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Impact of National Highway (NH-22) Expansion Activities on Ambient Air Quality in Mountainous Region

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ABSTRACT

The study was conducted to analyze the impact of highway expansion activity on air quality. The study area was divided into four equal sites based on distances viz. Site 1, Site 2, Site3 and Site 4. The observation on different air quality parameters at each site were recorded periodically (three times) at an interval of 15 days during pre-monsoon and post-monsoon seasons. The ambient air quality levels were compared with NAAQS standards. SO_2 concentration in the study area lies in between the range from 6.24 µg m^{-3} to 7.53 µg m^{-3}. NO_2 concentration in the study area varied from 16.82 µg m^{-3} to 26.98 µg m^{-3}. The highest SO_2 and NO_2concentration were observed in the post-monsoon season and lowest in the pre-monsoon season. The concentration of SO_2 and NO_2 lies within the permissible limits given by NAAQS in all the sites.

Key words: *Seasons, Physical, Construction, Concentration, Permissible, Ambient*

Introduction

Air pollution is one of the most acceptable environmental impacts during road construction. The impact of road widening project varies with the intensity of construction work (Walia *et al.,* 2017) and various operational stages. Road construction activities affect human wellness and the economic stability in a very severe matter. Generally, impacts on greenhouse gases footprint, acidification potential, human health, ozone depletion and impact on smog are various major environmental impacts of road construction (Marzouk *et al.,* 2017). The construction of roads is related with land clearing, ground excavation and cut and fills operation; ultimately produce particulate matter. Particulate matter is major sources of airborne ultrafine particles. Toxic chemical associated with air borne particulate cause diseases like asthma, heart rate variability and mortality. Moreover, Diesel exhaust is recognized as carcinogenic in nature while assimilation of ultrafine particles damage genetic material (Bruggs *et al.,* 2007) of organism. The purpose of present study is to assess the effects of highway expansion activities on air quality. The results of the study may be helpful to control the degradation level of air quality due to road expansion activities.

Materials and Methods

The study area (Fig. 1) lies in between 31°05'10" to 32 °10'50" North latitude and 76°57'05" to 70°07 '45" East longitude in the adjoining forest of Shogi- Shimla - Dhalli bypass realignment under NH-22 in districts of Solan and Shimla in Himachal Pradesh. The forest road is 51m wide and 27 km long. In order to assess the effect of highway expansion on air quality, the area was divided into four uniform segments based on distance viz. Site 1, Site 2, Site 3, Site 4 and each site was considered as replication. The observations on different air quality parameters at each site were recorded periodically (three times) at an interval of 15 days during pre-monsoon (April and May) and post-monsoon (October and November) seasons in the year 2018 and 2019. In total there were 8 treatment combinations (4×2) which were replicated three times under randomized block design.

To assess the ambient air quality, the air samples were drawn by using Respirable Dust Sampler (Model No MBLRDS-002). The data on ambient air quality was recorded for eight hours at each site during day time from 9.00 am to 5.00 pm. The ambient air quality monitored at different sites of the study area was interpolated by comparing with the National ambient air quality standards (MoEF&CC notification G.S.R 826(E), dated 16.11.2009).

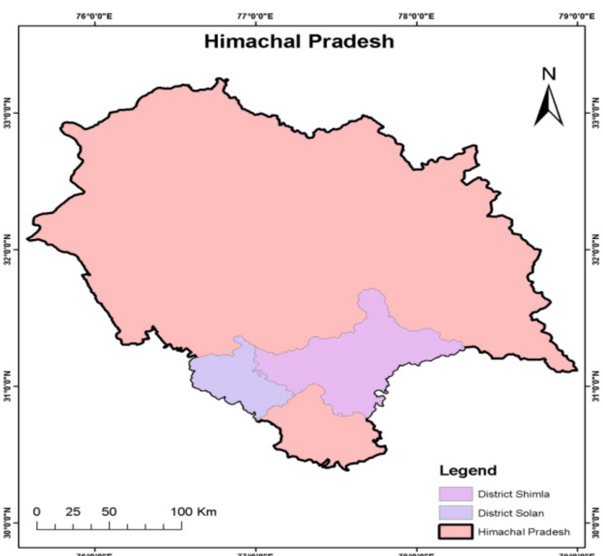

Fig. 2.1 Map showing the study area

Determination of sulphur dioxide in air

Determination of sulphur dioxide in ambient air was done by modified method (IS5182, part II) as given by West and Gaeke (1956). Sulphur dioxide from air is absorbed in a solution of potassium tetrachloro-mercurate (TCM).

Determination of Nitrogen Dioxide in air

Determination of Nitrogen dioxide in ambient air was done by modified Jacob and Hochheiser method IS, 5182 Part VI.

Interpretation of air quality

The ambient air quality monitored at different sites of the study area was interpolated by comparing with the National ambient air quality standards (MoEFCC notification G.S.R 826(E), dated 16.11.2009)

Statistical analysis

Statistical analysis under Randomized Block Design. Analysis of variance (ANOVA) was worked out and critical difference at 5% level of significance following Cochran and Cox (1967). Analysis of variance was done as per the model suggested by Panse and Sukhatme (2000). The data were analysed using MS-Excel, OPSTAT as per design of the experiment.

Results and Discussion

Distribution of Sulphur dioxide in the ambient air

The data presented in Table 1 that SO_2 concentration in the study area ranged from 6.24 µg m^{-3} to 7.53 µg m^{-3}. In the year 2018 seasons possessed a significant variation in SO_2 concentration with the highest (7.13 µg m^{-3}) observed in the post- monsoon season while lowest (6.45 µg m^{-3}) SO_2 was recorded in pre-monsoon. Irrespective of seasons, the highest (7.00 µg m^{-3}) SO_2 concentration was reported at Dhali which was statistically at par with (6.90 µg m^{-3}) at Majhhar, (6.72 µg m^{-3}) at Raghanv and lowest (6.55 µg m^{-3}) at Shunghal. The effect of two way interaction in between seasons and sites was found to be significant. Significantly, highest (7.35 µg m^{-3}) SO_2 concentration was noticed at Dhali in the post-monsoon season and lowest (6.24 µg m^{-3}) at Shunghal in the pre-monsoon season respectively. Similarly, the same pattern was observed in the year 2019 with respect to season. The seasonal variation in SO_2 concentration in the study area indicated the highest (7.35 µg m^{-3}) SO_2 in the post- monsoon season while lowest (6.81 µg m^{-3}) was recorded in the pre-monsoon season. Whereas, among sites it was found that the highest (7.40 µg m^{-3}) SO_2 concentration was recorded at Dhali statistically at par with (7.09 µg m^{-3}), at Majjhar, (7.02 µg m^{-3}) at Raghanv and lowest (6.83 µg m^{-3}) was observed at Shunghal. The most important sources of sulphur dioxide were emission from vehicles due to burning of fossil fuels and vehicle exhaust in the air. The effect of two way interaction between seasons and sites was found to be significant. Significantly, highest (7.53 µg m^{-3}) SO_2 concentration was registered at Dhali in the post- monsoon season while the lowest (6.47 µg m^{-3}) concentration of SO_2 was noticed at Shunghal in the pre-monsoon season respectively. The combined effect of three way interaction sites x season x year revealed significant variation in the concentration of sulphur dioxide in the air. The highest (7.53 µg m^{-3}) SO_2 was noticed in post-monsoon season at Dhali in 2019 while the lowest (6.24 µg m^{-3}) So_2 was reported in pre-monsoon season at Shunghal along the national highway in 2018. The pooled effect of both the years in the respective area revealed that season possessed variation in SO_2 concentration monsoon season. The highest concentration of SO_2 in post- monsoon season might be due to incomplete combustion of fuels, biomass burning and chemical changes during the interaction in between gases in the dry season. The results were in line with the study of Chao *et al.* (2014). The data further showed that among different sites, that the highest (7.20 µg m^{-3}) SO_2 concentration was reported at Dhali which was statistically at par with (6.99 µg m^{-3}) at Majjhar, (6.87 µg m^{-3}) at Raghanv and lowest (6.69 µg m^{-3}) was observed at Shunghal. The two way interaction seasons x sites was found to be significant with respect to SO_2. Significantly, highest (7.44 µg m^{-3}) SO_2 concentration was noticed at Dhali in the post- monsoon season while the lowest (6.36 µg m^{-3}) at Shunghal in the pre-monsoon season respectively.

Distribution of NO_2 in the ambient air

The data given in Table 2 revealed that NO_2 concentration in the study area ranged from 16.82 µg m^{-3} to 26.98 µg m^{-3}. In the year 2018 seasons showed significant trend in NO_2 concentration in the study area with the highest (24.52 µg m^{-3}) NO_2 was recorded in the post- monsoon season while the lowest (21.29 µg m^{-3}) concentration was recorded in the pre-monsoon season. Among different sites irrespective of seasons, the highest NO_2 concentration of 25.74 µg m^{-3} was noticed at Majjhar which was statistically at par with (24.34 µg m^{-3}) at Shunghal, (23.41 µg m^{-3}) at Dhali while the lowest (18.14 µg m^{-3}) concentration was recorded at Raghanv. The two way interaction

Table 1. Seasonal variations in concentration of SO_2 (µg m^{-3}) at different sites

	2018			2019			Pooled		
	Pre-monsoon	Post-monsoon	Mean	Pre-monsoon	Post-monsoon	Mean	Pre-monsoon	Post-monsoon	Mean
Shunghal	6.24	6.86	6.55	6.47	7.19	6.83	6.36	7.02	6.69
Raghanv	6.35	7.09	6.72	6.78	7.25	7.02	6.56	7.17	6.87
Majhhar	6.55	7.24	6.90	6.73	7.44	7.09	6.64	7.34	6.99
Dhali	6.65	7.35	7.00	7.27	7.53	7.40	6.96	7.44	7.20
Mean	6.45	7.13	6.79	6.81	7.35	7.08	6.63	7.24	6.94
$CD_{0.05}$	Sites		: 0.04	Sites		: 0.06	Sites		: 0.03
	Season		: 0.03	Season		: 0.04	Season		: 0.02
	Sites x Season		: 0.05	Sites x Season		: 0.09	Sites x Season		: 0.05
							Sites x Season x Year		: 0.07

Table 2. Seasonal variations in concentration of NO_2 (µg m^{-3}) at different sites

	2018			2019			Pooled		
	Pre-monsoon	Post-monsoon	Mean	Pre-monsoon	Post-monsoon	Mean	Pre-monsoon	Post-monsoon	Mean
Shunghal	25.24	23.44	24.34	26.69	26.98	26.84	25.97	25.21	25.59
Raghanv	16.82	19.46	18.14	25.07	26.17	25.62	20.94	22.82	21.88
Majhhar	21.92	29.56	25.74	22.14	26.34	24.24	22.03	27.95	24.99
Dhali	21.18	25.63	23.41	25.59	25.78	25.68	23.39	25.71	24.55
Mean	21.29	24.52	22.91	24.87	25.32	25.60	23.08	25.42	24.25
$CD_{0.05}$	Sites		: 3.19	Sites		: NS	Sites		: 2.25
	Season		: 2.26	Season		: 2.46	Season		: 1.59
	Sites x Season		: NS	Sites x Season		: NS	Sites x Season		: NS
							Sites x Season x Year		: NS

was found to be non-significant in between season and site.The same pattern was noticed during second year 2019, the significant variation in NO_2 concentration with respect to seasons in the study area showed the highest (24.87 µg m^{-3}) in the post- monsoon season while the lowest (26.32 µg m^{-3}) NO_2 was observed in the pre-monsoon season whereas; the season and the site resulted into a non-significant interaction. The non-significant effect was found during three way interaction of year x season x site.The pooled effect of both the years found significant impacts of seasons in the NO_2 concentration. The highest (23.08 µg m^{-3}) NO_2 was reported in the post- monsoon season while the lowest (26.32 µg m^{-3}) was recorded in the pre-monsoon season. The maximum concentration of NO_2 in the post- monsoon season could be due to changes in some climatic conditions such as lowering of mixing height and less precipitation which helps in the deposition of NO_2 in post- monsoons as compared to the pre-monsoons. The results are similar to the outcomes of Jain and Sexena (2002) who had also found highest concentration of NO_2 in the post- monsoon seasons. The data further showed that the highest (25.59 µg m^{-3}) NO_2 concentration was observed at Shunghal statistically at par with (24.99 µg m^{-3}) at Majjhar, (24.55 µg m^{-3}) at Dhali and lowest (21.88 µg m^{-3}) was noticed at Raghanv. The maximum NO_2 concentration in Shunghal may be due to oxidation of NO which might have deposited in the ambient air because of scanty rains, low relative humidity and high average day temperature. The results are in conformity with the outcomes of Majumder *et al*. (2008) and Weng and Yang (2006) who have also found intense vehicular density and in conjunction with poor vehicle and fuel quality with less efficient catalytic converters as the main source of NO_2 emissions in the ambient air. Further the two way interaction in between season x site was observed to be non–significant.

Conclusion

The study revealed that the spatial and seasonal changes in pollutant level during highway expansion have started to influence the air of the region. The highway expansion activities havedo not significant effect on ambient air quality. To mitigate the adverse effect of highway expansion activities, air quality monitoring should be carried out during and post-construction phase at least once in a season.

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Conflict of Interest

There is no conflict of interest for this manuscript.

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