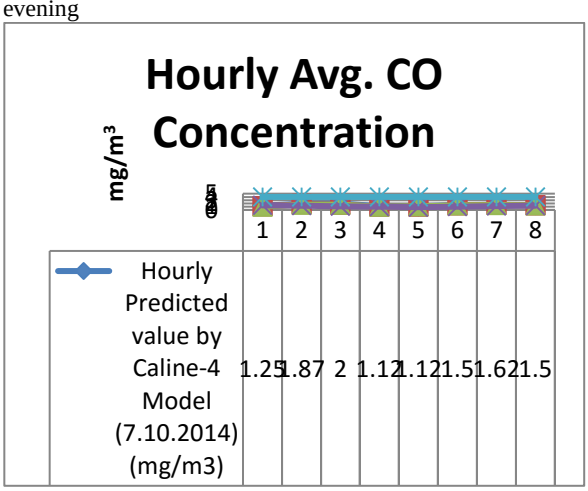

Fig: 10: 8 hrs. Avg. Co Concentration

6. Conclusions

This paper presents prediction of air pollutant 'CO' concentration emitted from Automobiles vehicles in the near field of MMA Jauhar Marg, Jamia University Campus, New Delhi.

Air Quality monitoring has been done by Respirable Dust Sampler (RDS) for sampling up to 8 hrs. Air pollutant emission from traffic volume is calculated with the help of Caline-4/2.1 model & Avg. weighted Emission Factors obtain through ARAI Pune, 2008 report on "Emission Factor Development for Indian Vehicles".

CALINE-4/2.1 Model and other meteorological data were used for prediction of 'CO' concentration in the vicinity of the research work in order to ensure compliance with the National Ambient Air Quality Standard (NAAQS) for ambient air quality.

Monitored Results indicates that the concentration of CO, NOx and SOx are observed well below to the National Ambient Air Quality Standard 2009 (NAAQS) whereas Particulates matter (PM10) was observed 392µg/m3 much more then NAAQS value of 100µg/m3which is nearly 4 times the std. value.

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