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Impact of Transpotation Activities on the Ambient Air Quality along the Mm University Road Network: A Case Study

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***Abstract**: Vehicles mainly consume non-renewable fossil fuels, and are a major contributor of green house gases, particularly CO_2 emission. Transport accounts for 26% of global CO_2 emissions and is one of the few industrial sectors where emissions are still growing. Relatively small amounts of carbon monoxide (CO), sulphur dioxide (SO_2), nitrous oxide (N_2O), lead (Pb) and hydrofluorocarbon (HFC) are emitted during the combustion of petroleum-based products in internal combustion engines. The present study involves the analysis of ambient air quality surrounding Maharishi Markandeshwar University (MMU). Due to rapid commercialization in the area the traffic load has greatly increased contributing to a large amount of vehicular emissions. Motorized vehicles namely, Buses, Tractor/Trolley, 2 Axle Truck, Cars, Motor Cycles and Auto Rickshaw were considered for the purpose of generating an emission inventory. Traffic frequency was collected for a period of 24 hours. Carbon Dioxide, Carbon Monoxide, Hydrocarbon, Nitrous Oxide, Lead, Sulphur Dioxide and particulate concentrations where obtained with the help of Highway Development Management (HDM- 4) Software. The study revealed that among the green house gases, carbon dioxide concentration is maximum with a concentration of 2.75 g/ vehicle km. Tractor/ Trolley, cars, motor bikes and auto rickshaws are contributors of the same.*

***Keywords:** HDM-4, greenhouse gasses, vehicle fleet, vehicular emissions*

I. Introduction:

Transportation systems are increasing everywhere due to globalization and liberalization. It is the largest consumer of commercial fuel energy and accounts for about 35% of the total liquid commercial fuel consumption by all sectors (Singh, A. et al. 2008). The number of road vehicles has increased by nearly 92.6% from 1980 to 2004. These vehicles mainly consume non-renewable fossil fuels, and are a major contributor of green house gases, particularly CO_2 emission (Ramachandra, T.V. 2009). Transport accounts for 26% of global CO_2 emissions and is one of the few industrial sectors where emissions are still growing (Chapman, L. 2009). Relatively small amounts of carbon monoxide (CO), sulphur dioxide (SO_2) and nitrous oxide (N_2O) are emitted during the combustion of petroleum-based products in internal combustion engines. In addition, lead (Pb) and hydrofluorocarbon (HFC) emissions are also included. Due to around nine times increase in the number of vehicles and four-fold increase in freight and passenger travel demands, gasoline and diesel consumption has increased drastically between 1980 and 2000 (Singh, A. et al. 2008). The largest sources of transportation emissions include passenger cars, light and heavy- duty trucks, pickup buses, minivans, auto rickshaws, motor bikes etc.

The air pollution around the university campuses has different sources, including the traffic activity, lab works and transportation from the surrounding areas. Universities spread over large areas are highly populated since they support educational, commercial and residential activities and a direct consequence of increase in population is a simultaneous increase in then vehicles. Thus the air quality around them need to me maintained so as to provide safe and healthy environment for the inhabitants.

II. Methodology:

Site Selection:

The institutional road network was selected for the analysis of ambient air quality surrounding Maharishi Markandeshwar University (MMU). The university is spread across approximately 200 acres situated in the village Mullana. It comprises of MM Hospital, MM Medical colleges, MM Engineering College, MM Institute of management and MM International School. Hostels, apartment facilities and market areas are also available. Due to rapid commercialization in the area the traffic load has greatly increased contributing to a large amount of vehicular emissions

Fig (1): MMU Main Road

Data Collection:

For the purpose of emission inventory, traffic frequency was collected for a period of 24 hours starting from 7:30 a.m till next morning 7:30. The mode of collection of traffic data was manual. The university petrol pump was chosen as the point of data collection. Both to and fro motion of vehicles was considered during counting. Although the university road also connects to nearby villages, maximum vehicles crossing the petrol pump was assumed to enter the university. Dominant vehicles contributing to emissions in the area comprise of university buses, trucks, tractor/trolley, cars, motor cycle and auto rickshaw. Necessary road data and vehicle fleet was also collected.

Data Analysis:

The vehicular emission inventory was generated through the Highway Development Management (HDM- 4) Software (The software requires various input data which will ultimately yield output through Project Analysis in the form of major air pollutants namely hydrocarbons, carbon monoxide, nitrous oxide, sulphur dioxide, carbon dioxide, particulates and lead**.**

III. Results And Discussions:

1. The 2.3 km road stretch linking the university campus with the Jagadhri highway was selected for analysis of the vehicular pollution and its effect on the environment with the help of HDM-4. The figure (Fig. 2) shows an interface of the software highlighting key features of the road network and traffic data consisting motorized and non- motorized vehicles in the form of Annual Average Daily Traffic.

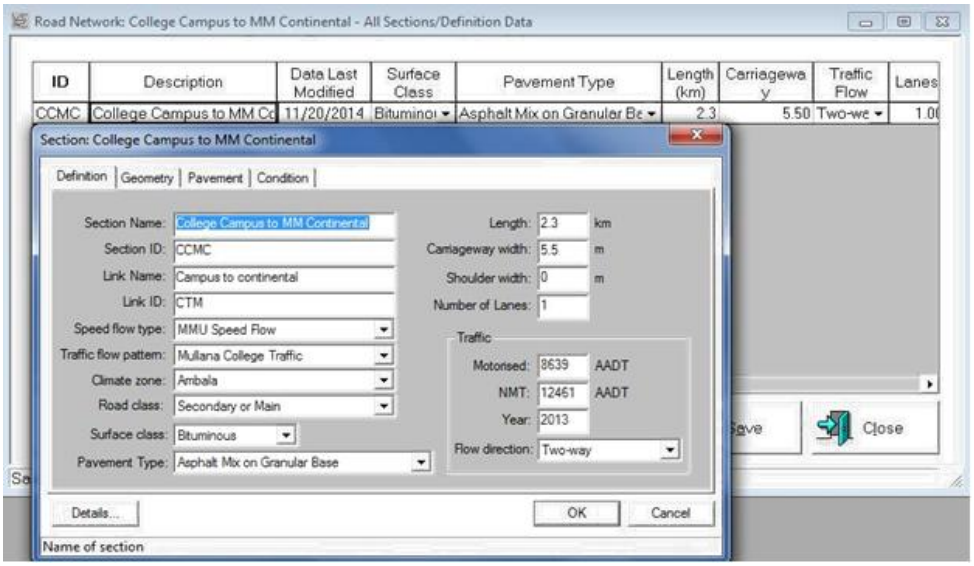

Fig (2): HDM-4 Window Highlighting Key Features of Road Network and Traffic Data

2. Vehicles are the major non-point mobile sources responsible for causing air pollution in the selected area since there are no industries in the vicinity. Motorized vehicles namely, Buses, Tractor/Trolley, 2 Axle Truck, Cars, Motor Cycles and Auto Rickshaw were considered for the purpose of generating an emission inventory. Since the university aims to go green, motorized vehicles are restricted beyond the parking zone. This was further justified during manual counting of around 12500 Non-Motorized vehicles (pedestrians and bicycles) crossing the site selected for the analysis. Table 1 shows the vehicle fleet on hourly basis for a period of 24 hours. Peak hours for traffic load were observed during the start and end of the working hours.

Table (1): Vehicle Fleet on Hourly Basis for a Period of 24 Hours

Time period	Buses	Tractor /Trolley	2 Axle Trucks	Cars	Motor Cycles	Auto Rickshaw
7:30-8:30	31	5	1	250	505	80
8:30-9:30	14	1	2	230	216	105
9:30-10:30	7	5	0	171	212	36
10:30-11:30	7	2	1	211	241	37
11:30-12:30	0	3	2	194	227	49
12:30-13:30	1	1	0	233	285	69
13:30-14:30	6	1	3	198	239	54
14:30-15:30	11	4	1	232	336	65
15:30-16:30	8	3	2	189	274	61
16:30-17:30	26	4	0	214	419	74
17:30-18:30	13	0	0	228	184	31
18:30-19:30	0	1	0	177	258	9
19:30-20:30	0	2	1	238	474	9
20:30-21:30	0	1	1	337	401	12
21:30-22:30	0	0	0	112	119	5
22:30-23:30	0	0	0	6	2	0
23:30-00:30	0	0	0	2	0	0
00:30-01:30	0	0	0	1	0	0
01:30-02:30	0	0	0	0	0	0
02:30-03:30	0	0	0	8	1	0
03:30-04:30	0	2	0	6	5	0
04:30-05:30	0	5	0	15	19	2
05:30-06:30	0	1	0	6	16	2
06:30-07:30	1	2	0	25	102	9

3. The vehicle fleet shows that out of the selected motorized vehicles, motorcycles are maximum in number. Cars fall second in the category of most used vehicle. A few trucks and tractor/ trolley were also found entering the university which can be attributed to the ongoing construction activities within the campus and nearby areas. For the convenience of students, staff and patients moving in the region auto- rickshaws are also frequent. Fig. 3 shows a graphical representation vehicular frequency in the study area over 24 hours.

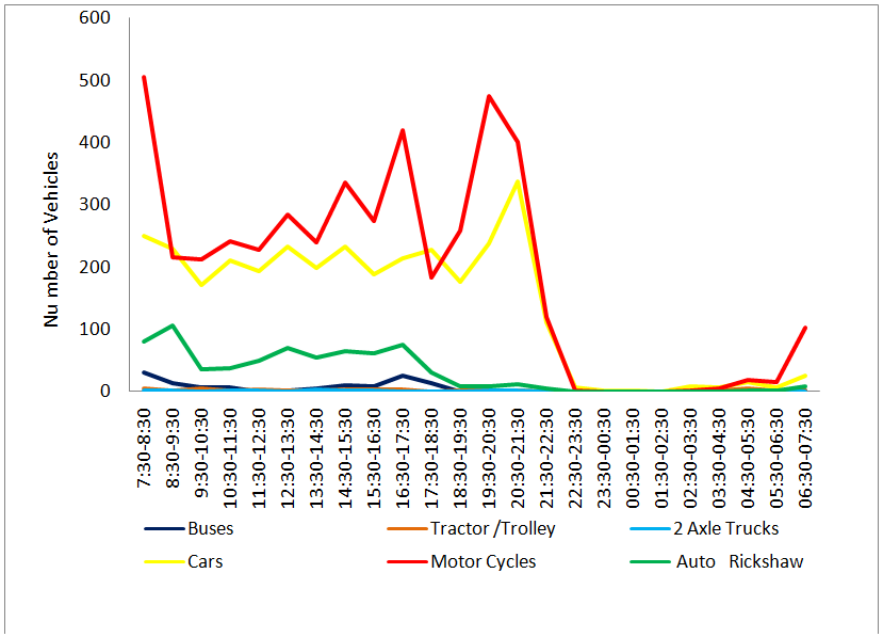

Fig. (3): Vehicular Frequency in the Study Area Over 24 Hours.

4. Emissions generated from the vehicles in the study area include Carbon Dioxide (CO_2), Carbon Monoxide (CO), Hydrocarbon (HC), Nitrous Oxide (N_2O), Lead (Pb), Sulphur Dioxide (SO_2) and particulates .The concentration of these emissions obtained by HDM-4 Software were plotted against each vehicle type (Fig.4) and a comparative analysis was done. 2 Axle Trucks were found to generate maximum amount of particulate matter and green house gases CO_2, N_2O and SO_2 while Tractor/ Trolley contribute most CO in the ambient environment. Hydrocarbon concentration in the region was also found high due to a frequent motion of motor bikes and auto rickshaws. Lead was also found in the air because of cars which happen to be the most common four wheeler.

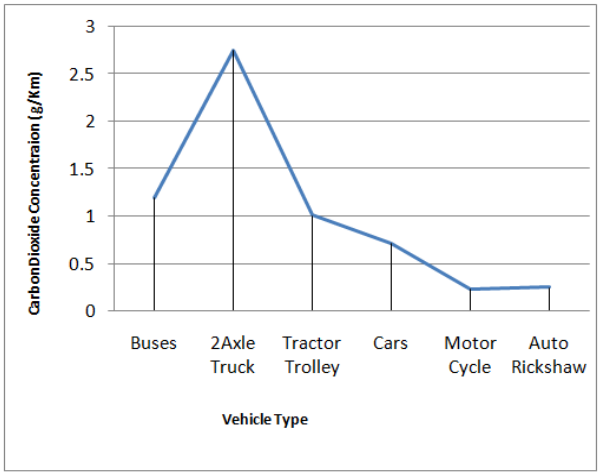

Fig.(4.1): CO_2 Concentration Against Vehicle Type

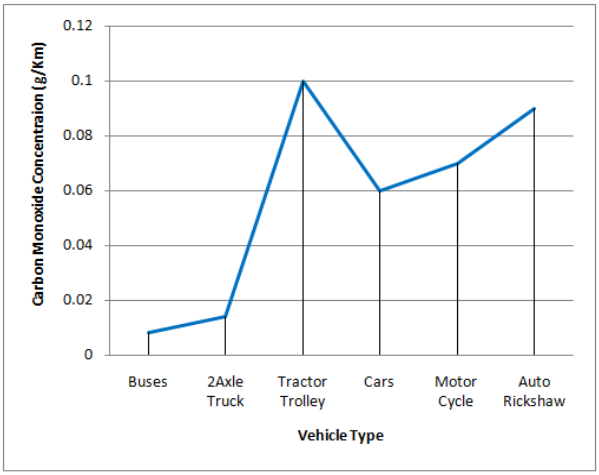

Fig.(4.2): CO Concentration Against Vehicle Type

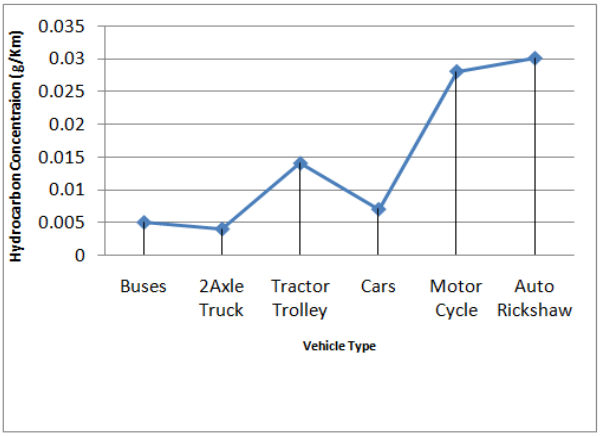

Fig.(4.3): Hydrocarbon Concentration Against Vehicle Type

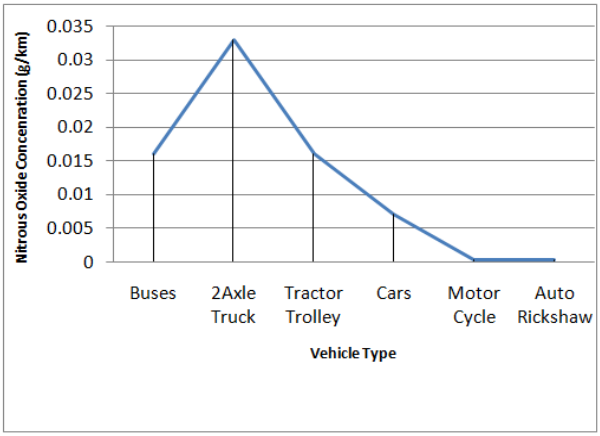

Fig.(4.4): N_2O Concentration Against Vehicle Type

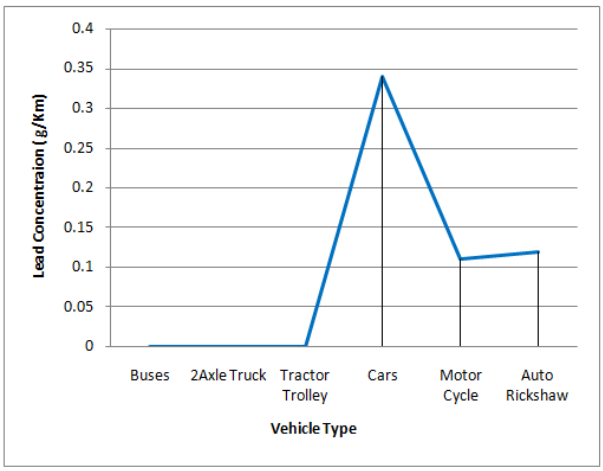

Fig.(4.5):Lead Concentration Against Vehicle Type

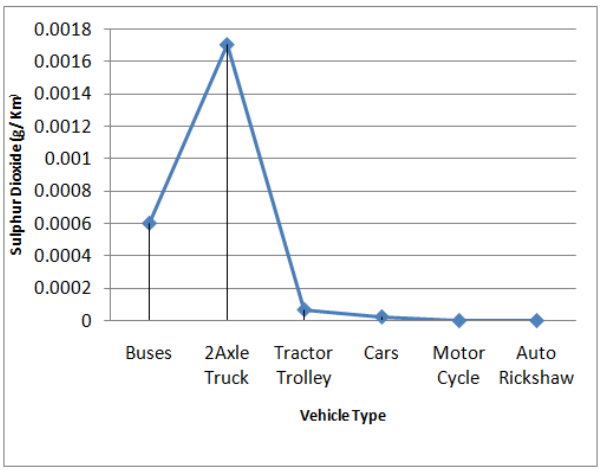

Fig.(4.6): SO_2 Concentration Against Vehicle Type

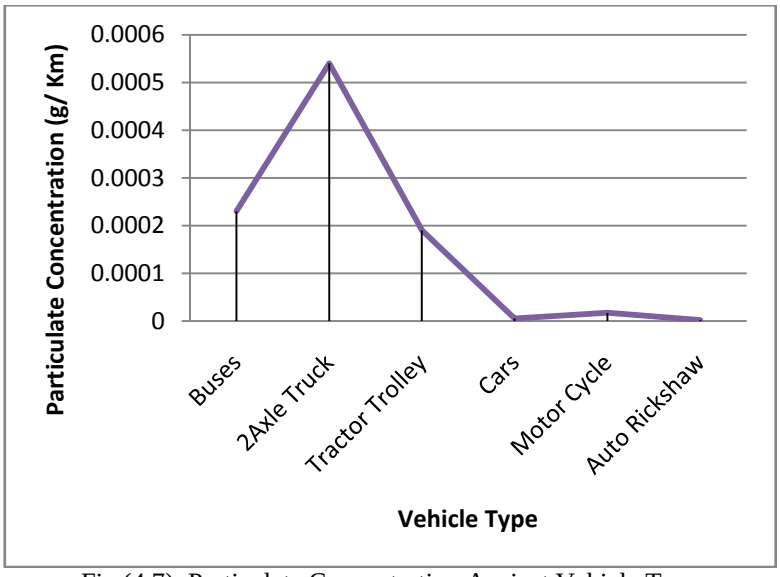

Fig.(4.7): Particulate Concentration Against Vehicle Type

IV. Conclusions

The emission inventory generated for the institutional road network of Maharishi Markandeshwar University shows that the ambient air in the region is polluted due to the transportation activities in the vicinity. The vehicle fleet shows that motor bikes and cars are among the most used vehicles polluting the air with lead, carbon monoxide and hydrocarbons. Among the green house gases, carbon dioxide is maximum with a concentration of 2.75 g/ vehicle km. Tractor/ Trolley, cars, motor bikes and auto rickshaws are contributors of the same. Carbon Monoxide released during incomplete combustion of fuel is also leading to air contamination. However, the air environment is of reasonable quality and can be further controlled by switching on to cleaner fuels like CNG.

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