Assessment of Indoor And outdoor Air Monitoring In JSS Hospital, Mysuru

Ramyashree .H.S[1], Istalingamurthy.D[2]
[1]Dept of Environmental Engineering
[2]Professor, Dept of Environmental Engineering
[1, 2] Sri Jayachamarajendra College of Engineering, Mysuru-570006, Karnataka, India

Abstract- *Ambient air.the major source of increase in the air pollutant concentration in the ambient air are due to rapid industrialization and urbanization along with the automobile emission. Hence, the present study the ambient air quality has been monitored for NOX, SO2, PM10, PM2.5 and indoor microbial pollutants such as bacteria and fungai. Their sources include both anthropogenic and natural sources. This study deals with measurement of ambient air quality in the hospital environment for different seasons like (summer ,winter and monsoon) and the air quality monitoring for bio aerosols was done in different wards (general ward, maternity ward, lobby) of JSS hospital. High volume air sampler was used for monitoring, particulate dust sampler and microbial air sampler for bacteria and fungi. The various meterological parameters such as wind speed, wind direction, temperature, humidity, precipitation are considered for the different seasons. The experiment was carried for ambient air quality monitored for for NOX, SO2, PM10, and PM2.5 in µg/ m3 at four different location around the hospital area .location (1) front gate, location (2) entrance, location (3) car parking area, location (4) scooter parking area for the three different seasons like winter, pre-monsoon and monsoon. It was found that all the pollutant concentration was within the standards expect the PM10 which was exceeding the NAAQ standards 136.2 µg/ m3 in winter may be due to more vehicular traffic. The pollutant concentration decreases in monsoon season due to the precipitation, wind speed and humidity. The vehicular count was done for the 24hour the maximum volume was during 9AMto12am and 4M-8PM, the vehicular emission contributes the major source for pollution. The bacterial and fungal samples were collected and characterized to identify and isolate the different species of microorganisms present in the different wards of JSS hospital, the bacterial concentration in CFU/m3 was measured at different wards like General ward, lobby, maternity ward , ICU of JSS Hospital and found more at General ward 135 CFU/m3. And the bacterial and fungal concentration depends on the number of people and hygiene condition in the hospital. Prediction of air pollution dispersion using CALINE4 model for pollutant concentration such as NOx and PM10 with the input corresponding meteorological parameter like temperature, wind speed, wind direction is collected for different season. Results of CALINE4 Model for PM10 concentration was found to be marginally over-predicted than the actual field monitored data during the study period (i.e., from December, 2016 to June, 2017) .NOx prediction from the CALINE4 Model was found to be under-predicted when compared with the field monitored data. This may be due to the presence of atmospheric nitrogen in the ambient air which also contributes to the field monitored NOx concentration. Wastewater.*

Keywords- ambient air quality, NO_X , SO_2 ,$PM_{2.5}$, PM_{10}

I. INTRODUCTION

Environmental monitoring is a systematic approach for observing and studying the condition of environment. For the healthy human being require to breathe in a clean air but due to increasing the transportation system fresh air get polluted. Transport system make the impact on environment in which we live. Increase in vehicle gives rise to increasing traffic related pollutant emission. Therefore, to track the effect of this pollution on environment and health of individual it is necessary to track the level of pollution in urban and sub urban areas. Many health related issues are arising from air pollution. Major source of air pollution is road traffic emission which emits the 97% of CO and 75% of NO. Therefore, air quality monitoring is needed in order to provide useful information about the pollution and can take appropriate measures to mitigate the negative impact whenever it is necessary. The purpose of monitoring the air quality is not only to collect the data but also provide the information which is required by the scientist, planners, policy makers to make a decision on improving and managing the environment [1]

1.2 Need for Monitoring

Clean air is vital need for every human being. Polluted air causes many health problems and several damages. Therefore to make any step ahead of controlling the pollution rate it is necessary to monitor the air quality which may help us to make a right decision at right time. There are various causes of increasing the pollution such as smoke automobile exhaust, chemical discharge from industries,

radioactive substance etc.these are main reason of decreasing the quality of air. The main gases which directly affect the human health are carbon monoxide (CO), hydrogen sulphide, sulphur dioxide (SO2), Nitrogen dioxide (NO2) and the main contribution of these gases are traffic related pollutant emission. Huge efforts are required to improve the quality of air in both outdoor and indoor environment. Monitoring of environment has been controlled from manual to the automatic control step by step. There are various improvement in the instrument of environment monitoring but still cannot meet the harsh environment [2]

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 [3]

On inhalation of carbon monoxide it combines selectively with hemoglobin of the blood (Hb) and form carboxyhemoglobin (COHb), resulting reduction in oxygen carrying capacity of blood. High carbon monoxide level is potentially deadly and fatal to human life as carbon monoxide is a very dangerous asphyxiant. Carbon monoxide cause headache, fatigue, impaired judgment and dizziness, it also affects the functioning of heart and brain. [3]

All atmospheric substance that are not gases but may be suspended droplets, solid particle or mixture of the two are generally referred to as particulates. Particulate matter causes respiratory problems like asthma, reduction in visibility and cancer. It also affects lungs and tissues. [4]

1.3 Bioaerosols

Bioaerosols are particulate matter of biological origin which include, living organisms such as bacteria, virus, fungi, their metabolites, toxins and fragments. Hospital environment contains a diverse range of bioaerosol population. The importance of estimation of quantity and type of these bioaerosol has been emphasized due to their effect on human [5]

1.4 Sources of air pollutants

The main contributing factors to air pollution are the overwhelming concentration of vehicles, poor transport infrastructure and the establishment of industries in urban agglomerations.[7]. Vehicle emission can be a major contribution to smog because SOx, NOx, NH3 and VOCs generated from vehicle exhaust can form secondary RSPM. RSPM levels at locations in residential areas and traffic intersection were higher than the NAAQS (annual average) during 2001 (CPCB, 2003). The cause of the high CO concentration may be ascribed to emissions from vehicle exhaust resulting on hospitals' central high-traffic locations, while the high PM10 levels at hospitals may be associated with air conditioning, therapeutic action, and patient motion . [6]

1.5 Air pollution modeling and CALINE4 model

Modeling of air pollution has been accomplished with the aid of Gaussian Dispersion Plume models that accounted for the temporal and spatial dispersion characteristics of the pollutants. Vehicular emission is generally considered as a line source in air dispersion models. Line source models are used for assessing the effects of roadway emissions [8]

They are computer-based models that calculate the distribution of the pollutants in the atmosphere from specified emission sources and meteorological scenario. The present research paper, thus, evaluates the application of CALINE 4 in predicting the concentrations of Carbon-mono-oxide (CO) in the study area.CALINE4, the latest in CALINE series models, is most widely used. Gaussian based vehicular pollution dispersion model to predict air pollutant concentrations along the highway under rural (i.e. Open), semi urban and urban conditions with and without street canyon effects. CALINE series of models have been used extensively all over the world, including India for regulatory purposes. CALINE4 offers several advantages over the other previous models and has been used by many researchers to predict pollutant concentrations of vehicular pollutants along the roads/ highways in Indian climatic conditions.

II. MATERIALS AND METHODS

2.1 Meteorological data collection

The meteorological data was collected from Karnataka State Natural Disaster Management Centre website www.ksndmc.org. Daily average values of temperature, relative humidity, wind speed, wind direction and rainfall were collected for 3 months continuously (december2016, February, March& April, May 2017).

Ambient air quality studies are carried out using following instruments,

- High Volume Air Sampler (HVAS)
- Gaseous Sampling Attachment

- PM2.5 Dust Sampler (DS)
- Microbial Air Sampler (MAS)

2.2 Monitoring location details

As the objective of the project was to study the air quality in sensitive area of the city in the different seasons. Hospital which was chosen as monitoring sites, i.e JSS hospital. Figure 2.1 show the locations of monitoring stations on Mysuru city map while Figures show the monitoring location of JSS Hospital on Google map respectively. The monitoring station near The JSS hospital is located on busy MG road in Agrahara in SouthEastern part of Mysuru city.

Fig 2.1 Sampling locations in JSS Hospital

2.3 Sampling Procedure (SO2, NO2, and SPM)

The number of samples taken, the frequency of sampling and the methodology is described below.

Outdoor air quality is monitored using High Volume Air Sampler (HVAS) around the hospital area. HVAS was run for 8 hours fitted with glass fiber filter paper to collect the suspended particulate matter and the air entering HVAS is allowed to flow through the absorbing solutions of NO2 and SO2 respectively. Using the HVAS, monitoring was done in 4 cycles where the instrument was run for 8 hours each day and the meteorological data was collected for the corresponding time period.

P Suspended Particulate Matter The exposed filter paper was weighed in an electronic balance. The mass concentration of suspended particulate matter was calculated using the formula

$$C = \frac{(W2 - W1) \times 10^6}{V}$$

Where C = Mass concentration of suspended particulates in mg/cum
W2 = Final weight of filter paper in grams
W1 = Initial weight of filter paper in grams

PM2.5 The exposed filter paper was weighed in an electronic balance. The mass concentration of PM2.5 was calculated using the formula

$$C = \frac{(W2 - W1) \times 10^6}{V}$$

Where C = Mass concentration of PM2.5 in mg/cum
W2 = Final weight of filter paper in grams
W1 = Initial weight of filter paper in grams Monitoring of NO_2, SO_X, Particulates & procedure for laboratory analysis

2.4Vehicular traffic studies

A traffic study is a detailed examination and analysis of a transportation system supported by data collection. The data collection process was conducted using the CCTV camera at the monitoring location in an orderly manner which ensures that, data gathered is both defined and accurate. The collected data provides a baseline for further analysis. Traffic volume studies are conducted to determine the number, movements, and classifications of roadway vehicles at a given location [9]

2.5 Bioaerosols (bacteria and fungi)

Taking into consideration, the national and the international scenario, this project is directed towards working on characterizing and management of bioaerosols in the hospital environment of Mysuru city, more precisely choosing specific wards in the hospital which includes general wards (male/ female), maternity ward, children's' ward, neonatal ICUs, the hospital lobbies and the ambient air surrounding the hospital.

The microbial air sampler was used to monitor bioaerosols concentration in different wards of the hospital. The sampling was done both for indoor and outdoor environment. The microbial air sampler was fitted with disposable plastic petri-plates containing blood agar, PDA and PCA. The sampler was run continuously for 15 minutes in each sampling location. The various wards in which sampling was done were,

- General ward (male/female)
- Children's
- Maternity ward
- Hospital lobby
- Ambient air (outdoor)

The sampling was repeated for 3 more different days at different time periods, in the hospital to acquire more air

samples that would help easy identification and characterization.

Was conducted for synthesized iron oxide nanoparticles coated sand to known the elements present in the material by atomic weight percentage. Water bath shaker was used for preparation of adsorbent and batch adsorption studies.

III. RESULTS AND DISCUSSION

3.1 Study Area

As the objective of the project was to study the air quality in sensitive area of the city in the different seasons. Hospital which was chosen as monitoring sites, i.e JSS hospital. The monitoring station near The JSS hospital is located on busy MG road in Agrahara in SouthEastern part of Mysuru city.

3.2 Field Data Collection

In the present study, the surface data such as: length of the road, and type of the study area were collected. Vehicular traffic counts have been recorded during ambient air quality monitored days using CCTV camera. Meteorological data such as: wind speed and its direction, temperature, pressure, relative humidity and precipitation were collected over a period of 7months i.e., from December, 2016 to June, 2017.The details of these data collected have been discussed in the following sections.

3.3 Meteorological data

Meteorological parameters such as: wind speed and its direction, temperature, pressure, relative humidity, maximum mixing depth and precipitation are responsible for the dispersion of air pollutants in the atmosphere can be seen in figure 4.1(a),(b),(c),(d). Hourly data were collected from www.wunderground.com over the study period. The maximum mixing depth values were collected from the “atlas of hourly mixing height and assimilative capacity of atmosphere in India” as published by Indian Meteorological Department, New Delhi. The meteorological parameters were analyzed for seasonal variation and have been discussed in the following paragraphs

3.4 Traffic volume study

To estimate the contribution of vehicular emissions to the ambient air quality, the numbers of vehicles passing through the study area during the monitoring days were collected by installing CCTV camera. The vehicular volume has been counted with help of compact disc having the record of each monitoring day’s 24 hours traffic flow data. The traffic volume have been categorized into four groups i.e., 2 wheelers, 3 wheelers, 4 wheelers used to conduct emission inventory. The plots for variation in the traffic flow for week days and weekends were as shown in the Figures 3.1(a) and (b). From the plots it can be stated that, trend followed by 2 wheelers and 4 wheelers on week days during peak traffic volume was found to be between 09:00 and 11:00 hours (morning peak hours) and, 17:00 and 20:00 (evening peak hours). During weekends peak traffic volume was noticed between 10:00 and 12:00 (morning peak hours) and 17:00 and 20:00 (evening peak hours).3 wheelers were distributed maximum during morning hours and nil during night hours between 00:00 hours and 4:00 hours.

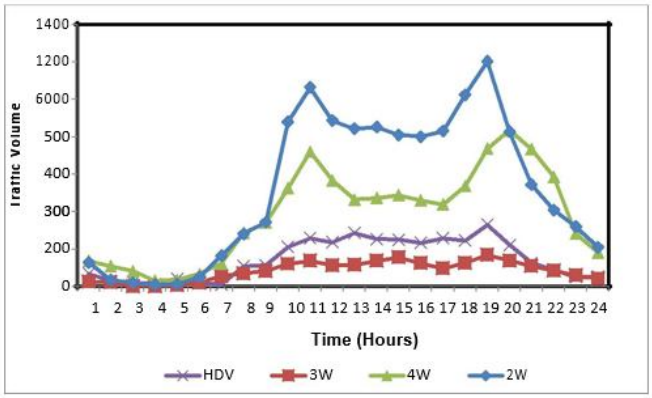

Fig 3.1(a) Traffic variations along the study area during weekdays

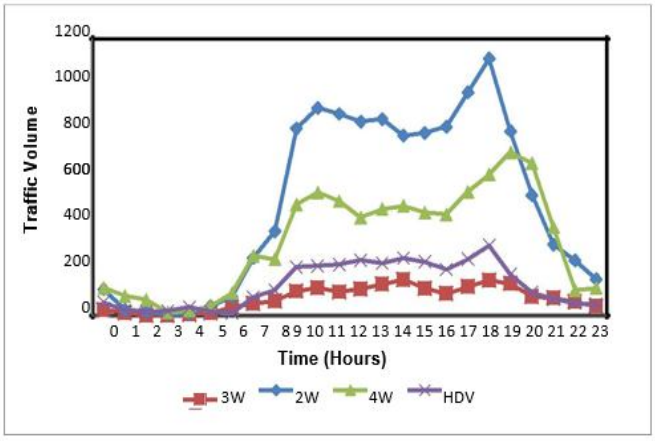

Fig 3.1(b) Traffic variations along the study area during weekends

3.5 Ambient Air Quality Monitoring

At all the identified monitoring stations, the concentration of oxides of nitrogen and sulphur dioxide was found to be within the permissible limits of National Ambient

Air Quality Standards (NAAQS) of (80 µg/m^3). PM_{10} and $PM_{2.5}$ were found to be exceeding the standards of 100 µg/m^3 and 80 µg/m^3, respectively. [10] Have studied the traffic contribution to the ambient air quality. They showed that, $PM_{2.5}$ concentration ranged from 50.46 µg/m^3 to 88.06 µg/m^3 which indicate that, as the receptor points were away from the roadway, the pollutant concentration were found to be decreasing. In the present study, to understand the distribution of air pollutants over the study area, plots were made between concentrations of pollutants against location for four different seasons. The concentrations of SO_2, NOx, PM_{10} and $PM_{2.5}$ at Location 1 (front gate JSS hospital), Location 2 (front of the hospital building) and Location 3 (near hospital car parking area) location4 (scooter parking area) were made, shown in table 3.1(a), (b),(c) and figure 3.2 (a), (b) and (c). It was observed that, PM_{10} was exceeded in all the seasons except during monsoon. However, other parameters such as SO_2, NOx, and $PM_{2.5}$ were found to be within the permissible limits of NAAQ Standards at all the monitoring locations. During winter season, the temperature was in the range of 9˚ C to 22˚ C, due to which the pollutants dispersion in the atmosphere was lower. The pollutant concentration was found to be higher in pre-monsoon season and which may be due to the summer holidays during which there will be increase in fleet movement of vehicles. Pollutant concentration recorded in receptors located near (Location 1) and (Location 3) were found to be higher as the vehicular count and some road constriction is going on. During monsoon season all the air pollutant concentration were found to be within the permissible limits at each receptor point which may be due to precipitation which scavenges the air pollutants from atmosphere to ground level.

Table 3.1(a) Status of ambient air quality at 4 different locations in the study area during winter

Monitoring Station And Date	NOx, µg/ m^3	SO_2, µg/ m^3	PM_{10}, µg/ m^3	$PM_{2.5}$, µg/ m^3	Remark
24/12/2016 Front Gate	21	4.06	137	11.09	Located near road side
10/01/2017hospital Building Entrance	18.06	2.76	112.3	13.6	Traffic volume
16/01/2017Hospital Car Parking	17.9	3.08	123	11.3	
1224/01/2017hospital Scooter Parking	17.06	4.2	120.3	10.9	

Table 3.1(b) Status of ambient air quality at 4 different locations in the study area during Pre Monsoon

Monitoring station and date	NOx, µg/ m^3	SO_2, µg/ m^3	PM_{10}, µg/ m^3	$PM_{2.5}$, µg/ m^3	Remark
18/05/2017 FRONT GATE	15.2	3.6	83.6	8.2	Due to rain
01/06/2017 ENTRNACE	14.03	2.3	72.3	7.6	Due to rain
15/06/2017 CAR PARKING AREA	15.1	2.21	66.9	6.69	
24/06/2017 SCOOTER PARKING	13.09	3.1	56.9	7.2	

Table3.1(c) Status of ambient air quality at 4 different locations in the study area during Monsoon

Monitoring station and date	NOx, µg/ m^3	SO_2, µg/ m^3	PM_{10}, µg/ m^3	$PM_{2.5}$, µg/ m^3	Remark
26/02/2017 FRONT GATE	19.6	4.03	130	9	located near road side
05/03/2017 ENTRNACE	17.06	3.3	120	10.3	
13/03/2017CAR PARKING AREA	18	4.96	136.2	12.6	Traffic volume
21/03/2017SCOOTER PARKING AREA	17.6	3.6	126	10.06	

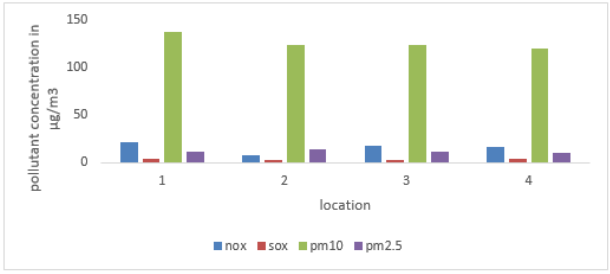

Fig 3.2(a) Plot of ambient air pollutants concentration at different locations in the study area during winter season

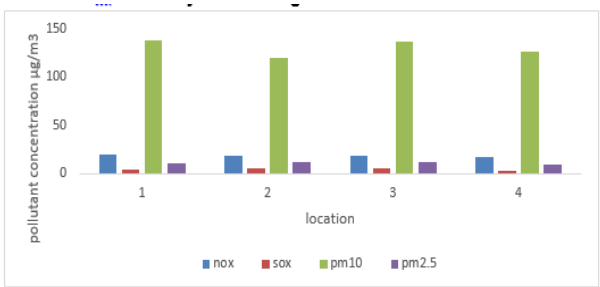

Fig 3.2(b) Plot of ambient air pollutants concentration at different locations in the study area during pre-monsoon season

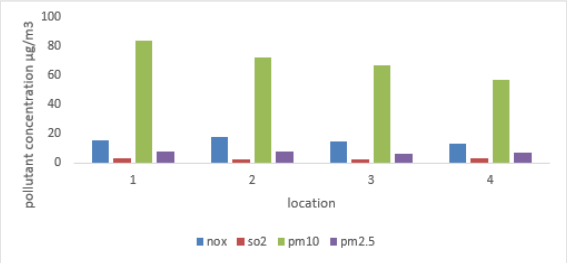

Fig3.2(c) Plot of ambient air pollutants concentration at different locations in the study area during monsoon season

3.6 Validation of Ambient Air Quality Monitored Data with Model Results.

The predicted value of NOx and PM2.5 after the run of CALINE4 model is shown in the table 2 (a) (b)

Validation of field monitored data with the air dispersion model has to be done with the help of statistical analysis. The statistical parameters are being used for comparison with Pearson's correlation coefficient.

Predicted value with measured value are given in eqns. (3.1) (3.2).

$$y = 0.372\ x + 9.48 \qquad (3.1)$$
$$y = 1.41\ x - 22.17 \qquad (3.2)$$

From the plot,fig 3.3 (a),(b) it is observed that, CALINE4 model slightly over-predicts the pollutant concentration when compared with monitored values. The R^2 value of 0.9284 and Pearson's Correlation (r) = 0.95 indicated that, the model results are in good agreement with the monitored data.

Location	No_x concentration in µg/m3
Front gate	30
Building entrance	25
Car parking area	30
Two wheeler parking area	30

Table 3.2(a) Predicted No_x concentration at four identified locations in JSS hospital.

Location	Pm10 concentration in µg/m3
Front gate	60
Building entrance	70
Car parking area	60
Two wheeler parking area	70

Table 3.2(b) Predicted PM_{10} concentration at four identified locations in JSS hospital.

Location	Pm10 concentration in µg/m3
Front gate	60
Building entrance	70
Car parking area	60
Two wheeler parking area	70

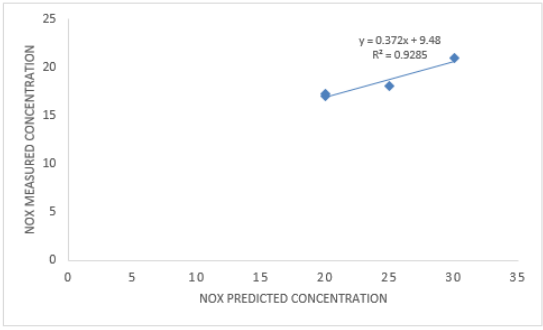

Fig 3.3(a) Plot for correlation between predicted and observed no_x Concentration

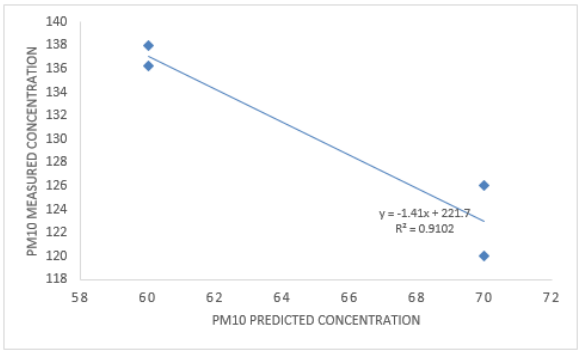

Fig 3.3(b) Plot for correlation between predicted and observed PM10 Concentration.

3.6 Indoor air quality monitoring

Indoor air monitoring is carried out in the JSS Hospital and the monitoring and analysis was done as discussed below.

3.6.1 Microbial analysis:

Table 3(a) below shows the concentration of bacteria in various sampling locations of JSS Hospital. It is observed that the concentration in Lobby of the hospital and the ambient air around hospital have highest value.

Table 3.3 (a) bacterial concentration in various sampling location inside the JSS hospital

Ward JSS Hospital	CFU/m3
Maternity ward	105
General ward	135
Lobby	1 05
Ambient air	120

3.6.2 Fungal Analysis:

The monitoring results of fungal species detected are as shown in Table3 (b). Aspergillus Niger was the most predominant fungal species found in the hospital. The following Table 4.1 shows the percentage of fungal species occupying the plates in various wards of the JSS Hospital

Table 3.3(b) fungal concentration in various sampling location inside the JSS hospital.

Hospital Area/Monitoring Date	Fungal Species Identified	Percentageof Species Occupying The Plates
NICU-k 2/02/2016	Aspergillus niger	100
Lobby 2/02/2016	Aspergillus niger	60
	Aternaria/Penicillium species	45
General ward 2/02/2016	Aspergillus niger	70
	Flavus	30
Maternity child 2/02/2016	Aspergillus niger	60
	Fusarium species (monoliforme)	60

IV. CONCLUSIONS

The concentration of NO_2, SO_2 measured in JSS hospital are within the NAAQ standards. It is observed that the pollutant concentration increases with increase in vehicle count, therefore the main source of pollution in the study locations was found to be vehicle exhaust.Bioaerosol concentrations measured in different wards of JSS Hospital showed the presence of bacteria and fungi of different strains, the species identified were nonpathogenic.PM10 concentration was found to be (140 µg/m³) which is higher than the permissible limit of 100 µg/m³ during winter and pre-monsoon season at the monitored Location(1) front gate , which may be due to receptors located near to the roadway as well as due to the peak traffic flow was observed .Results of CALINE4 Model for PM10 concentration was found to be marginally over-predicted than the actual field monitored data during the study period (i.e., from December, 2016 to June, 2017)

REFERENCES

[1] Abdullah Kadri, Elias Yaacoub, Mohammed Mushtaha, And Adnan Abu-Dayya "Wireless Sensor Network For Real-Time Air Pollution Monitoring" IEEE Forum On Strategic Technology -2013.

[2] Haibao Wang, Tingting Wu ,And Guangjie Wu,"Air Quality Monitoring System Based On Frequency Hopping System 2010 IEEE.

[3] P. Balashanmugam, A. R. Ramanathan and V. Nehru Kumar, "Ambient Air Quality Monitoring in Puducherry" in International Journal of Engineering Research and Applications Vol. 2, issue 2, Mar-Apr 2012.

[4] D S Khandbahale and R S Saler, "Ambient Air Quality Monitoring in Nashik city (Maharashtra, India)" in BionanoFrontier, Vol. 6 (2) July – December 2013.

[5] Dubey, B., Pal, A. K. and Singh, G. (2013) " Assessment of vehicular pollution in dhanbad city using CALINE 4 model", Earth and Environmental Sciences, 3, pp 156-164.

[6] Pastuszka J. S., Marchwinska-Wyrwal E., and Wlazlo A. (2005). "Bacterial Aerosol in Silesian Hospitals: Preliminary Results". Polish Journal of Environmental Studies, Vol 14(6), pp 883-890

[7] Hsu Y-C., Kung P-Y., Wu T-N., and Shen Y-H., (2012), "Characterization of Indoor - Air Bioaerosols in Southern Taiwan". Aerosol and Air Quality Research, Vol 12, pp 651- 661

[8] Gupta U., (2006), "Valuation of Urban Air Pollution: A Case Study of Kanpur City in India". Kathmandu, Nepal: South Asian Network for Development and Environmental Economics.

[9] Nagendra, S.M.S., Khare, M., 2002. Line Source Emission Modelling, Atmospheric Environment, 36: 2083- 2098. [3] Venkatram, A., Horst, T.W., 2006. Approximating dispersion from a finite line source. Atmospheric Environment 40, 2401–2408.

[10] Dubey, B., Pal, A. K. and Singh, G. (2013) " Assessment of vehicular pollution in dhanbad city using CALINE 4 model", Earth and Environmental Sciences, 3, pp 156-164.

[11] Guihua Wang, G., Bai, S. and Joan., M. J. (2009) " Identifying contributions of onroad motor vehicles to urban air pollution using travel demand model data", Transportation Research Part D, 14, pp 168-179.

[12] Alenezi, R., Al-Anzi, B., Abusam, A. and Ashfaque, A. (2012) "Seasonal Influence on the Ambient Air Quality in Al Jahar City for Year 2010", Journal of Environmental Protection, 3, pp 1711-1718.