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Assessment of Ambient Air Quality in the Campus of University of Horticulture and Forestry Nauni-Solan Himachal Pradesh

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Abstract

The present study aims at finding out the seasonal variation of air quality parameter in the campus of University of Horticulture and Forestry, Nauni and calculate the air quality index (AQI) by selecting four sites namely traffic, residential, farming and forest. The air quality parameters under study were TSPM, PM_{10}, NO_x, SO_2 and VOCs. For all the air pollutants, the maximum concentration was found at traffic area while the minimum concentration was found at forest area. The pollutant concentration was highest at traffic followed by residential, farming and forest sites. Seasonally, the concentration was highest during autumn followed by summer and monsoon. The AQI of the campus ranged from good to moderate. The highest AQI was observed during autumn at traffic site while the lowest AQI was observed during monsoon at forest site. Seasonally, monsoon showed the best air quality while the autumn showed the highest AQI. The AQI of traffic showed a moderate air quality during all the three seasons while the rest of the study areas showed a good air quality. The study revealed that the concentrations of the air quality parameters were within the permissible limits in the University campus. However, the traffic site had the highest concentration of the pollutants and also showed a moderate air quality index.

Keywords: Horticulture; Nauni; Air Quality Index; Air pollution

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Introduction

Air pollution is now a serious worldwide public health problem. Developmental activities like industrial expansion, mining exploration, transportation and constructional works etc. cause degradation and drastic changes in every component of environment. Air pollution has emerged in the past few decades as the most crucial problem to mankind and a large number of studies in this regard have been undertaken in all over the World [1]. Clean, pollution-free and hygienic living surroundings are essential as they are directly related to human health and better living standard of the country [2]. Naturally, the sources of pollutants are volcanic eruptions, forest fires and dust storms whereas, anthropogenic source of pollutants comes from burning fossil fuels, industrial and vehicular emissions, power plants, mining, drilling and construction of roads [3]. Sulphur dioxide, nitrogen dioxide and suspended particulate matter are regarded as major pollutants in India. The effect of particulates depends on its shape, size, concentration and time of exposure in relation to its mass and composition [4]. About 60 percent of air pollution in Indian cities is due to automobile exhaust emission. The vehicular emission contains more than 450 different organic chemical compounds either in gaseous or in particulate or in the combined forms. The emission loads in Indian urban cities are in the range of thousands of tons per day. Among air pollutants, particulate matter (PM) is a ubiquitous and it is especially a major problem due to its adverse health effect, visibility reduction and soiling of buildings [5].

Ambient air quality refers to the quality of outdoor air in our surrounding environment. It is typically measured near ground level, away from direct sources of pollution. There are many factors that affect air quality, making the search for clean air quite a complicated issue [6]. Air quality is a scale reporting the air pollution. It transforms weighted values of individual air pollution related parameters (e.g. SO_2, CO, visibility, etc.) into a single number or set of numbers and is widely used for air quality communication and decision making in many countries. The objective of an AQI is to quickly disseminate air quality

information (almost in real-time) that entails the system to account for pollutants which have short-term impact [7].

Awareness of daily levels of air pollution is important to the citizens, especially for those who suffer from illness caused by exposure to air pollution. AQI is a tool, introduced by Environmental Protection Agency (EPA) in United States of America (USA) to measure the levels of pollution due to major air pollutants. In India, National Ambient Air Quality Standards (NAAQS) are the standards for ambient air quality set by the Central Pollution Control Board (CPCB) that is applicable nationwide. The CPCB has conferred this power by the Air (Prevention and Control of Pollution) Act, 1981.

Materials and Methods

Sudy area

The University is located at Nauni which is 13 km from Solan town. It is situated at the height of 1260 meters above mean sea level at 30°51'53"N latitude and 77°10'8"E longitude **(Figure 1).**

The main campus experiences all three seasons viz. summer, monsoon and monsoon. The University has five buses which services daily from Solan city to the University campus. In addition to this, 200-250 vehicles enter the campus premises daily. With development and increase in the number of students and staff, more activities have been going on and increase in number of vehicles and their frequent use has resulted in increase in pollution of air in the campus. Students and staff come from Solan daily in University buses and private vehicles that resulted in increased vehicular emission. The University is also frequently visited by farmers and students for workshops and field visits. On top of that, the University has a scenic beauty, thus people come over to enjoy this beauty which further aggravated the problems of pollution. Also, the campus encounters peculiar weather as it is surrounded by hills on all the sides, which restricts the transport and dispersion of the pollutants.

Sampling method and analysis procedure

The study was conducted at the University campus during the year 2017 by selecting four sites namely traffic, residential, farming and forest (control). To study the effect of seasons on the ambient air quality, three seasons viz. summer (April-May), monsoon (July-August) and autumn (October-November) were considered. The data was recorded for eight hours at each site during day time. In each of the site, three locations were selected as replications to minimise error. The sampling was carried out using two instruments viz. Respirable dust sampler (Cat. No MBLRDS-002) and Environmental Perimeter Air Station (EPAS).

Sulphur dioxide has been analysed by modified West and Gaeke Method IS 5182, part II; Nittrogen dioxide by modified West and Gaeke Method IS 5182, part II and particulate matter (RSPM and NRSPM) by Gravimetric method IS 5182 part IV. TSPM

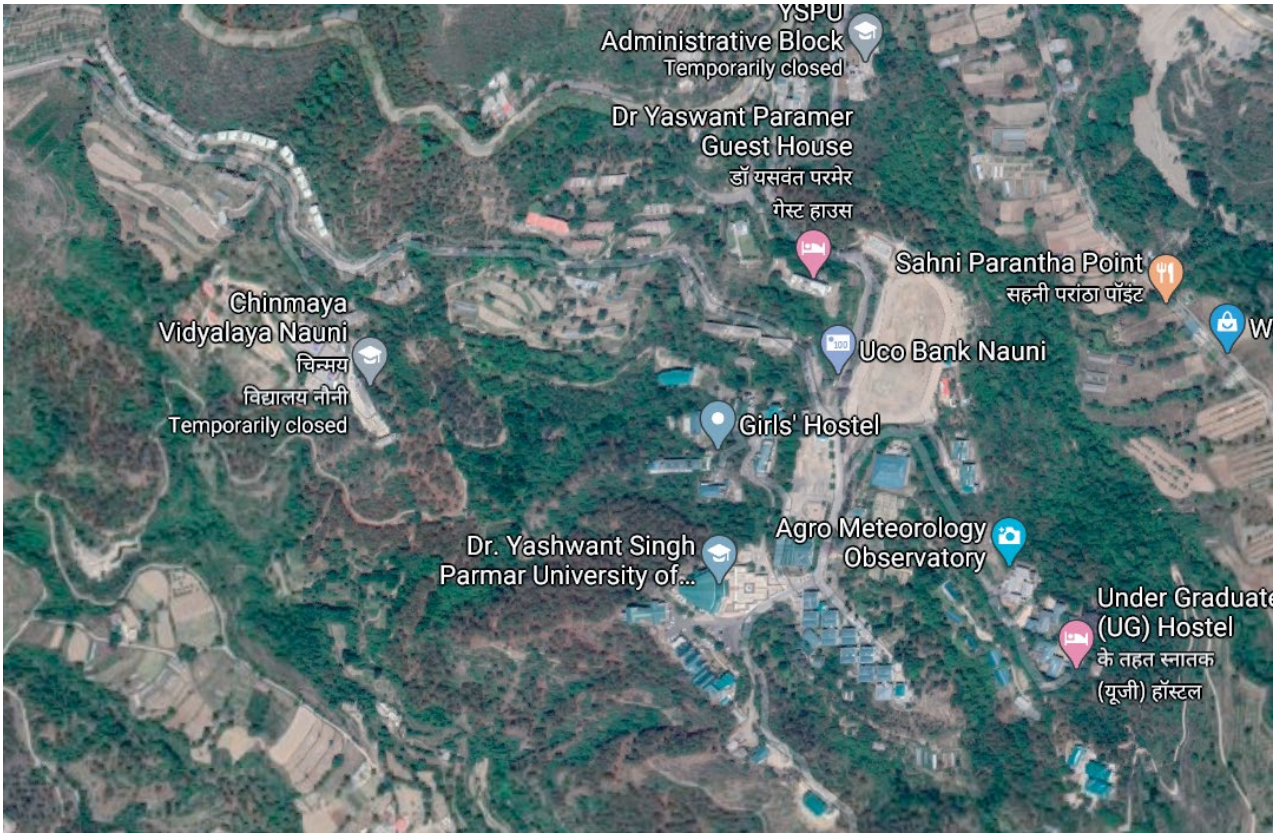

Figure 1 Satellite image of the study area.

concentration has been calculated by summing up the two. For measuring the concentration of VOCs in the ambient air, the digitalized Environmental Perimeter Air Station (EPAS) was used.

Air quality index

The quality of air in the study area had been estimated from the air quality index. The air quality index had been calculated from the observed SPM, PM_{10}, NO_2 and SO_2 values using the formula.

$$AQI = 1/4\times (I_{PM10} / S_{PM10} + I_{SPM} / S_{SPM} + I_{SO2}/ S_{SO2} + I_{NO_x} / S_{NO_x}) \times 100$$

Where,

I_{PM10}, I_{SPM} I_{SO2} and I_{NO_x} are individual values of respirable particulate matter, sulphur dioxide, oxides of nitrogen and suspended particulate matter, respectively.

S_{PM10}, $S_{SPM,}$ S_{SO2} and S_{NO_x} are the standards of ambient air quality.

Results and Discussion

The concentration of pollutants during various seasons in study at different locations was given in **Tables 1-3.** Site-wise variation of the air quality parameters in the University campus showed that there was a similar trend on the concentration of the pollutants at the selected sites. For all the air quality parameters considered, the concentrations at the sites showed a decreasing trend of traffic > residential > farming > forest. Seasonal variation of the air quality parameters in the University campus also showed a similar trend. The concentration of the pollutants during the seasons was in the order of autumn > summer > monsoon.

Table 4 shows the values of Air Quality Index calculated from the data of different seasons for the ambient air quality of the University campus during 2017. The highest AQI value of 90.60 was observed during autumn season at traffic site followed by 81.80 and 61.55 at the same site during summer and monsoon respectively. The lowest AQI value of 9.2 was observed during monsoon season at forest (control) site followed by 11.07 and 14.73 at the same site during summer and autumn. As a whole, autumn season showed the highest AQI values at all the study sites while the monsoon season showed the lowest AQI value.

The different rating scales of AQI are depicted in **Table 5.** The AQI scale is divided into six categories as given in the table. The higher the AQI value, greater is the level of pollution and so is the risk.

Figure 2 shows the AQI trends of the sites in the three seasons (summer, monsoon and autumn) during the study. The best

Table 1 Concentration of pollutants (µg/cu-m) at University Campus during Summer, 2017.

S. No	Location	Particulate Matter		SO_2	NO_x	VOC
		TSPM	PM_{10}			
1	Traffic	105.55	21.67	1.36	12.11	2.13
2	Residential	33.34	19.76	0.72	8.14	1.07
3	Farming	20.51	9.97	0.24	2.41	0.97
4	Forest	10.43	3.19	0.19	1.18	0.83

Table 2 Concentration of pollutants (µg/cu-m) at University Campus during Monsoon, 2017.

S. No	Location	Particulate Matter		SO_2	NO_x	VOC
		TSPM	PM_{10}			
1	Traffic	91.16	20.73	BDL	11.06	1.12
2	Residential	29.43	18.29	BDL	4.03	0.90
3	Farming	19.24	9.26	BDL	1.51	0.81
4	Forest	8.95	2.25	BDL	0.67	0.72
BDL= Below Detection Limit						

Table 3 Concentration of pollutants (µg/cu-m) at University Campus during Autumn, 2017.

S. No	Location	Particulate Matter		SO_2	NO_x	VOC
		TSPM	PM_{10}			
1	Traffic	123.22	23.28	2.13	14.72	3.20
2	Residential	46.45	19.32	0.93	9.60	2.63
3	Farming	26.67	10.33	0.37	3.72	1.57
4	Forest	11.12	3.81	0.21	1.77	1.42

Table 4 Air Quality Index of the University Campus.

Seasons / Sites	Summer		Monsoon		Autumn	
	AQI	Description	AQI	Description	AQI	Description
Traffic	81.80	Moderate	61.55	Moderate	90.60	Moderate
Residential	32.35	Good	21.87	Good	46.60	Good
Farming	16.72	Good	14.8	Good	21.56	Good
Forest	11.07	Good	9.2	Good	14.73	Good

Table 5 Rating scale of AQI values.

AQI value	Remarks	Health Concern
0-50	Good	None/minimal health effect.
51-100	Moderate	Few or none for the general population.
101-150	Unhealthy for sensitive groups	Possible respiratory or cardiac effect for most sensitive group.
151-200	Unhealthy	Increasing symptoms of respiratory illness.
201- 300	Very Unhealthy	Aggravation of heart and lung disease.
301- 500	Hazardous	Serious aggravation. Risk of death in children

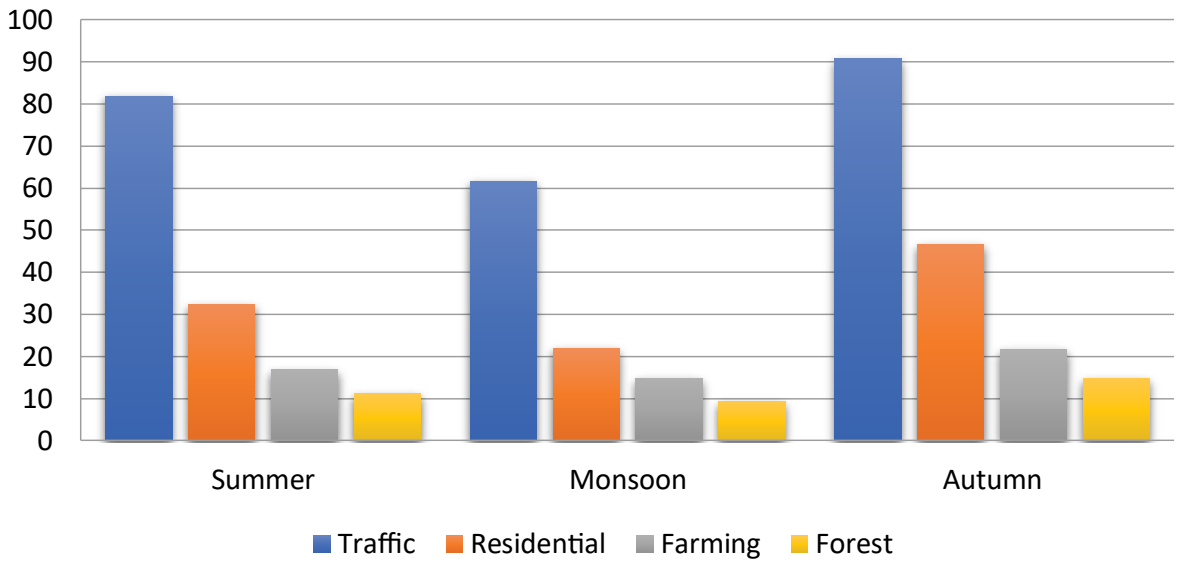

Figure 2 Seasonal variation of AQI at different sites during the study period.

air quality was found during monsoon season at all the sites whereas autumn season showed the lowest air quality. Monsoon season in the campus received a greater amount of rainfall which resulted into washing out of the air pollutants thus exhibiting the best air quality. The relatively lower air quality was shown during autumn season because of the calm atmospheric conditions which resulted into less dispersion of air pollutants away from the campus.

Conclusion

The study inferred that the concentrations of all the air quality parameters were within the permissible limits in the University campus. The AQI in the campus ranged from 'good' to 'moderate' during the three seasons in study. The seasons of the year also have impact on the air quality. Monsoon season showed the best air quality in terms of AQI while autumn season showed the highest AQI. The traffic site has the highest concentration of the pollutants and also showed a moderate air quality index during summer, monsoon and autumn season while residential, farming and forest sites showed a good air quality.

Conflict of Interest

There is no conflict of interest regarding the publication of this paper.

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