Emission Inventory of Criteria Air Pollutants for Delhi

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Introduction

Delhi is one of the many megacities struggling with punishing levels of pollution from industrial, residential, and transportation sources. In the past one decade a lot of policies and regulations have been implemented which have had a noticeable effect on pollution levels. In this context, air quality models provide a powerful tool to study the impact of development plans on the expected air pollution levels and thus aid the regulating and planning authorities in decision-making process. In air quality modelling, emissions at regular interval are one of the most important inputs in the modelling domain. The primary aim of the present study is to develop an emission inventory of criteria pollutants using the primary and secondary information about the sources as domestic, industries, power plants and vehicles for Delhi. Three criteria pollutants namely, CO, NO_x, and PM10 are considered and a grided emission inventory with resolution of 2 km x 2 km over Delhi has been prepared taking into account land use pattern, population density, traffic density, industrial areas, etc.

Study area and Methodology

The study area made over the map of Delhi has been shown in Figure 1. Delhi is the capital and one of the most polluted cities in India.

The emission of pollutants due to domestic, industrial and power plants has been estimated through the information collected from concerned agencies/department.

However, vehicular emission has been estimated using three different methods. First two (i) and (ii) are based on empirical formulations (Goyal et al., 1998) and (iii) is through USEPA International Vehicular Emission (IVE model), which are as follows:

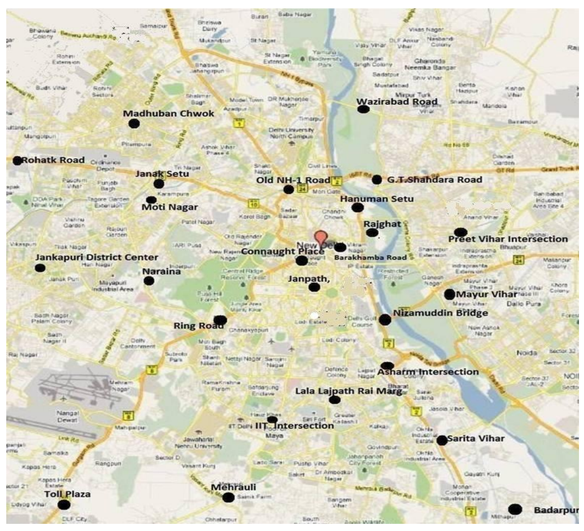

Figure 1: Delhi study area with CRRI monitored stations (source: www.mapmyindia.com).

Estimation of vehicular emission

- Method 1: $E_i = N_i \times ef_i \times VKT_i$ → N_i is the number of vehicle (DSH (2010)), VKT_i is vehicle kilometer travel per day (SIM series (July, 2008))
- Method 2: $E_{ij} = N_{ij} \times ef_i \times RL_j$ → N_{ij} is number of i^{th} category vehicle in j^{th} grid, RL_j is the road length in j^{th} grid
- Method 3: IVE model (IVEM, 2008)

Emission factor (g/km) in all three methods are based on ARAI (2007)

Results and Discussions

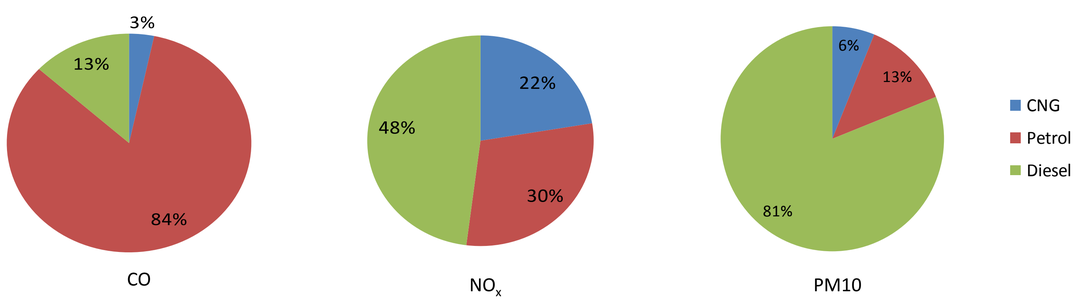

Figure 2: Percentage of different fuels for CO, No_x and PM10 in total vehicular emission

The emission of vehicles, running on different fuels has been studied and shown in Figure 2. The percentage of NO_x from CNG vehicles is found to be more in comparison to CO and PM10. Similarly, the petrol and diesel vehicles are the main source of vehicular emission of CO and PM10 pollutants.

The percentage share from each category of vehicles in total emissions has also been shown in Figure 3, which reveals that 2-wheelers are the main contributor of CO emissions. The Cars, HCV and 3 wheelers are the major contributor of NO_x emission. In addition, PM10 is mainly contributed by HCV and LCV.

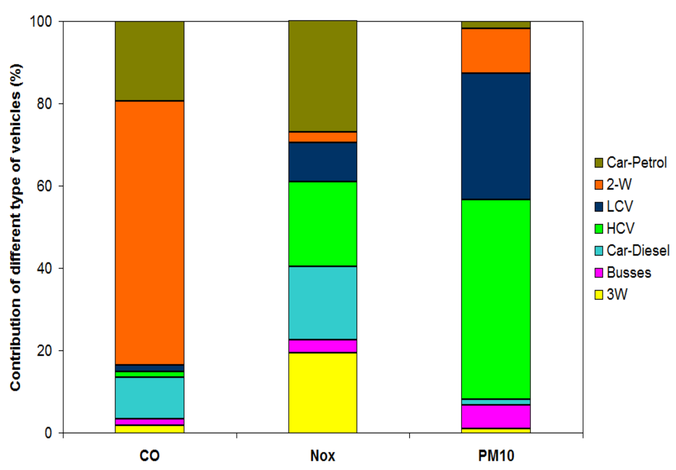

Figure 3: Contribution of different categories of vehicles in total vehicular emission

The vehicular emissions of all the three methods are compared with NEERI (2010) vehicular emissions of the base year 2007 in Table 1. Table 1 shows that vehicular emission of method 3 i.e., IVE model is showing the better agreement with NEERI (2010) emissions compared to other two methods.

Table 1: Comparison of estimated vehicular emission (tonnes/day) from present methods and past study

Pollutant	Method 1	Method 2	Method 3	NEERI (2010)
CO	291.56	276.73	252.76	217.80
Nox	152.98	110.42	97.54	85.00
PM10	14.45	13.67	12.05	9.70

The total emissions of CO, NO_x and PM10 are shown in Table 2. This table suggests that vehicular sources are the main contributor to CO emission. In addition, No_x and PM10 are mainly emitted by power plants and vehicular sources.

Table 2: Estimated Emission (tonnes/day) of all type of sources

Total emission	Vehicular sources	Power plants	Domestic sources	Industrial sources
CO (331.59)	252.76	13.99	59.88	4.95
NO_x (390.55)	97.54	228.15	40.53	24.32
PM10 (45.92)	12.05	29.45	2.88	1.52

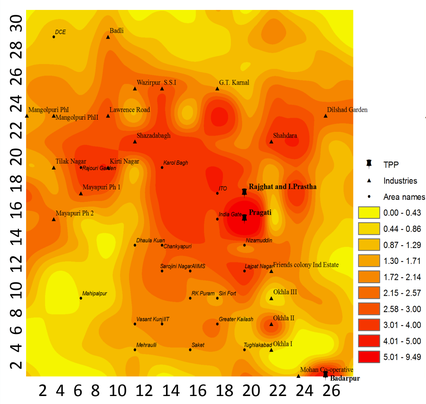

Figure 4 (a): Spatial distributionof CO emission from all type of sources in tonnes/day

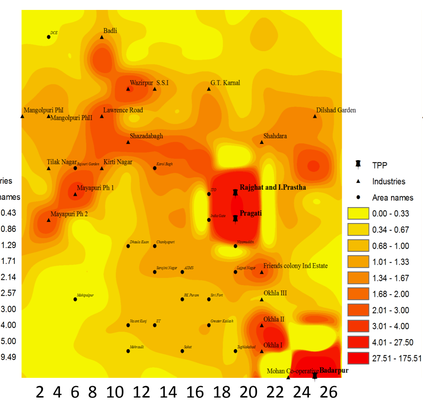

Figure 4 (b): Spatial distribution of NO_x emission from all type of sources in tonnes/day

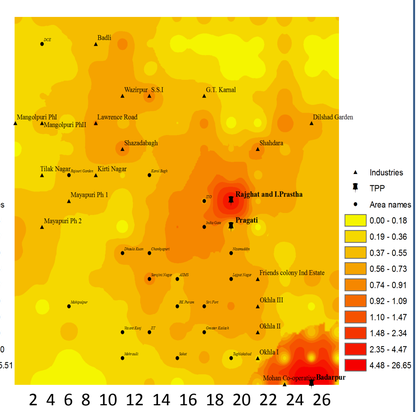

Figure 4 (c): Spatial distribution of PM10 emission from all type of sources in tonnes/day

The total emissions due to all type of sources are spatially apportioned in Figure 4. The CO emissions have higher values in those grids, where major traffic intersections are located. However, the higher values of NO_x and PM10 are estimated in power plants grids.

Conclusions

A 2008-09 emission inventory of CO, NO_x and PM10 has been prepared for Delhi.

Petrol and Diesel vehicles are the main contributor as 84% and 81% for vehicular emission of CO and PM10 respectively.

Vehicular source is found to be the main contributor as 76%, 26% and 25% of total CO, PM10 and NO_x emissions respectively. In addition, It is observed that 4.21% CO, 58.41% NO_x and 64.13% PM10 are contributed by power plants only.

The spatial plots of emissions are indicating the hotspots near the major traffic intersection for CO. However, power plants grids are showing the hot spots for No_x and PM10.

Annual emission estimates depend on the representativeness of specified emission factors and activity levels. There are no standards for estimating activity levels, and consistency must be established among independent studies and comparisons need to be made between measured ambient concentrations and those estimated from models in the inventories.

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