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# QUALITATIVE AND QUANTITATIVE EMISSIONS OF DIFFERENT VEHICULAR POLLUTANTS IN KHREW INDUSTRIAL AREA, KASHMIR.

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## ABSTRACT

*The on-road transport sector is one of the most important sources of pollutant emissions, as it is directly linked to economic growth. Transportation systems are increasing everywhere and the improvements in technology are insufficient to counteract growth. The present study of vehicular pollution in khrew Industrial area was carried out to determine the concentration of vehicular pollutants in different months from June to Nov 2017.The cement polluted area of khrew is situated 26 Kms away in the Southeast of Srinagar. There are number of cement factories in this area. The results obtained from are given in table 3, which shows the total emissions from different vehicles. The vehicular traffic is now recognized as one of the main sources of air pollution in this area and has noticeable impact on air quality. Emissions have been estimated using emission factor and activity based approach recommended by IPCC. The highest concentration of pollutants by different vehicles was recorded in summer (June) which can be attributed to the high vehicular load due to the various construction activities going on in this part of year, whereas the lowest was recorded in early winter (November). Vehicular emissions vary with type, efficiency and type of fuel used. Emission analysis based on the vehicle type reveal that buses and trucks contribute higher $CO_2$ ($CO_2$: 87.6.5%, CO: 71.09% Nox: 96.23).*

***KEY-WORDS**: Emissions, Vehicular, Pollutants, Industrial, Khrew, Kashmir*

## INTRODUCTION

Transport preludes the development of a nation. Economic development of a region depends on transport and it plays a very crucial role in urbanization. Energy consumption also varies with the modes of transport and public transport system has less average energy consumption per passenger per kilometer (Singh, 2006). With increase in traffic volume and change in travel related characteristics, vehicular emissions and energy consumption have increased significantly since two decades in India (Neshamani et al., 2006). Over the last two decades, number of registered vehicles has increased dramatically from 5.4 million in 1980-81 to 72.7 million in 2003-04 (TEDDY, 2006). Percentage of two wheelers has shown rapid growth (doubling in every 5 years) which constitutes 70% of total motor vehicles of India (MoSRTH, 2004).About 80% of passenger and 60% of freight movement depend on road transport (MoF, 2000). It is estimated that about 60-70% of total air pollution is caused by automobiles in all the major cities in India (Mishra 1998). The pollution from vehicles is due to discharge like CO, unburnt HC, Pb, NO2 and SO2 and SPM mainly from tailpipes (Dayal, 2011).

In cities road traffic contributes as much as 90-95% of CO ,60-70% of NOx and Hydrocarbons and a major share of SPM ( Mishra 1998). Road, rail and air are responsible for emission of 80%, 13% and 6% respectively (TEDDY, 2006). Emissions from vehicles accounts for about 60% of the GHG are from various activities in India (Patankar, 1991). Buses, omni buses, taxi, trucks, lorries, light motor vehicles (goods), trailers and tractors use diesel as a fuel, while as two wheelers, light motor vehicles (passenger), car and jeeps use gasoline. The present study of vehicular pollution in Khrew Industrial area was carried out to determine the type and quantity of different vehicular pollutants in different months from June to Nov 2017.

## MATERIALS AND METHODS

**Study area details**

The present study pertaining to vehicular load was carried out at Khrew area of district Pulwama .The cement polluted area of Khrew is situated 26 Kms away in the Southeast of Srinagar at an altitude of 1870 within the geographical co-ordinates of $34^0$ 1N' latitude and $75^0$ 1'E longitude. The area is surrounded by mountains on its north and east sides; sites exploited for limestone extraction for the production of cement. Across the Buthan hill it abuts the core area of Dachigam National Park.The natural vegetation in the study area is generally of herbs and dwarf shrubs. The vegetation on the upper reaches of the northern aspects holds *Pinus wallichina as* the major cover. On the slopes mostly shrubs are found scattered in patches wherever soil and moisture conditions are favourable.

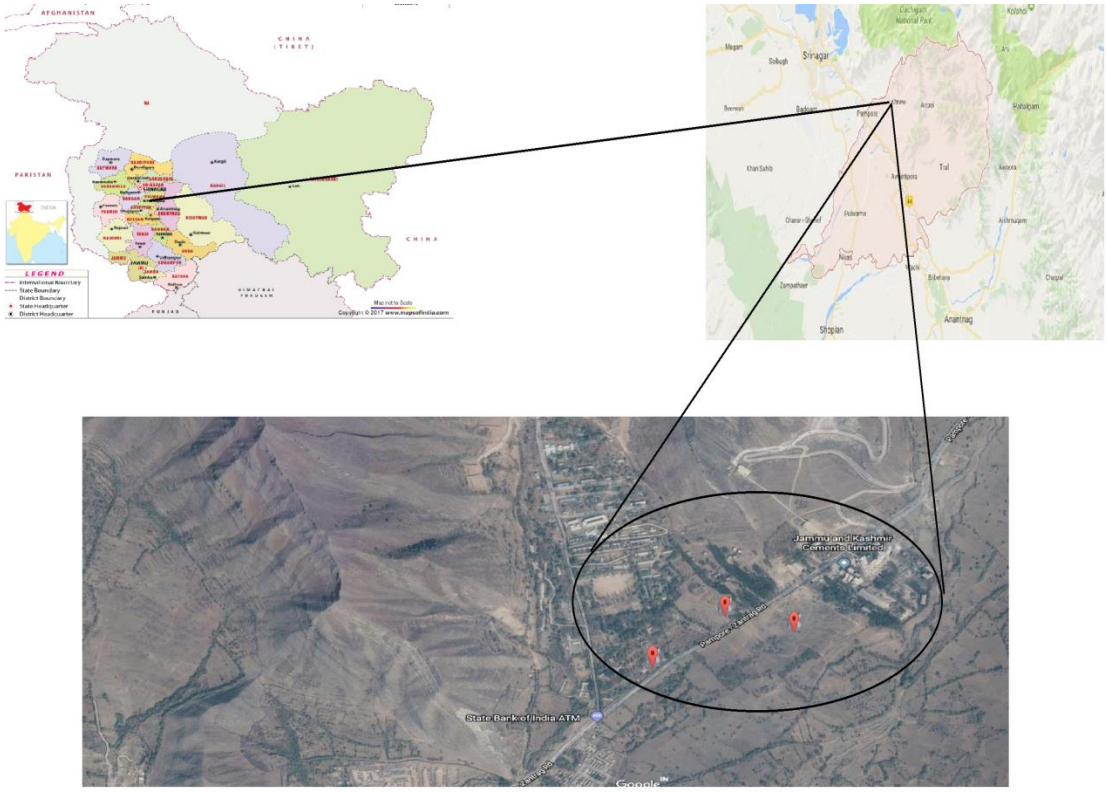


Fig 1: Outline map of study area.

## METHODOLOGY

The vehicular pollution analysis required handling of extensive amount of data .The following parameters were used for the study of the vehicular pollution and emission estimation.

**Survey**

Survey regarding the type and number of vehicles passing to and fro in the Khrew area was conducted by observing and recording the same for a particular span of time during every sampling .A stretch of road (10km) was selected for this study between Khrew and Zantrang. The total number of vehicles passing to and fro through this segment under different categories viz. two wheeler (2W) ,four wheeler gasoline(4WG), Direct injection of fuel (DI) and buses and trucks (B&T) was calculated.

The present study aims to estimate emissions of various pollutants (e.g., CO, NOX, SO2, PM, CH4, HC) from transport sector in Khrew industrial area from June to November 2017. Bottom–up approach was adopted, which is based on annual average fuel utilization for different vehicle category, number of vehicles and the corresponding emission factors (Gurjar et al., 2004). **Classification of vehicles**

A broad classification of vehicles for the purpose of emission inventory was made as:

1. Two Wheeler (2W).

2. Four Wheeler gasoline (4WG).
3. Four Wheeler diesel with direct injection of fuel (DI).
4. Heavy duty diesel vehicles (B&T).

**Vehicle population:**

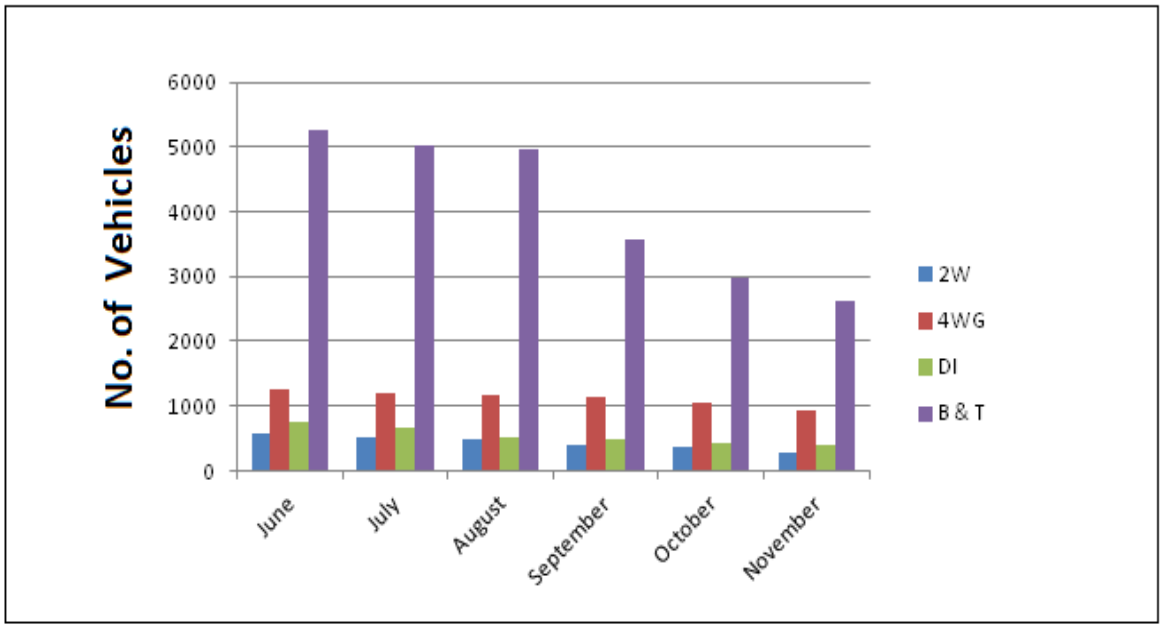


**Fig 2: Monthly variation in number of vehicles from June –November 2017.**

The number of vehicles ranged from 293 to 5262 as shown in figure 2 in a period of six months for 72 hours per month .The lowest (293) was recorded in the month of November by two wheelers (2W) and the highest was recorded in the month of June by buses and trucks (B&T).

**Quantification of emission**

Emissions from road were quantified based on the number of vehicles and distance travelled in a year per different vehicle type, which is given by ( Sahu et al., 2011).

$$Ei = \sum (Veh\ j \times Dj) \times Ei\ ,\ j,\ km.$$

Where,

Ei = Emission of compound (i);

Vehj = Number of vehicles per type (j);

Dj = Distance travelled per different vehicle type (j);

Ei, j, km = Emission of compound (i) from vehicle type (j) per driven kilomet

**Emission factors**

An emissions factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (U.S. EPA, 2009). Emission factors of various types of vehicles are compiled from previous studies and regulatory agencies (UNEP, 1999; Kandlikar and Ramachandran, 2000; EEA, 2001; Mittal and Sharma, 2003; ARAI, 2007; CPCB, 2010b) (Refer to Table 1 in Supporting Material, SM).

| POLLUTANT | Bus | Omni buses | Two wheelers (2W) | Light motor vehicles Passenger (DI) | Cars and jeeps (4WG) | Taxi | Trucks and lorries | Light motor vehicles | Trailers and tractors | | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **$CO_2$** | 515.2 | 515.2 | 26.6 | 60.3 | 223.6 | 208.3 | 515.2 | 515.2 | 515.2 | | Mittal and Sharma, 2003 |
| **CO** | 3.6 | 3.6 | 2.2 | 5.1 | 1.98 | 0.9 | 3.6 | 5.1 | 5.1 | | CPCB, 2007 |
| **NOx** | 12 | 12 | 0.19 | 1.28 | 0.2 | 0.5 | 6.3 | 1.28 | 1.28 | | CPCB, 2007 |
| **$CH_4$** | 0.09 | 0.09 | 0.18 | 0.18 | 0.17 | 0.01 | 0.09 | 0.09 | 0.09 | | EEA, 2001 |
| **$SO_2$** | 1.42 | 1.42 | 0.013 | 0.029 | 0.053[a] | 10.3[b] | 1.42 | 1.42 | 1.42 | | Kandlikar and Ramachandran, 2000 |
| **PM** | 0.56 | 0.56 | 0.05 | 0.2 | 0.03 | 0.07 | 0.28 | 0.2 | 0.2 | | CPCB, 2007 |
| **HC** | 0.87 | 0.87 | 1.42 | 0.14 | 0.25 | 0.13 | 0.87 | 0.14 | 0.14 | | CPCB, 2007 |

[a]Indian Institute of Petroleum (IIP), Automotive Research Association of India (ARAI) used in UNEP, 1999
[b]Mittal and Sharma, 2003

Table 1. Emission factors for road vehicles (g $km^{-1}$)

## RESULTS AND DISCUSSIONS

| Categories | $CO_2$ | CO | NOx | $CH_4$ | $SO_2$ | PM | HC |
|---|---|---|---|---|---|---|---|
| Two wheelers 2W | 703.28 | 58.14 | 4.99 | 4.72 | 0.31 | 1.3 | 37.52 |
| Cars 4WG | 15099.68 | 133.68 | 13.48 | 11.45 | 3.55 | 2.34 | 16.86 |
| Passenger cars DI | 1963.33 | 166.04 | 41.65 | 5.83 | 0.92 | 6.49 | 4.53 |
| Buses and trucks | 125672.71 | 878.12 | 1536.73 | 21.91 | 346.36 | 68.28 | 212.12 |

Table 2. Emission from different vehicle types (Kgs).

The present study of vehicular pollution in Khrew Industrial area was carried out to determine the concentration of vehicular pollutants in different months from June to Nov 2017. The results obtained from Khrew industrial area are given in table 3, which shows the total emissions from different vehicles. Vehicular emissions vary with type, efficiency and type of fuel used. Emission analysis based on the vehicle type reveal that buses and trucks contribute higher $CO_2$ ($CO_2$: 87.6.5%, CO: 71.09% Nox: 96.23%) compared to two wheelers ($CO_2$: 0.49%, CO: 10.81%, HC: 4.6%), passenger light motor vehicles ($CO_2$: 1.36%, CO: 13.43%, NOx: 1.9%) and cars ($CO_2$: 10.5% CO: 10.81% NOx :0.84% ) are different table 2.

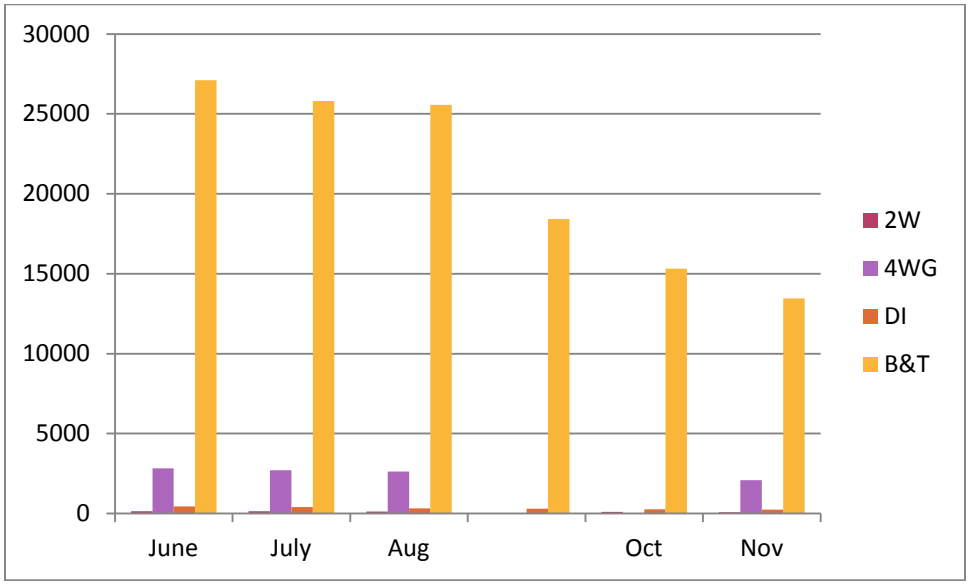


Fig 3: Monthly variation in $CO_2$ emission (Kg/10 Km stretch) by different vehicles

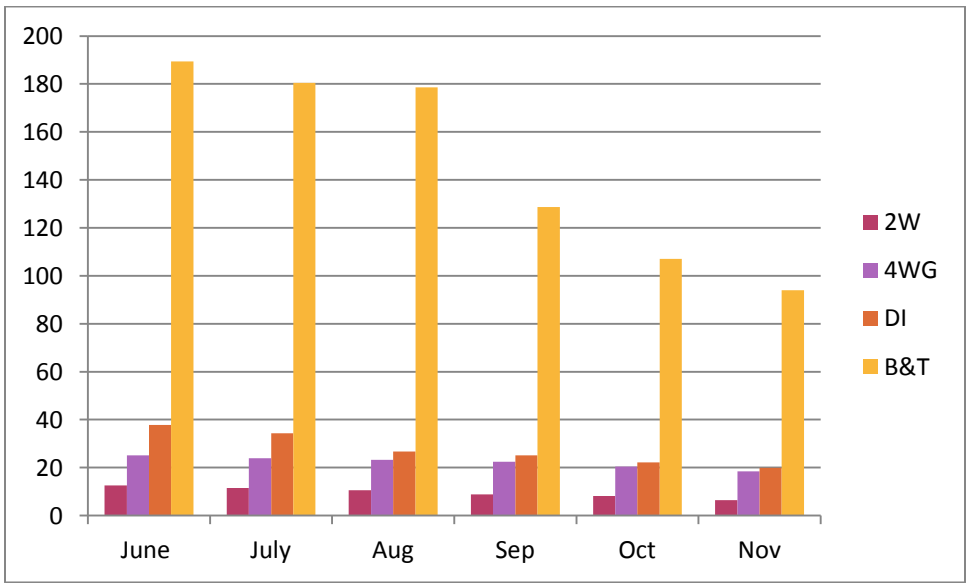


Fig 4: Monthly variation in CO emission (Kg/10 Km stretch) by different vehicles

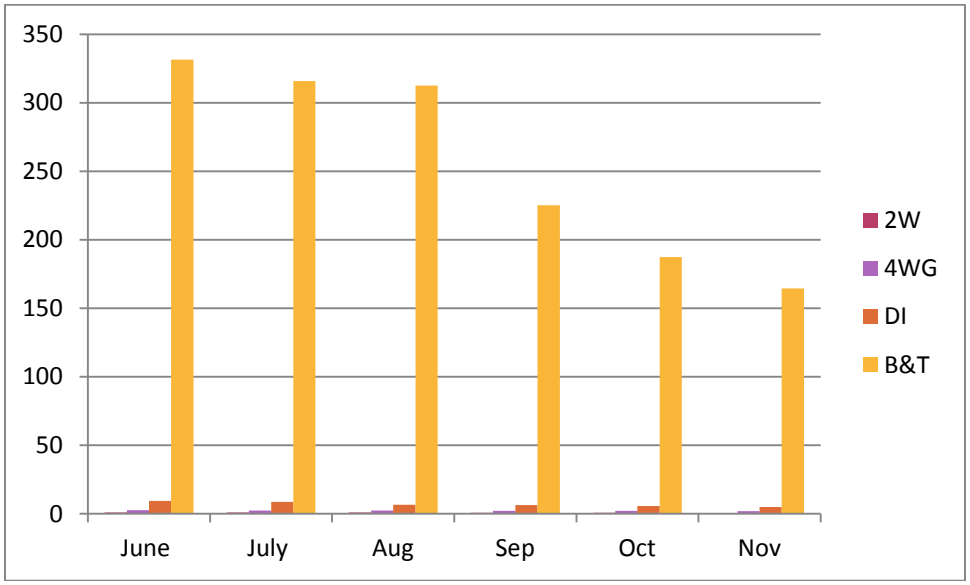


Fig 5: Monthly variation in $NO_2$ emission (Kg/10 Km stretch) by different vehicles

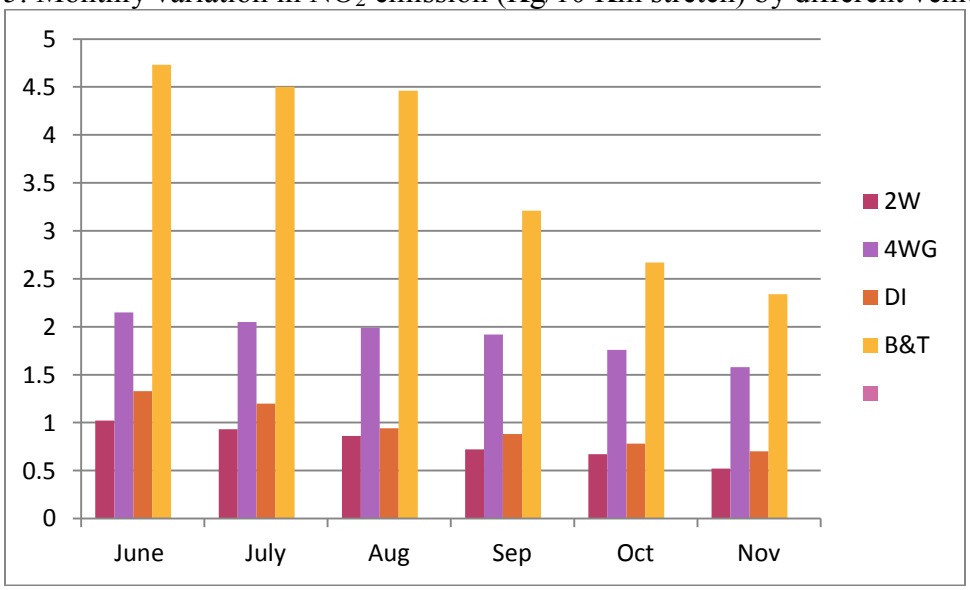


Fig 6: Monthly variation in $CH_4$ emission (Kg/10 Km stretch) by different vehicles

The total Carbon dioxide ($CO_2$) emissions ranged from 703.28kg to 125672.71kg by different types of vehicles (table 2). The lowest was in the month of November (77.93kg) by two wheelers and the highest emission was from Buses and trucks (27109.82kg) figure (3), which is due to the fact that buses and trucks were more in number and emisson factor for trucks is also on the higher side (table 1). $CO_2$ formation requires abundant supply of oxygen and the same is formed when the fuel is completely burnt. Of the total vehicular emissions, Carbon Dioxide contributes 97.56% which is in agreement with the study done by (Ramachandra 2009).The total Carbon Monoxide (CO) emissions ranged from 58.14kg to 878.12.kg by different types of vehicles (Table 2). The lowest was in the month of November (6.44kg) by two wheelers and the highest emission was from Buses and trucks (189.43kg) in June figure (4), which is due to the fact that Khrew being an industrial area harbours many cement factories and to

transport the cement, trucks are often used. The present contribution of CO to the total emissions is 9% higher than reported by (Guttikunda 2012).The reason could be due to less population of petrol driven vehicles than diesel vehicles, as carbon monoxide emissions from diesel engines is comparatively less. The total $NO_x$ emissions ranged from 4.99kg to 1536.73kg by different types of vehicles (table 2). The lowest was recorded in the month of November by two wheelers (2W) 0.55kg due to less number of two wheelers plying on the roads in harsh winters as people prefer to stay indoors, and the highest emissions was recorded in the month of June331.50kg by Buses and trucks (fig 5). $NO_X$ emissions from the present study are many times less than reported by (Ramachandra 2009; Guttikunda 2012). The total $CH_4$ emissions ranged from 4.72kg to 21.91kg by different types of vehicles (table 2).The lowest was recorded in the month of November by two wheelers ( 0.52kg) and the highest was recorded by B&T (4.73kg) fig 6.

The total $SO_2$ emissions ranged from 0.31kg to 346.36kg by different types of vehicles (table 2).The lowest was recorded in the month of November by two wheelers ( 0.038kg) and the highest was recorded by B&T (74.72kg) fig 7. The contribution of Sulphur dioxide (0.23%) towards total emissions is in agreement with the study done by (Guttikunda 2012) in Delhi metropolitan city. The total Particulate matter (PM) emissions ranged from 1.3kg to 68.28kg by different types of vehicles (table 2).The lowest was recorded in the month of November by two wheelers( 0.14kg) and the highest was recorded by B&T (14.73kg) fig 8.The total Hydrocarbons (HC) emissions ranged from kg to 212.12kg by different types of vehicles (table 2).The lowest was recorded in the month of November by Passenger vehicles (0.54 kg) and the highest was recorded by B&T (45.77kg) fig 9. The different types of vehicles showed monthly variations in the emissions of gaseous and particulate matter i.e. carbon dioxide, carbon monoxide, nitric oxide, sulfur dioxide, methane, hydrocarbons and particulate matter. This is because due to the variation in growth of vehicles and type of fuel fuel used.

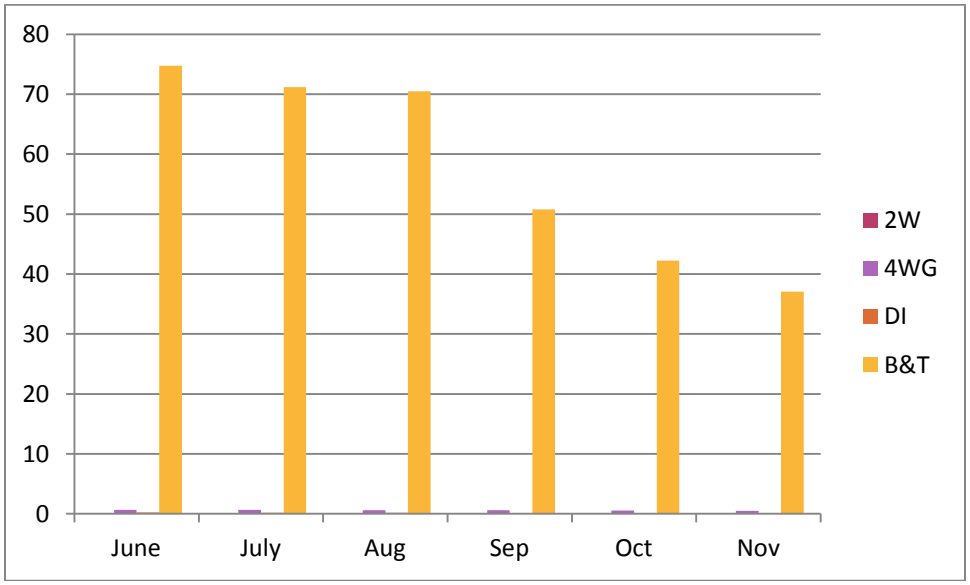


Fig 7: Monthly variation in $SO_2$ emission (Kg/10 Km stretch) by different vehicles

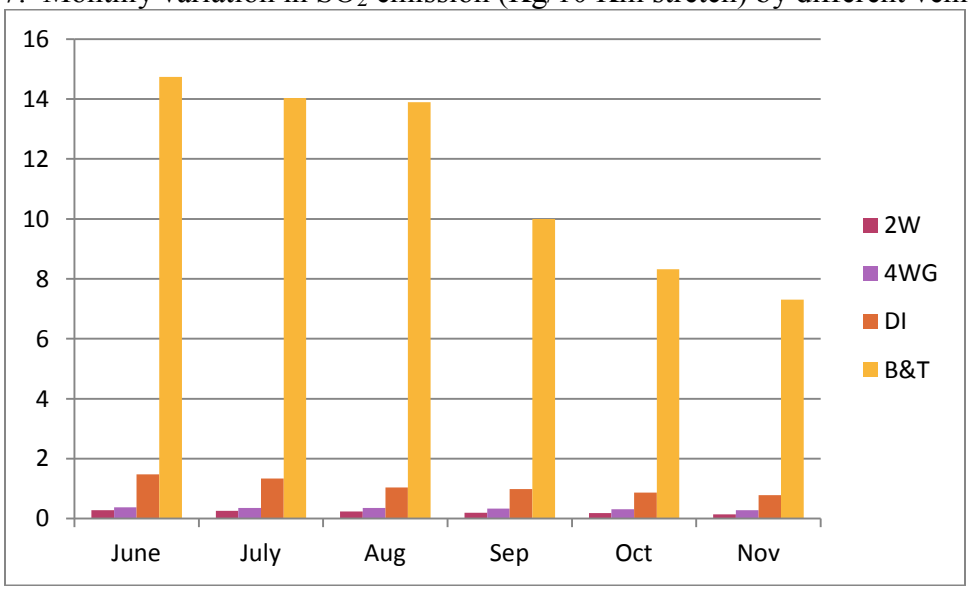


Fig 8: Monthly variation in PM emission (Kg/10 Km stretch) by different vehicles

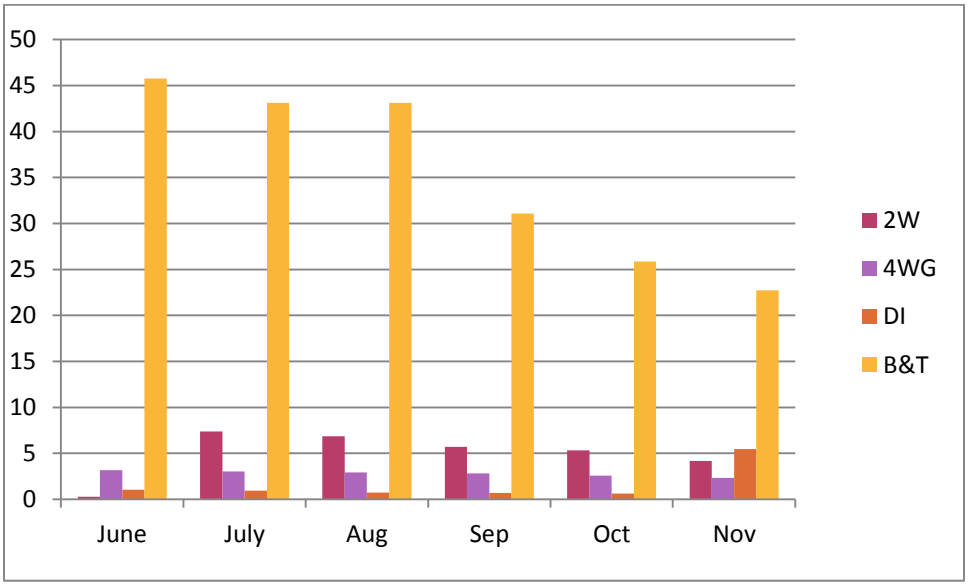


**Fig 9**: Monthly variation in HC emission (Kg/10 Km stretch) by different vehicles

## CONCLUSION

From the above discussion it has been found that the highest emission of pollutants was emitted by heavy duty buses and trucks The data also revealed that highest emission of pollutants in the summer season might cause more negative effect to the plants and trees especially to the road side vegetation as compared to control sites. Therefore phasing out of commercial vehicles older than 15 years and the conversion of buses taxis to compressed natural gas (CNG) are some of the reflecting policies of government to curb the increasing emissions from vehicles. Further the concerned authorities should check the PUC certificate of vehicles before entering a particular region .Plants that are efficient in absorbing the pollutants from vehicles need to be planted alongside the road to mitigate the harmful effects of pollution.

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