S.Aruna, et. al. International Journal of Engineering Research and Applications
www.ijera.com
ISSN: 2248-9622, Vol. 10, Issue 7, (Series-VII) July 2020, pp. 12-17

RESEARCH ARTICLE OPEN ACCESS

Estimating Ambient Air Quality of National Highway in the Outskirts of Chennai, South India using Air Quality Models

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ABSTRACT
The number of vehicles has been increased due to growth of population, industrialization and urbanization. Due to increase in number of vehicles movement it causes 60% of air pollution is being triggered in nearby regions. The assessment of each situation must be required to anticipate the quality of air in urban areas, with the intention to sustain the levels of air quality with the permissible limits by means of measuring the certain traffic management. In this study, the area chosen was the National Highway which was located between Tambaram and Chengalpet, in Tamil Nadu. India. The amount of Carbon Monoxide pollutant was investigated at 6 locations and in each location, the air quality performance was examined. All the concentration values of Carbon Monoxide pollutant were checked with the reference of National Ambient Air Quality Standards (NAAQS) and the CO values were projected by means of CALINE4, AERMOD and SRMLS Model. From the research, it was concluded that SRMLS Model performs superior to the CALINE4 and AERMOD. The assessment of the viable dating among the Concentration of CO pollutant with the traffic parameters such as flow of traffic, classification of vehicles was done.

KEYWORDS-CO pollution, Modelling, Traffic parameters, CALINE4, AERMOD, SRMLS

Date of Submission: 18-07-2020 Date of Acceptance: 02-08-2020

I. INTRODUCTION

Clean air is essential for the health of people and the environment, and although significant improvements have been made in many countries over the last two to three decades, air quality — particularly in urban areas — remains a priority issue on most national environmental agendas [1].

In India, there have been a reduction in the quantity of vehicles whose age is over 15 years. Air pollution may be defined as any atmospheric condition in which certain substances are present in such concentrations that they can produce undesirable effects on man and his environment [2].

In the current investigation, it was discovered that motor vehicles play a significant reason for air pollution in urban areas. Transportation activities have been identified as a single major source of air pollution in urban areas [3]. The automobile engineers are working on the procedure to decrease crowding and improve the movement of vehicles conditions in urban roads which may decrease the environmental impacts on the nearby areas. Motor vehicles as a combined emission source make a significant contribution to the atmospheric pollution inventory; that contributed over 90% of CO emission in the urban area [4].

Concentrations of TRAPs (traffic-related air pollutants), including nitrogen oxides (NOx), volatile organic compounds (VOCs), carbon monoxide (CO), primary fine particulate matter (PM2.5), black carbon (BC), and organic carbon (OC), in particular, have been found to be elevated near heavily trafficked roads[5]. Emissions from motor vehicle operations near major roads have led to elevated concentrations of certain air pollutants, including carbon monoxide (CO); nitric oxides (NOx); nitrogen dioxide (NO2); coarse (PM10 –2.5), fine (PM2.5), and ultrafine (PM0.1) PM; black carbon (BC); and benzene near large roadways when compared with overall urban background levels[6]. Carbon Monoxide (CO) is one of the principal pollutants in the atmosphere and has an important

impact on the chemical production of tropospheric ozone [7].

With the identity of cities like Chengalpattu in Tamilnadu as fast-growing urban centres because it very closer to the capital town and additionally holds many industries, academic institutions and additionally many houses because of urbanization. In this situation, it very important to take a look at the ambient air first-class in that location. The Traffic is being motivated by way of few parameters analysed for figuring out 'Pollution Black spots' and recommending to take measures for controlling traffic for the relief of the problem. Comprehensive investigations had been directed for recognizing the causes for immoderate emissions from vehicles.

Modeling is a valuable alternative to characterize the influence of traffic-generated emissions on the temporal and spatial variability in air pollutant concentrations in the near-roadway environment [8]. In view of the requirement to use advance models that might assist in count on the quantity of pollution inside the city streets. The concentrations of pollutants in city streets and connections to be created to associate the automobile population, traffic parameters and emission factors. Many models have been devised to describe the dispersion of pollutants from roadways [9]. Several dispersion models for motor vehicle exhaust gas have been constructed [10]. The accuracy of this approach depends very much on the reliability of traffic data (traffic volume and velocity, their temporal and spatial variations, on road vehicle composition etc) and the choice of emission factors [11].

It has been observed from several studies that air pollution plays an important role in the genesis and augmentation of allergic disorder and it is described as a disease of civilized society [12]. A very large number of diffusion models have been proposed for air quality prediction of urban regions [13].

II. METHODOLOGY

2.1 STUDY AREA

In this study, the area chosen is from Tambaram to Chengalpet which is located on National Highway which connects from Chennai to Dindigul. These both areas are rapidly developing towns which is nearer to Chennai the capital city of Tamilnadu. These areas have a greater number of industries, educational institutions and more residential areas. Due to this, the range of motors has improved at some stage in the last few years. But these regions lack road infrastructure for transport which has induced extra effect to the surroundings. Due to lack of budget and time, the data accumulated collected was between Tambaram and Chengalpet. The location map of the study area was shown in the figure 1.

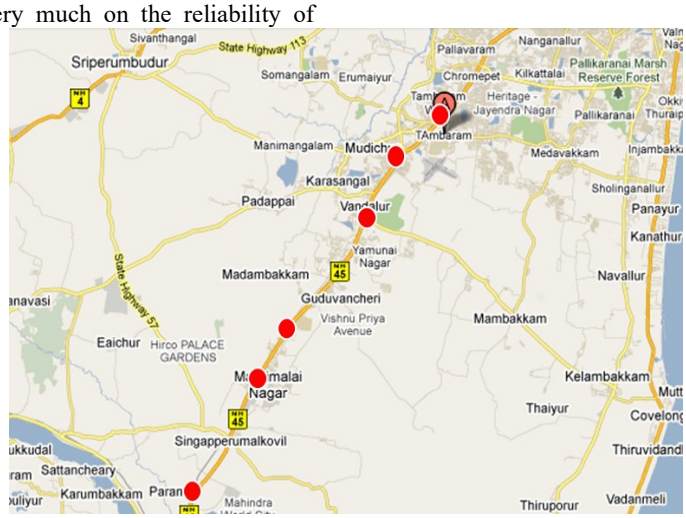

FIG.1 STUDY AREA
(Source: Googlemaps)

2.2 METHODOLOGY

Parameters which includes quantity of the vehicle's movement, speed of the cars, statistics concerning weather and amount of carbon monoxide pollutant had been accumulated manually and compiled as per necessities of the model version used. To gather the quantity of vehicles motion, each link guide approach turned into followed. Count of Different vehicles was taken between 0830hours and 1230 hours and also between 1430 hours and 1800 hours with regular time interval of each 15 min. The link traits of diverse link, as an example, the length and breadth of the connection, form of activity were likewise acquired by guide strategies.

To estimate the average speed of various vehicles, the velocity, the inspection of the speed changed into accomplished with the aid of writing down the quantity of the randomly selected motors on the road in which the possibility of stopping the vehicle in stretch couldn't be carried out. It can do on the access and go out of the lane. In this have a look at the Indian motors Carbon Monoxide emission norms (1996) became formulated by way of the Automotive Research Association of India (ARAI). CO emission of automobiles in every lane this is taken as weighted average emission is evaluated via multiplying the quantity of motors through type with corresponding emission component and need to sum it up.

To measure the speed of the wind and direction, a device known as Anemometer was used. To measure the temperature of the area, Digital Thermometer was utilized. To measure the amount of CO pollutant in the traffic, a portable multi gas monitor with digital display was used. Based at the atmospheric stability Class B and distance of downwind, Horizontal and vertical dispersion parameters were taken.

III. ANALYSIS AND DISCUSSION

The CO pollutant concentration was assessed by way of utilizing CALINE4, AERMOD and SRMLS Model. As the emission of automobiles is usually taken into consideration as major supply in air dispersion model. AERMOD, CALINE4 and SRMLS models were applied to foresee the traffic-based pollutants close to roadways. These models need to feed few information which involves traffic movement, emission factors from each vehicles and the meteorological factors.

3.1 Development of Possible Relationship among Concentration of CO Pollutant and Traffic Parameters

In order to create certain measures to control traffic, it is must to reduce the quantity of pollutants and it is very much needed to find out the possible relationship of pollutants with traffic parameters. Scatter plots have been created to have a connection among the concentration of Carbon Monoxide and types of vehicles. An investigation was made to find out the difference between the Carbon Monoxide pollutant concentration and traffic flow speed. Unsuitable measures of managing traffic, insufficient road structure and poor street conditions had been observed to result in interference to clean development of traffic, as cross back and forth activities.

3.2 SRMLS Model for estimating CO pollutant concentration

SRMLS models had been created thinking about flow of traffic, speed of traffic flow, petrol and diesel pushed cars as illustrative factors and watched CO pollutant concentration as needy variable (y). From this model, the observed SRMLS value versus Predicted SRMLS value for Carbon Monoxide pollutant was plotted in the graph. The graph is shown in figure 2.

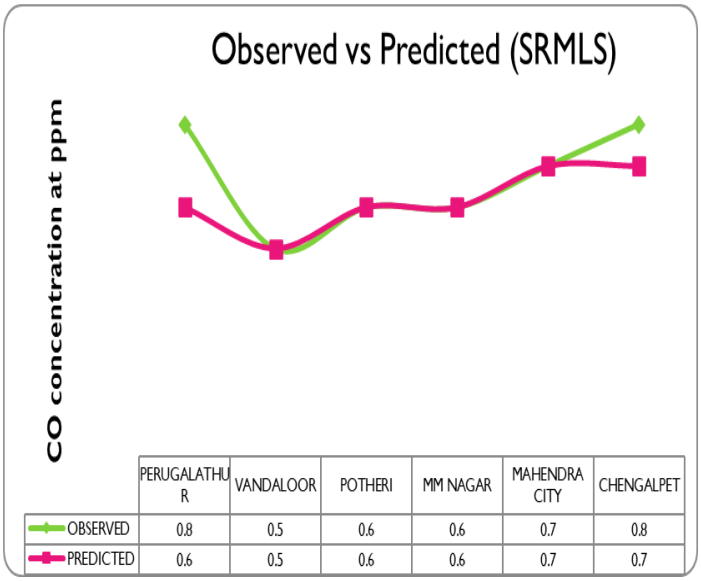

FIG. 2 OBSERVED VS PREDICTED(SRMLS) CO VALUE

3.3 Comparison of Performance of Models

SRMLS model values were observed to have a quite properly concurrence with the watched values than CALINE4. If there need to be an incidence of CALINE4, the CO values were seen as beneath anticipated. SRMLS model values were seen as near to the observed values. The explanation behind under expectation and over forecast might be because of varying wind speed, dispersion parameters and traffic flow. The approval of the models is completed through looking on the RMS Percentage errors. RMS Percentage errors of each models CALINE4, AERMOD and SRMLS models are determined by taking the observed CO and calculated CO values. From this examination it was seen that SRMLS Model are performing admirably in expectation of CO esteems than different models. High RMS Percentage error suggests the assortment of precise obstacles, which to be predictable after some time and space, must be taken into consideration. For developing dispersion parameters for Indian situations pollutant concentrations at various receptor allows need to be anticipated.

3.4 Air Quality Index

For every one hour the average CO pollutant concentration value was determined. In these 6 points investigated, it becomes located that air quality indices changed into used to evaluate the air great over distinct points. The result is expressed as percentage of applicable widespread of the pollutant. If the index is low, then the air quality will be better. The Air quality index is measured based upon the ambient air quality in every point.

3.5 Comparison of Link wise Ambient CO Concentration with NAAQS

The value of CO pollutant concentration at every point is measured and validated with the National Ambient Air Quality Standards (NAAQS). Amount of Ambient CO pollutant is four.0ppm in residential regions. The maximum one-hour average CO concentration was calculated over each point. It was found that in all six points the value of CO pollutant was below the standard value in NAAQS.

IV. CONCLUSION

The concentration of CO pollutant is located to be prolonged with the variety of vehicle. In any case, the attention of CO pollutant emerges as located to growth more with quantity of motorcycles than different form of vehicles. The concentration of CO pollutant is developing at the same time as there may be decrease in velocity of car due to the fact the vehicles will spend greater time during traffic. The high estimation of R^2 was detected between traffic capacity and the CO concentrations which shows that vehicles on the hyperlinks is definitely associated to the carbon monoxide concentration. SRMLS model is working best to the other models namely CALINE4 and AERMOD. This demonstrates models need to be adjusted together with various factors. Ambient air quality performance is evaluated over each one of the 6 points. The estimations have discovered that air quality is appropriate in any respect 6 points. The sort of model that is created for forecasting CO pollutant concentration is beneficial to create measures for controlling traffic.

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