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Effects of vehicular movement on environmental health: A case study of National Highway 148 B, Mahendragarh, Haryana

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Abstract
Over the past 50 years, global population growth and industrialization have led to environmental degradation. India is one of the developing nations where ongoing industrialization and urbanization in the name of development are leading to the deterioration of air quality day by day. Transport sector plays a significant role in development, but it also accounts for a growing proportion of air pollution. Considering the mounting evidence of the effects of air pollution on health, the present study was undertaken to assess the ambient air quality status near the highways. The samples were collected for particulate matter (PM_{10}), sulphur dioxide (SO_2), and nitrogen dioxide (NO_2) during pre-monsoon and post-monsoon for the year 2023 for the section of national highway 148B passing through Mahendragarh district, Haryana. The sampling sites were selected based on the aerial distance from the highway. In the present study, it is observed that nearby the national highways high concentration of pollutants was found due vehicular traffic. Residential areas adjacent to these roads receive the maximum input of traffic exhaust pollutants, converting them into a localized high pollution zone. The environment as well as human health are both adversely affected by air pollution. A negative association was found between the distance from the highways and the ambient air concentration of pollutants. As we move away from the highway, the pollutant concentration decreases, resulting in improvement in air quality.

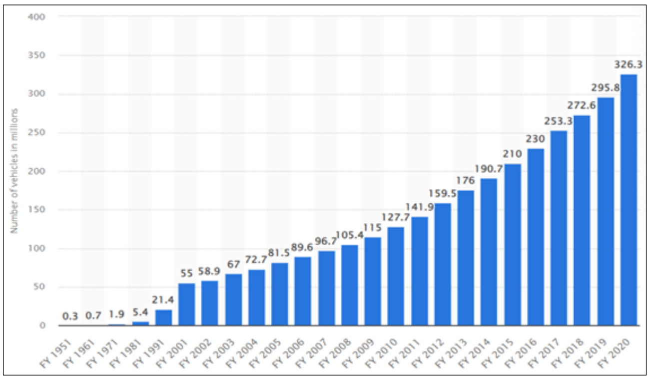
Keywords: Air quality monitoring, NAAQMS, AQI, PM_{10}, $PM_{2.5}$, SO_2, NO_2

Introduction

Globally, vehicles have played an important role in today's livelihood since their invention and continued to grow in popularity throughout the twentieth century. As they provide convenience, they also have some negative consequences, like air pollution and global warming. As populations and economies expand, countries across Asia have recorded soaring motorization growth (covering four-wheeled motorized vehicles), with increases of more than 200% in some countries during 2010–2019, as well as significant growth in two and three wheelers (Transport, Climate and Sustainability Global Status Report, 3rd edition, Asia Regional Overview).

In Asia, between 2000 and 2020, private vehicle ownership surged by approximately 1 billion vehicles, with two- and three-wheelers accounting for more than 75% of all private vehicles in low and lower middle-income countries. (Gota *et al*., 2022). Exponential growth in the number of registered vehicles in India from 0.3 to 326.3 million (FY 1951–2020) is shown in Figure 1 as per the Office of State Transport Commissioners/UT Administration report for the year 2021.

Road transport is the dominant mode of transport in India, both in terms of traffic share and contribution to the national economy. Apart from facilitating the movement of goods and passengers, road transport plays a key role in promoting equitable socio-economic development across regions of the country (MoRTH Annual Report 2021-22). Existing source apportionment studies (TERI 2016, TERI 2019) for the Delhi NCR region have found the main contributing sectors to PM 2.5 emissions to be transport, thermal power plants, medium and small industries, burning of agro-residue, burning of biomass, and open waste burning. For PM10, the main contributing sectors have been found to be construction dust and road dust. Emission from heavy-loaded and badly maintained automobiles contributes most to the air pollution problem in India (Trivedi *et al*., 2003) [13]. Road duty, high traffic density, and poorly maintained heavy vehicles and 2–3 wheelers are the major factors that seem to deteriorate the air quality of the region (Khanna *et al*., 2013) [4].



(**Source:** https://www.statista.com/statistics/1023507 /india-registered-vehicles-number)

Fig 1: Number of registered vehicles across India (FY 1951 to 2020) (in millions)

As per the WHO report (2022), air pollution is one of the greatest environmental risks to health. In 2019, 99% of the world's population lived in places where the WHO air quality guidelines were not met. 99% of the world's population breathes air that exceeds World Health Organization air quality guidelines (The State of Global Air Quality Funding 2022). India has been identified as the world's third most polluted country, as per the World Air Quality Report 2023 by Swiss organization IQAir.

As people's purchasing power increases, the number of vehicles continuously increases, which leads to an increase in traffic density. Air pollution from traffic poses a serious health threat to inhabitants living or working near busy roads. Emissions of pollutants in the air close to people's breathing zones pose a great risk to the environment as well as human health (WHO, 2020). Air pollution is the cause of a serious environmental health crisis in India. It was the third leading risk factor for mortality in India in 2017 (after dietary risks and high BP) as per the "Air Pollution in Gurugram: Causes, Effects, and Solutions Report, November 2020.".

Despite the increasing evidence of the negative impact of vehicular emissions on human and environmental health around National Highways, a gap was observed in the available data around the colonies living or set up in nearly NH. Such data is crucial and a prerequisite for studying health. Hence, this study was designed to collect samples of $PM_{2.5}$ and PM_{10}, SO2, and NO_2 along a section of NH148B in Mahendragarh district, Haryana, during the year 2023.

The Air Quality Index (AQI) is defined as a tool for analyzing and representing the air quality status of a city on a uniform basis. In many cities, air quality indexing is used by government agencies to determine the air quality, which enables the public to understand the environmental impacts.

The National Air Quality Index, launched by the Central Pollution Control Board (CPCB), shows an indicator of air quality standards and determines the possible health impacts on the basis of "one color, one code" for six categories: good, satisfactory, moderate, poor, very poor, and severe. The major air pollutants considered are particulate matter ($PM_{2.5}$ and PM_{10}), NO_2, NH_3, SO_2, CO, lead, and ozone. Here, the present study has been undertaken with the aim of determining the particulate matter, sulphur dioxide (SO2), and nitrogen dioxide (NO_2) levels in ambient air at different locations as per the arial distance from the highway section of NH148B. The study also presents the AQI near highways and creates awareness among the people.

Material & Methods

Study Area

Mahendergarh district is situated in the extreme south west corner of Haryana State. It lies between 27^0 48' to 28^0 50' north latitude and 75^0 56' to 76^0 52' East longitudes. Mahendergarh has five blocks named Ateli Nangal, Kanina, Mahendergarh, Nangal Chaudhary, and Narnaul and three sub tehsils i.e. Ateli, Kanina and Nangal Chaudhary. The district represents arid and semiarid climate, characterized by hot dry and windy summer, cold winters and humid warm monsoon season.

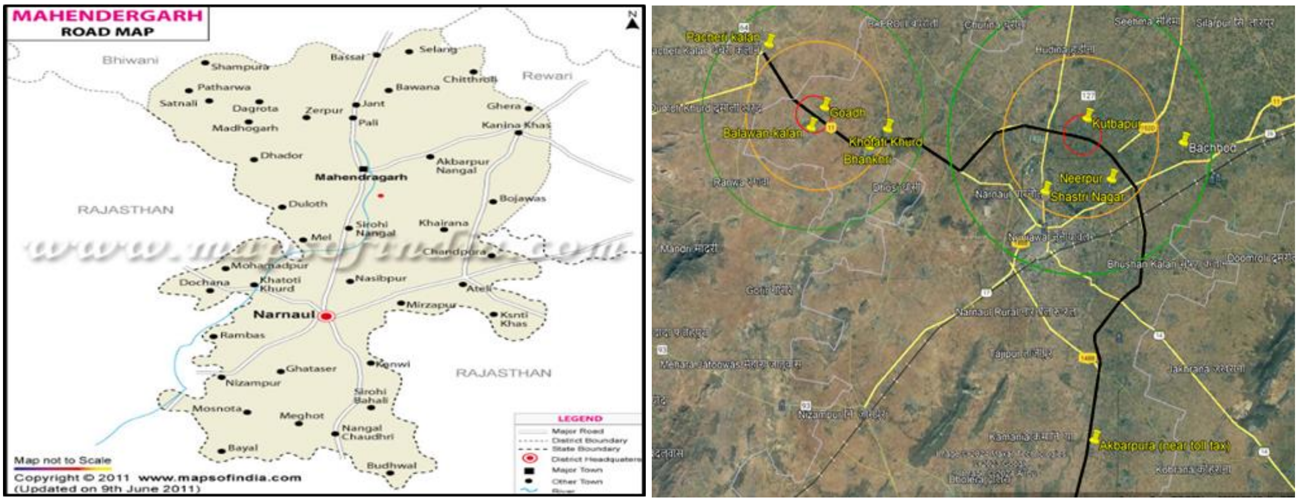


Fig 2: Showing Road map of Mahendragarh district, Haryana and Selected locations of NH148

Since it's an inland state, hence the transport system of Haryana is mainly road based, hence, also considered as veins and arteries of the state. Total number of national highways in Haryana are 40 covering a total length of 3,391.10 KM. Due to heavy traffic flow on these roads, the total road length increases from 3.99 lakhs to 63.31 lakhs from year 1951 to 2019 respectively showing 4.21% compound annual growth rate (MoRTH Annual Report, 2021-2022). For the purpose of air quality monitoring different locations were selected on the section of NH148 B, where 10 locations were identified on the basis of areal distance from the highway as shown in figure 2.

Sampling and analysis

The monitoring of ambient air was done in the pre-monsoon and post-monsoon seasons of the year 2023 at 10 selected locations. The PM_{10} samples were collected using a respirable sampler and $PM_{2.5}$ samples were collected using a fine-particulate sampler along with a gaseous sampling attachment (for SO_2 and NO_2). Monitoring was carried out at different locations of the section nearby NH 148B during pre-monsoon and post-monsoon 2023 using a respirable dust sampler (for measurement of PM_{10}), a fine particle sampler ($PM_{2.5}$), and a gaseous sampling attachment (for SO_2 and NO_2). Samples collected for monitoring were analyzed for different parameters prescribed by the Central Pollution Control Board, New Delhi.

Table 1: Methodology - at a glance

S. No	Parameters	Method of Measurement	Apparatus used for sample collection and analysis
1.	PM_{10}	Gravimetric methods	Respirable Dust sampler
2.	$PM_{2.5}$	Gravimetric methods	$PM_{2.5}$ Sampler
3.	SO_2	Spectrophotometric	Spectrophotometer
4.	NO_2	Spectrophotometric	Spectrophotometer
5.	AQI	Calculation: $I_p= [\{(I_{HI} - I_{LO})/ (B_{HI} - B_{LO})\} * (C_p-B_{LO})] + I_{LO}$	

Result and Discussion

Ten monitoring sites for sampling were selected on the basis of aerial distance from the highway, from which samples were further categorized into three categories for discussion and assessment of the impacts of vehicular emissions on environmental health, as follows

1. **Category I:** near highway (within 1 km) shows AQI under the poor category (201-300);
2. **Category II:** within 2 km to 3 km away from highways shows moderate (101-200); and
3. **Category III:** A rural area or more than 5 km away from highways shows good to satisfactory air quality, as shown graphically.

Relation between Ambient air quality and distance from highway

PM_{10} and $PM_{2.5}$ show higher mass concentrations near highways or adjacent to roads, which fall into Categories I and II. As the distance from the highway increases, the levels of PM_{10} and $PM_{2.5}$ decrease, and the AQI also falls from a satisfactory to a good category, so the sites fall into category 3. A similar study for monitoring ambient air was carried out by Khanna *et al.* (2013) [4] in 2010–2011, showing a relation between pollutants and traffic density, where pollutants concentration was highest in commercial areas and lowest in residential areas.

Near-road monitoring can be conducted to assess the impacts of transportation systems on local air quality pollutant concentrations, evaluate motor vehicle emission control initiatives, and highlight the (negative) implications of transportation sources on local human health and/or the environment. need for further regulatory action.

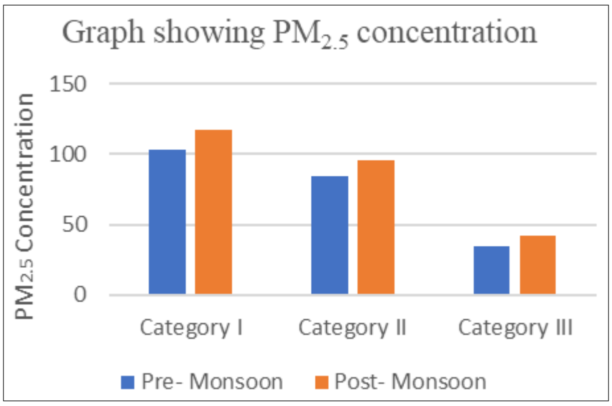


Fig 3: Month-wise mass concentration of $PM_{2.5}$

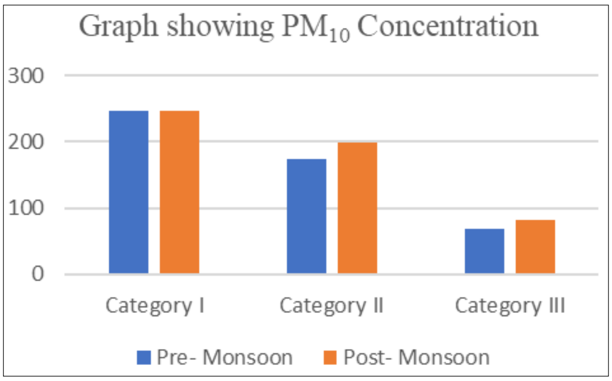


Fig 4: Month-wise mass concentration of PM_{10}

Particulate matter emitted through mechanical processes (brake wear, tire wear, re-suspended road dust) will tend to be in the particulate matter (PM_{10} & $PM_{2.5}$) fraction and can lead to elevated mass concentrations near highways/traffic junction. The particulate matter - PM_{10} & $PM_{2.5}$ concentration ranges from 68.12 to 247.62 μg/m^3 and 34.75 to 117.79 μg/m^3 respectively. The highest concentration of particulate matter was observed at Category I location. Similar study was carried out where this heavy concentration of population was found near highways due to rapid increasing vehicular traffic which shows vvehicles are majorly responsible for gaseous and particulate matter Emissions from Road Transport activity (Subramani *et al.* 2014 and Dutta, et. al 2021) [14, 1].

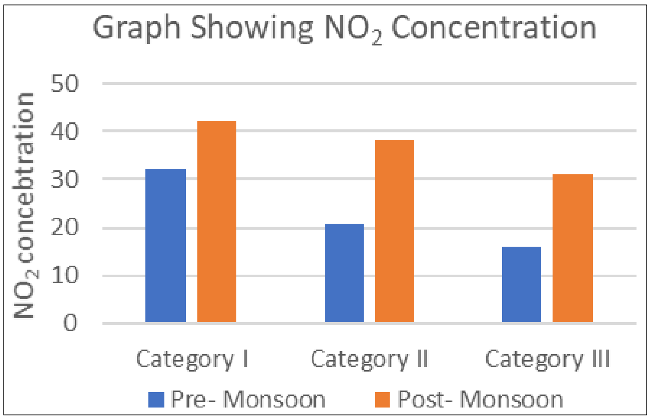


Fig 5: Month-wise mass concentration of NO_2

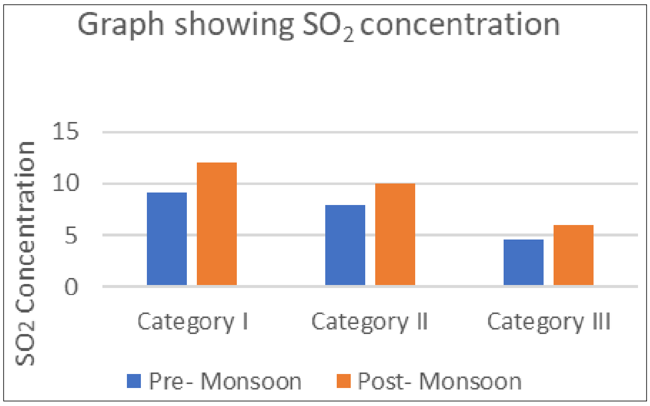


Fig 6: Month-wise mass concentration of SO_2

The gaseous pollutant concentrations of SO_2 and NO_2 were found below the permissible limits at all selected locations. The NO_2 and SO_2 concentrations ranged from 15.96 to 42.21 μg/m^3 and 4.58 to 12.41 μg/m^3 respectively, during the 2023 year. Similarly, NO_2 and SO_2 concentrations showed a slight decline in COVID duration (Singh *et al.*, 2021). And the Bhanarkar *et al.* (2002) [2] study also showed that the air pollution concentration in the Haryana sub-region for SO_2 and NO_2 was found below the permissible limits at all the locations. Though the decrease was significant as compared to other pollutant concentrations, the highest pollutant concentration was observed in Category I near highways and traffic sites and was lower in Category III.

Air Quality Index

Air Quality Index has been used for the ranking of overall air quality and also used as an easy way to understand pollution for common man, to create awareness among them.

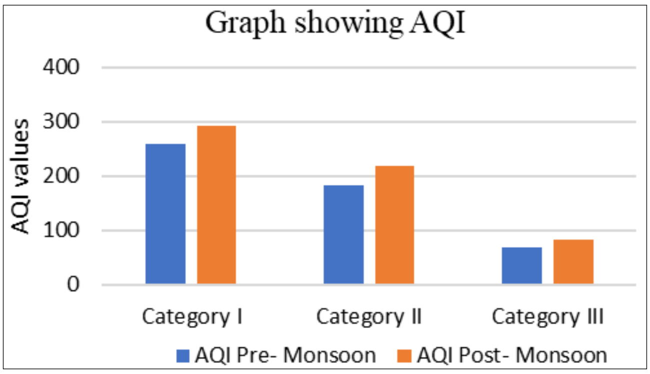


Fig 7: Graphical presentation of AQI showing pollutants

In category I, poor air quality was reported (near the highway, the AQI values were 201-300), category second shows moderate (101-200), and category third shows good to satisfactory air quality as per the index values in Table 2. A similar study shows that the AQI level is high because pollutants such as particulate matter (PM_{10} and $PM_{2.5}$) are the predominant cause of air quality deterioration near the traffic zone in the study area (Kala et. al. 2014) [6].

Conclusion

The annual average values (2023) of PM_{10}, $PM_{2.5}$, SO_2, NO_2, and AQI were 246 µg/m3, 110 µg/m3, 8.7 µg/m3, 37 µg/m3, and 275, respectively. The area nearby the section of NH 148 B (category I) shows a high level of pollutants (PM_{10}, $PM_{2.5}$, SO_2 and NO_2) in comparison to the area away from the highway. As we moved away approximately 2 km from NH 11 (category II), the pollutant concentrations declined, and the values for PM_{10}, $PM_{2.5}$, SO_2 and NO_2, and AQI were 64%, 71%, 80%, 78%, and 61%, respectively, in comparison to the values on the selected section of NH 148B. When the sampling location was placed ~ 5 KM away from the highway (category III), the pollutant concentrations further declined, and their values for PM_{10}, $PM_{2.5}$, SO_2, NO_2 and AQI were 28%, 32%, 55%, 65%, and 25%, respectively, when compared with the pollutant concentrations at selected highway sections. A negative association was found between the distance from the highways and the ambient concentration of pollutants.

It is concluded that vehicle transportation is one of the major causes of air pollution globally. The government is making an action plan to control air pollution, but it can actually be done if individuals take responsibility for cleaning planet Earth. In addition, planting more trees and reducing the use of vehicles can significantly help reduce air pollution levels. Further, the people should maintain a safe distance of at least 1.0 km from the highway to minimize the adverse health effects of vehicular movement.

References

1. Abhishek Dutta, Wanida Jinsart. "Gaseous and Particulate Matter Emissions from Road Transport: The Case of Kolkata, India", *Environmental and Climate Technologies*, 2021.
2. Bhanarkar AD, Gajghate DG, Hasan MZ. Air pollution concentration in Haryana sub region, India, Bull. Environ. Contam. Toxicol,2002:69:690-695.
3. Central Pollution Control Board, National Ambient Air Quality Standards (NAAQS), 2009.
4. DR Khanna, NS Nigam, R Bhutiani. Monitoring of ambient air quality in relation to traffic density in Barelly city (UP) India. Journal of Applied and National Science,2013:5(2):497-502.
5. International Day of Clean Air for blue skies, 2023
6. Jayshri Kala, Prof. Gunwant Sharma, Prof. Sudhir Kumar and Dr. Satish Pipralia (2014) "Study of Ambient Air Quality Status on Urban Roads using Air Quality Index -A Case of Jaipur City (Rajasthan, India)", International Journal of Theoretical & Applied Sciences,2014:6(1):138-147.
7. Ministry of Road Transport Highway - Annual Report 2021-22.
8. Office of State Transport Commissioners/UT Administration report (2021)
9. Road Transport Year Book publication 2019-2020).
10. S. Gota and C. Huizenga, 2022, Asian Transport 2030 Outlook, ADB.
11. TERI report 2016 & 2019.
12. Transport, Climate and Sustainability Global Status Report (3rd edition Asia Regional, 2023).
13. Trivedi s, Agarwal M, Rajput M. Trends in Sulphur dioxide and nitrogen dioxide concentration in and around Varanasi over theperiod 1989-2001. Indian Juornal Air Pollution Cont,2003:3(2):54-62.
14. T Subramani, S Arutselvan, SK Ganesan. Int. Journal of Engineering Research and Applications 4, Issue 6 (Version 5), 2014, 173-182.
15. The State of Global Air Quality Funding 2022.
16. World Health Organization (WHO), 2019; 2020 and 2023 report.
17. World Air Quality Report 2023 by Swiss organization IQAir.