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RESEARCH ARTICLE OPEN ACCESS

Determination of Traffic Magnitude and Its Time Dependent Variation Further Emission Audit To Assess Critical Pollutants near A Sensitive Location In Mysuru City

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ABSTRACT
Air pollution can be detrimental to public health and environment particularly in urban area, due to ever growing human and vehicular population, occupants of the sensitive areas of Mysore are under threat of air pollution. One such sensitive area chosen for study is Cheluvamba paediatric hospital in Mysore city. The main focus was to know the traffic volume and prepare emission inventory near Cheluvamba hospital. Number of vehicles passing through the junction were counted under six category using CCTV footages obtained from Mysore city police also Emission inventory was prepared for the number of vehicles passed through, this exercise was carried out in monsoon, winter and summer for period of 90 days. Emissions from vehicles at Cheluvamba hospital traffic intersection is determined on basis of categorised vehicle count, road length and Emission Standards of ARAI (Automotive Research Association of India)for three seasons showing 24-hour variations in Carbon monoxide, Nitrogen dioxide, sulphur dioxide andparticulate matter were depicted.
Key words: Emission Inventory, Vehicular Emission,

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I. INTRODUCTION

Urban air pollution is a major concern throughout the world in both, developed and developing countries[1].Transport heralds the economic development of a region and plays a very crucial role in its urbanization[2]. The traffic is increasing day by day at a very rapid rate in the developing countries like India[3].India has experienced substantial increases in vehicle miles travelled (VMT) in recent years. The increased traffic has resulted in increased pollutant emissions and the deterioration of environmental quality and human health in several major cities in India.[4] Swelling urban population in cities have resulted in severe air pollution affecting the surrounding environment and human health. The criteria pollutants responsible for deteriorating urban air quality are oxides of nitrogen (NO_X), sulphur dioxide (SO_2), carbon monoxide (CO), particulate matter (PM) and volatile organic compounds (VOCs)[1]. Re-suspension of road dust due to movement of traffic and tyre and brake wear are also some of the significant sources of ambient PM concentrations in urban areas[5] .

Mysore located at 12.30°N 74.65°E and has an average altitude of 770 metres above sea level, spread across an area of 128.42 km^2. Tourism and industriesare the major activity in Mysore. It also has four industrial areas in and around Mysore, in the Belagola, Belawadi, Hebbal and Hootagalli areas. Mysore is a major tourist destination in its own right and serves as a base for other tourist attractions in the vicinity, which attracts tourists both from domestic and international places leading to increase the vehicular growth of all classes, Since Mysore is growing both economically and geographically due to various and obvious activities, the city population is dependent on vehicles for movement from one place to another, which is major reason for traffic within the city causing air pollution, escalated effect of vehicular traffic can be witnessed near intersections and traffic junctions, particularly nearby sensitive area

The present study aims to know more about the impact of vehicular traffic on sensitive area, and hence in this work it is decided to find out magnitude of vehicular count, preparation of emission inventory and there by impact on sensitive location and estimate emissions of various

pollutants (CO, NO_X, SO_2, PM,)from traffic junction at hospital for different seasons.

II. MATERIALS AND METHODOLOGY

2.1 Study region

The present vehicularemission studies were carried out at sensitive location in the prime location of Mysore city, Cheluvamba Paediatric Hospital (N12°18'51.04" E76°38'54.05"), this site was selected because of the vulnerability of the receptors such as children/patients. The topographical and geographical features of these locations are shown in fig 2.1 and fig 2.2.

2.2 Vehicular count

Traffic flow patterns and their time dependent variations were studied in a real-time frame-by-frame basis. This was achieved by using CCTV footages installed at the identified monitoring location. This technique eliminates the errors from direct manual observations. Here, the total number of vehicles and their categories for daily and weekly and evaluation of data. The data so obtained was coupled with ARAI emissions standards so as to determine the total emissions of CO, NO_2, PM and SO_2.

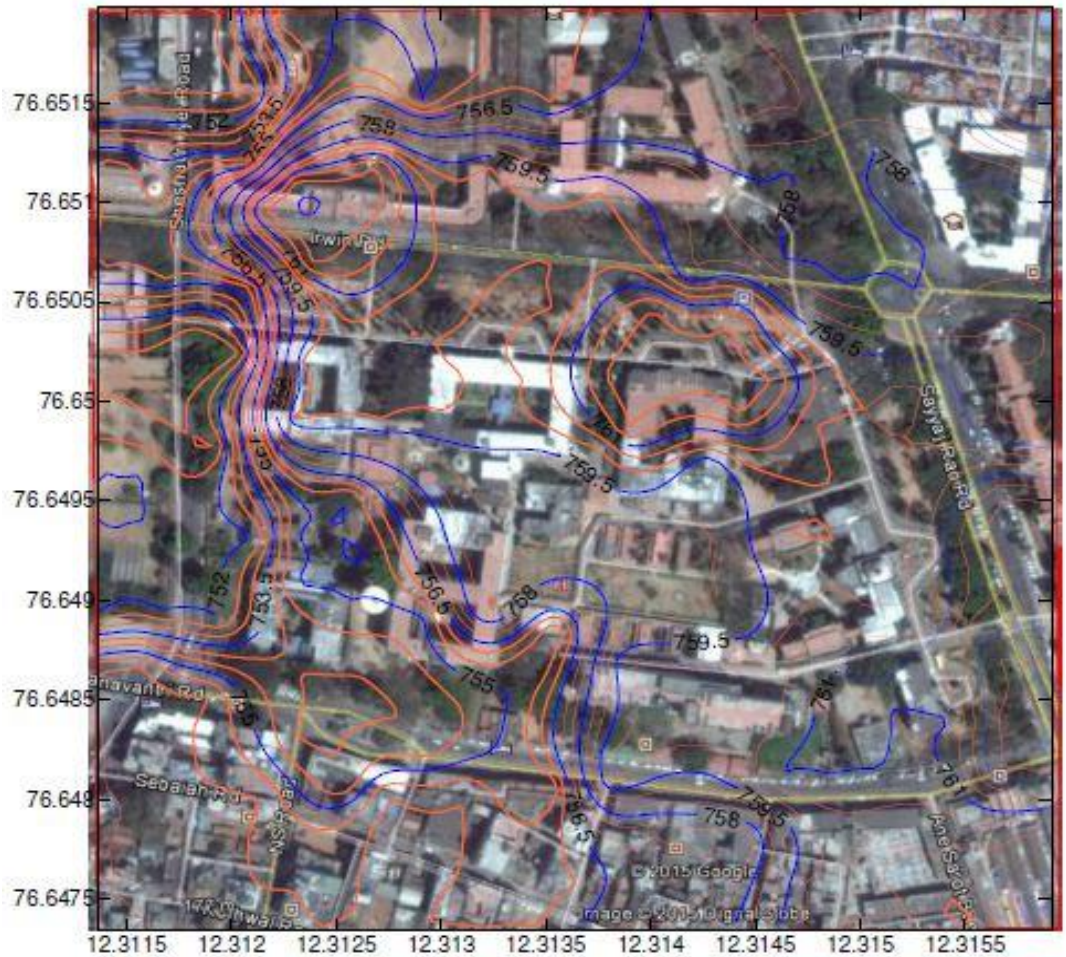

Fig. 2.1 Contour map of the Cheluvamba hospital

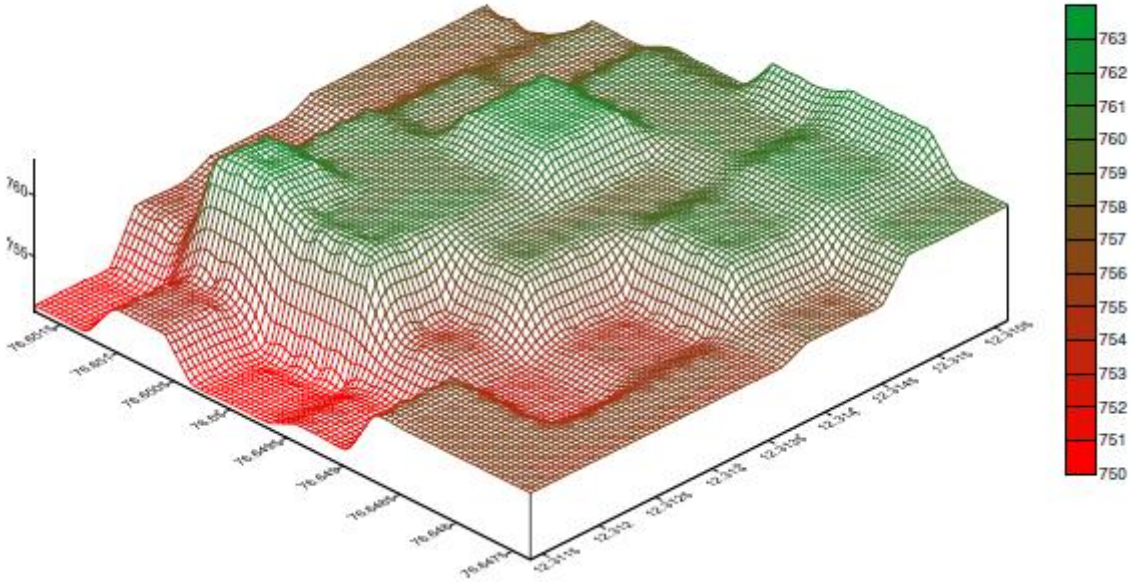

Fig. 2.2 Digital elevation map of Cheluvamba hospital

III. RESULTS AND DISCUSSION

3.1 Traffic volume at Cheluvamba hospital

The traffic flow at Cheluvamba hospital junction in Mysuru city studied for 90 days (3 months namely April, June and December representing three major seasons such as summer, monsoon and winter to show 24-hour variations in traffic flow of different categories of vehicles are depicted in Fig. 3.1 to Fig. 3.6

A. Summer-At the considered junction, road connecting city railway station to suburban bus stand intersects road connecting market to private bus stand would have allowed thousands of vehicles every hour. Through recorded video footage analysis, maximum 24hour vehicular count for the month of April was recorded on 13th day (66246)and minimum count was on 27th day (62217) with a difference of 6.08%, the fact that 13th day recorded more vehicle count could be attributed to the fact that it was a day before holiday, hence activities were more. Less number count was attributed to the fact that it was a middle of the week with no accelerated activity. Indicating the minimal difference in rate of change in traffic volume across the month. The hourly variations showed that peak traffic flow was from 14:00 – 15:00 hrs. (4584) could be due obvious reason that road is connecting bus stand and railway station and minimum during 01:00 – 02:00 hrs. (284 - 6.20% as that of peak) is due to the reason that no activity is carried throughout the city. Traffic flow rate of 70% up to peak was during 06:00 - 21:00 hrs. The traffic rates were well below 30% of peak count during 22:00 – 06:00 hrs. Even though the cumulative maximum of all vehicles were on 13th day, the maximum categorized vehicular count for different vehicles such as trucks (623) and buses (2965) on 11th day, SUVs (3435) on 29th day, cars (8532) on 15th day, rickshaw (12785) on 13th day and 2 wheelers (40035) on 24th day respectively. The monthly average of categorized contribution to the total traffic volume during this period was 0.888% (trucks), 4.264% (buses), 3.877% (SUVs), 13.005% (cars), 17.760% (rickshaws) and 60.206% (2-wheelers). These averages fluctuated minimally at 0.14%, 0.70%, 1.68%, 0.70%, 2.26% and 2.42% respectively for categorized vehicles.Vehicular volume for summer season at Cheluvamba hospital traffic intersection is graphically represented in fig 3.1

B. Monsoon - The maximum 24hour average vehicular count for the month of June was recorded on 24th (58120) and minimum count was on 27th day (57106) with a difference of 1.74%, reduction in number of vehicle compared to summer season is attributed to reduction of two wheelers in rainy season, indicating the narrow difference in rate of change in traffic volume across 30 days. The hourly variations showed that peak traffic flow was from 12:00 – 13:00 hrs (4151) and minimum during 01:00 – 02:00 hrs (258 - 6.22% as that of peak). Traffic flow rate of 60% up to peak were observed during 06:00-21:00 hrs. The traffic rates were well below 30% of peak count during 22:00 – 06:00 hrs. Even though the cumulative maximum of all vehicles were on 24th day, the maximum categorized

vehicular count for different vehicles such as trucks (490) on 5th day, buses (2290) on 24th day, SUVs (2073) on 24th day, cars (8014) on 29th day, rickshaw (10511) on 21st day and 2-wheelers (34787) on 24th day respectively. The monthly average of categorized contribution to the total traffic volume during this period was 0.819% (trucks), 3.940% (buses), 3.567% (SUVs), 13.766% (cars), 18.054% (rickshaws) and 59.854% (2-wheelers). These averages fluctuated minimally at 0.06%, 0.07%, 0.10%, 0.39%, 0.36% and 0.62% respectively for categorized vehicles.Vehicular volume for monsoon season at Cheluvamba hospital traffic intersection is graphically represented in fig 3.2

C. Winter - The maximum 24hour vehicular count for the month of December was recorded on 26th day (62710), reason could be attributed, it was a day after holidayand minimum count was recorded on 14th day (57776) with a difference of 7.87%, indicating minimal rate of changes in traffic volume. The hourly variations showed that peak traffic flow was from 11:00 – 12:00 hrs at 4329 and minimum of 236 (5.45% as that of peak) during 01:00 – 02:00 hrs. Traffic flow rate of 60% up to peak were observed during 06:00-22:00 hrs. The traffic rates were well below 30% of peak count during 22:00 – 06:00 hrs. Even though the cumulative maximum of all vehicles were on 26th day, the maximum categorized vehicular count for different vehicles such as trucks (592) on 11th day, buses (2835) was on 28th day, SUVs (2578) on 12th day, cars (8338) on 15th day, rickshaw (11723) on 25th day and 2-wheelers (38006) on 24th day respectively. The monthly average of categorized contribution to the total traffic volume during this period was 0.881% (trucks), 4.175% (buses), 3.709% (SUVs), 13.347% (cars), 17.920% (rickshaws) and 59.967% (2-wheelers). These averages fluctuated minimally at 0.14%, 0.70%, 0.77%, 0.88%, 1.45% and 1.89% respectively for categorized vehicles.Vehicular volume for winter season at Cheluvamba hospital traffic intersection is graphically represented in fig 3.3

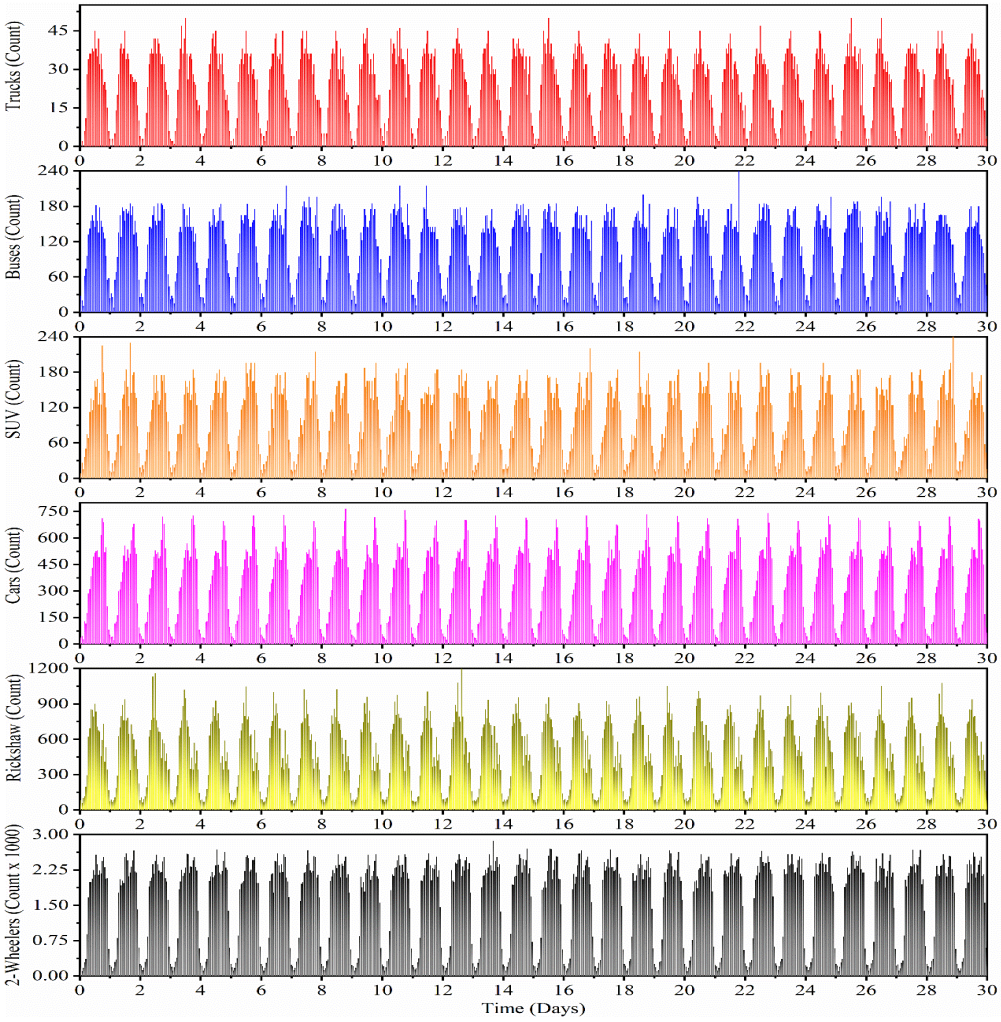

Fig. 3.1 Categorized vehicular volume for summer at Cheluvamba hospital junction

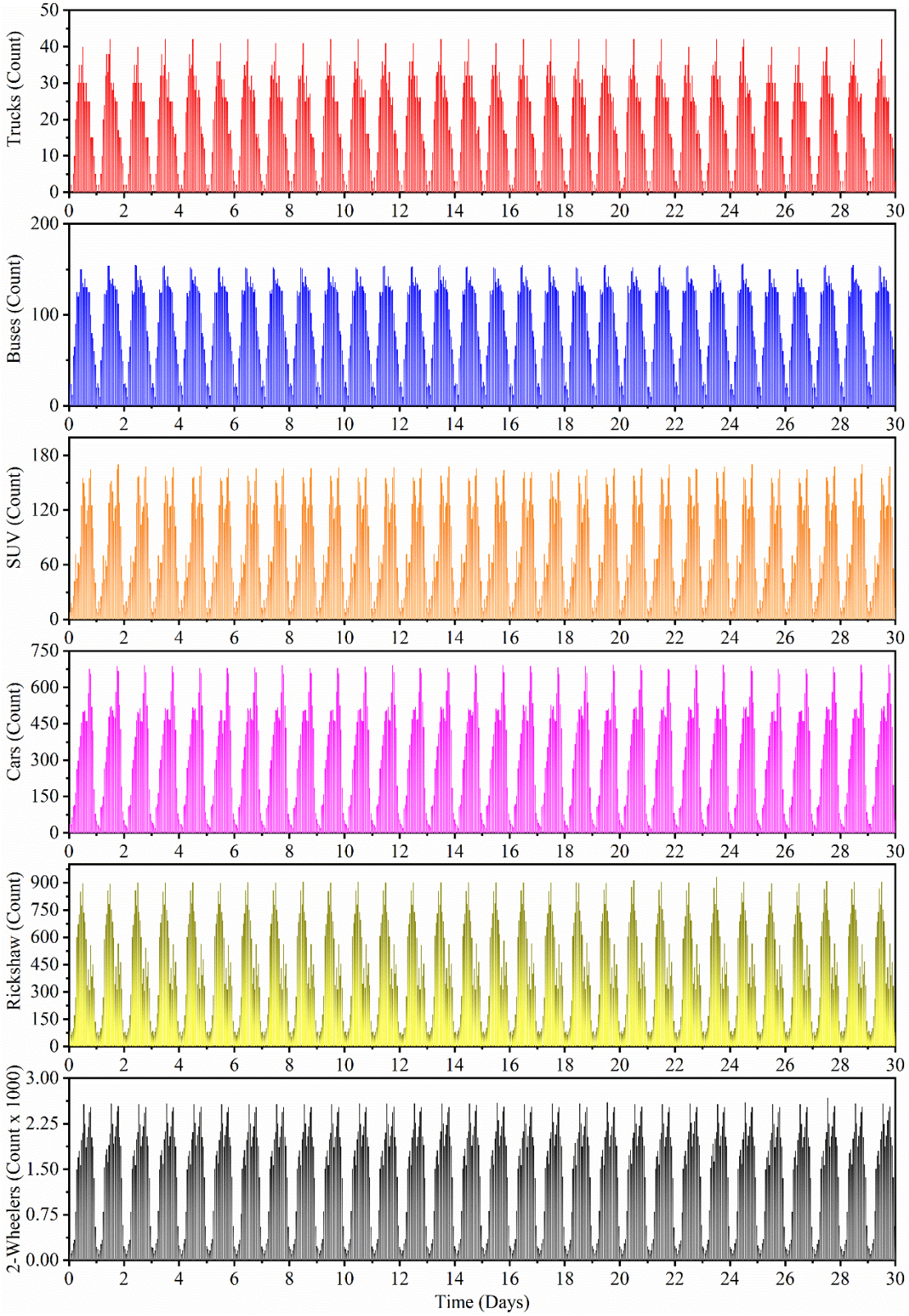

Fig. 3.2 Categorized vehicular volume for monsoon at Cheluvamba hospital junction

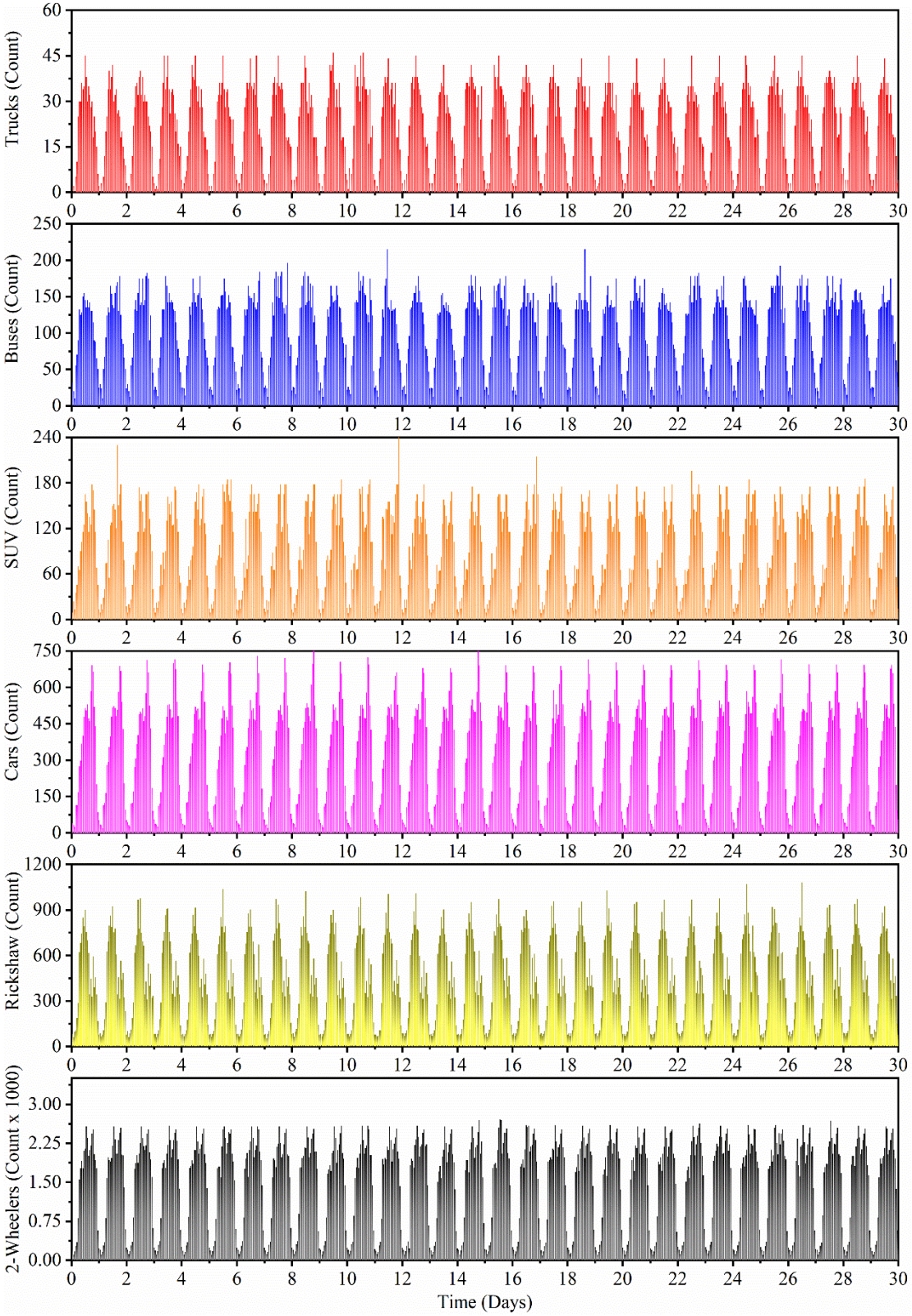

Fig. 3.3 Categorized vehicular volume for Winter at Cheluvamba hospital junction

3.2 Emission inventory

Emission inventory was prepared using the vehicular count for respective road. The key components of the inventory calculations also include pollutant specific standards and road length. Traffic volume studies were conducted to determine the number, movements, and classifications of roadway vehicles at a given location Also, the age of engine, commuting speed, maintenance and condition of roads further govern the emission characteristics[6]. It is the first step towards urban air quality prediction. Automotive Research Association of India's emission factors were considered in this inventory. These emission factors along with total number of vehicles per hour were used to calculate Emissions developed[7], [8].

Total Emissions=$\sum_{i=1}^{n}(V_1E_1 + V_2E_2 + V3E3-----VnEn*L$

Where E= emission factor for different category of vehicles, V= volume of different category of vehicle and L= length of the road From traffic studies, vehicles were categorized under 6 classes and their respective ARAI emission standards were used to determine the total emissions of CO, NO_2, SO_2 and PM at give road sections.

3.3 Vehicular emissions near Cheluvamba hospital

The vehicular emissions at Cheluvamba hospital junction in Mysuru city determined on basis of categorized vehicular count, road length and standard ARAI emissions for 90 days (3 months namely April, June and December) for a road length of 280.83 m adjacent to Cheluvamba pediatric hospital showing 24-hour variations in CO, NO_2, SO_2 and PM depicted in Fig. 3.4 to Fig. 3.6

A. Summer - In summer, the average hourly emissions of CO, NO_2, PM and SO_2 were 3175.54 g/h, 1.893 g/h, 137.09 g/h and 1.39 g/h respectively. The emission inventory showed that the maximum 24hour emissions of CO (79527 g/d), NO_2 (47.49 g/d), PM (3462.20 g/d) and SO_2 (35.33 g/d) for the month of April with a minimal variation of 6.80 – 9.50%. These maximum emissions were recorded on 13th, 29th, 11th, and 13th day respectively owing to categorized maximum vehicular days. The hourly variations of CO showed a peak of 6345.31 g/h on 13th day during 14:00 – 15:00 hrs and minimum of 442.34 g/h (6.97% as that of peak) during 01:00 – 02:00 hrs. The peak emission of NO_2 was 3.911 g/h during 20:00 – 21:00 hrs on 29th day and a minimum of 0.225 g/h (5.76% as that of peak) during 02:00 – 3:00 hrs. The peak emission of PM was 234.90 g/h during 13:00 – 14:00 hrs on 11th day and a minimum of 17.13 g/h (7.29% as that of peak) during 02:00 – 3:00 hrs. The peak emission of SO_2 was 3.29 g/h during 14:00 – 15:00 hrs on 13th day and a minimum of 0.22 g/h (6.59% as that of peak) during 02:00 – 3:00 hrs. Vehicular emissions for summer season near Cheluvamba hospital traffic intersection is shown in figure 3.4

B. Monsoon – In monsoon, the average hourly emissions of CO, NO_2, PM and SO_2 were 2845.48 g/h, 1.695 g/h, 119.04 g/h and 1.25 g/h respectively. The maximum 24hour emissions of CO (68916 g/d), NO_2 (41.07 g/d), PM (2883.73 g/d) and SO_2 (30.34 g/d) for the month of April with a very narrow variation of 2.10 – 2.60% across 30 days. These emissions were recorded on 24th day owing to categorized maximum vehicular days.

The hourly variations of CO showed a peak of 4919.04 g/h on 24th day during 11:00 – 12:00 hrs and minimum of 373.05 g/h (7.58% as that of peak) during 02:00 – 03:00 hrs. The peak emission of NO_2 was 2.869 g/h during 18:00 – 19:00 hrs on 24th day and a minimum of 0.193 g/h (6.73% as that of peak) during 02:00 – 3:00 hrs. The peak emission of PM was 195.49 g/h during 11:00 – 12:00 hrs on 24th day and a minimum of 14.36 g/h (7.35% as that of peak) during 02:00 – 3:00 hrs. The peak emission of SO_2 was 2.34 g/h during 11:00 – 12:00 hrs on 24th day and a minimum of 0.18 g/h (7.54% as that of peak) during 02:00 – 3:00 hrs.Vehicular emissions for monsoon season near Cheluvamba hospital traffic intersection is shown in figure 3.5

C. Winter – In winter, the average hourly emissions of CO, NO_2, PM and SO_2 were 2845.48 g/h, 1.695 g/h, 119.04 g/h and 1.25 g/h respectively. The maximum 24hour emissions of CO (75245 g/d), NO_2 (44.35 g/d), PM (3278.20 g/d) and SO_2 (33.26 g/d) for the month of April with a minimal variation of 9% – 12% across 30 days. These emissions were recorded on 24th, 26th, 28th, and 25th day respectively owing to categorized maximum vehicular days.

The hourly variations of CO showed a peak of 5281.54 g/h on 24th day during 11:00 – 12:00 hrs and minimum of 376.06 g/h (7.13% as that of peak) during 02:00 – 03:00 hrs. The peak emission of NO_2 was 2.980 g/h during 11:00 – 12:00 hrs on 26th day and a minimum of 0.197 g/h (6.60% as that of peak) during 02:00 – 3:00 hrs. The peak emission of PM was 209.18 g/h during 11:00 – 12:00 hrs on 28th day and a minimum of 14.59 g/h (6.97% as that of peak) during 02:00 – 3:00 hrs. The peak emission of SO_2 was 2.47 g/h during 11:00 – 12:00 hrs on 25th day and a minimum of 0.17 g/h (6.99% as that of peak) during 02:00 – 3:00 hrs.Vehicular emissions for winter season near Cheluvamba hospital traffic intersection is shown in figure 3.6

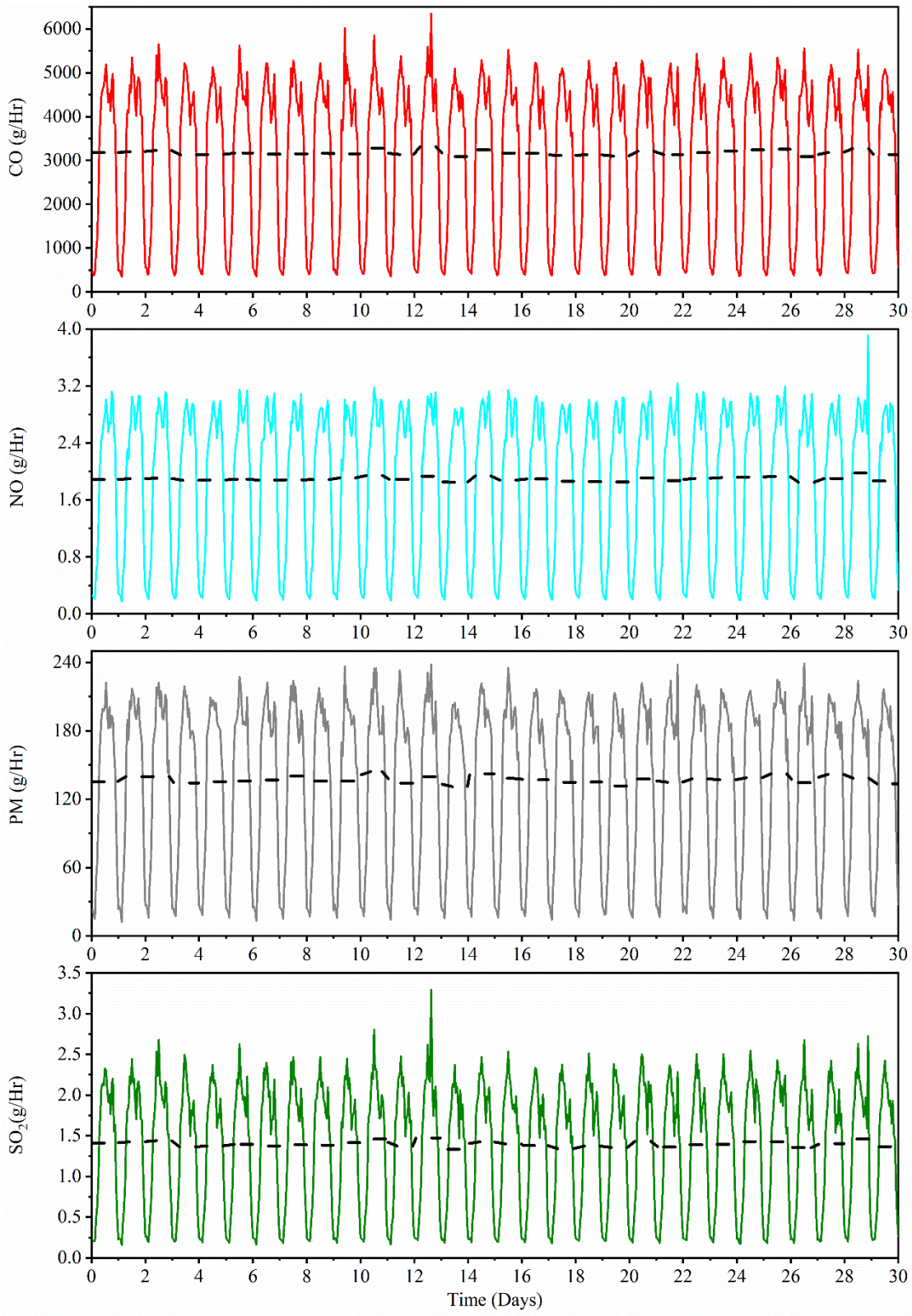

Fig. 3.4 Vehicular emissions for summer near Cheluvamba hospital

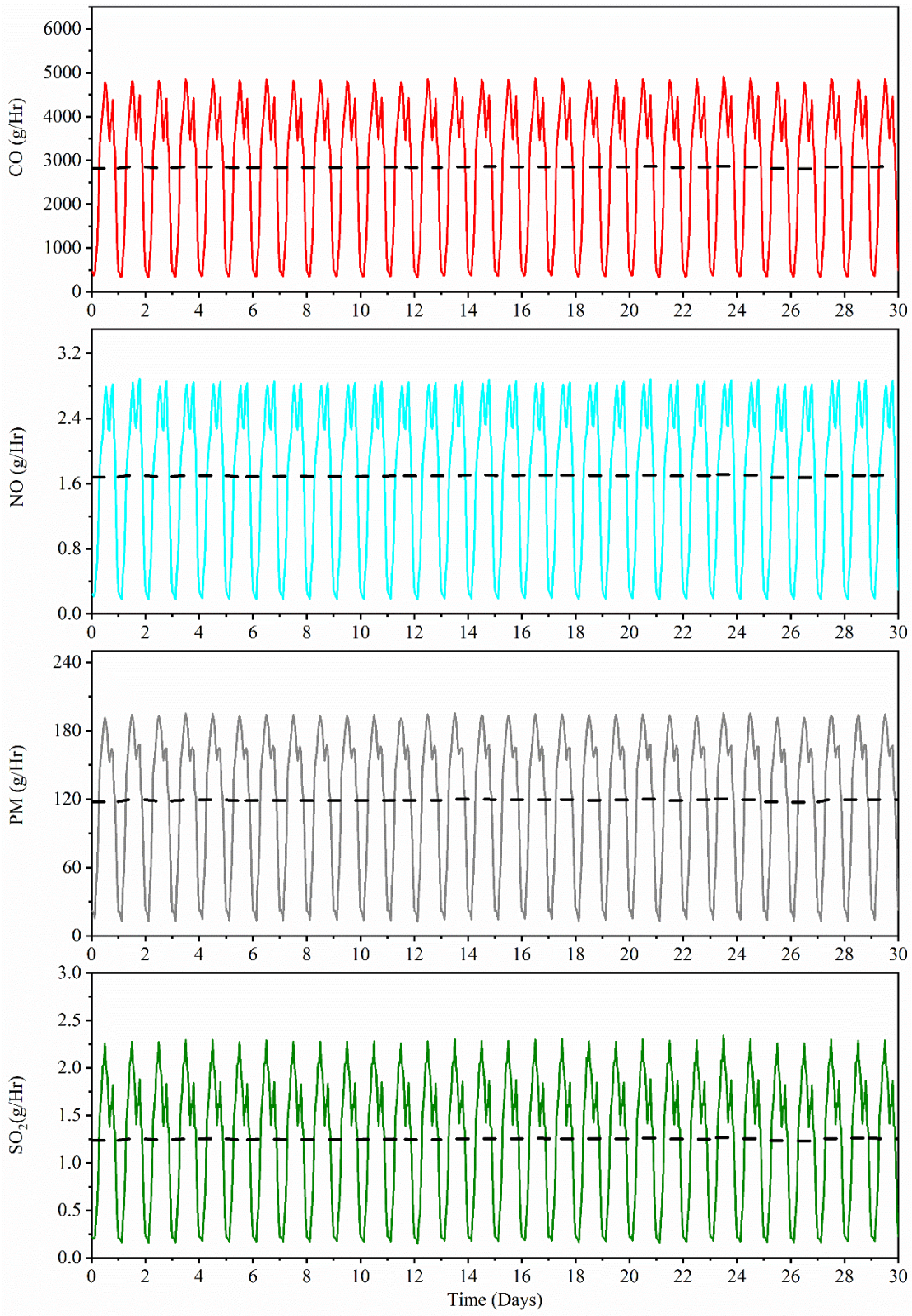

Fig. 3.5 Vehicular emissions for monsoon near Cheluvamba hospital

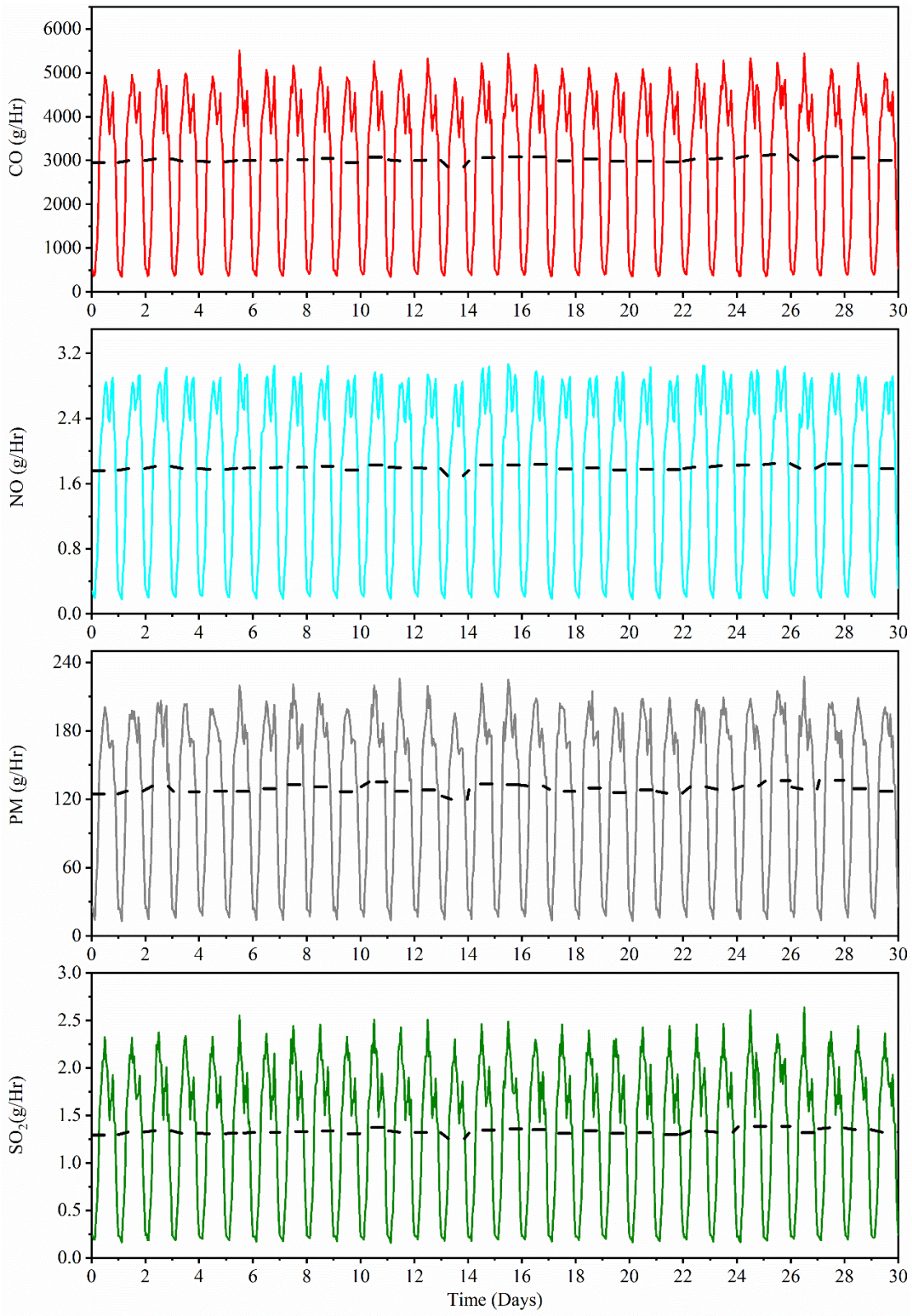

Fig. 3.6 Vehicular emissions in winter season near Cheluvamba hospital

IV. CONCLUSIONS

Cheluvamba Hospital located at major traffic junction connecting Railway station and central bus stand of Mysore city, carries traffic loads in excess of 60,000 vehicles per day.aThrough recorded video footage analysis, maximum 24hour vehicular count for three seasons was recorded. In summer season for the of month April, maximum vehicular count was recorded on 13th day (66246) and minimum count was on 27th day (62217) with a difference of 6.08% was noticed. In monsoon season,on 24thJune maximum count was recorded (58120) and minimum count was on 27th day (57106) with a difference of 1.74%, indicates the narrow difference in rate of change in traffic volume across 30 days. The maximum 24hour vehicular count for the month of December was recorded on 26th day (62710) and minimum on 14th day (57776) with a difference of 7.87%, indicating minimal rate of changes in traffic volume.

Vehicular emissions at Cheluvamba hospital junction in Mysuru city determined based on categorized vehicular count.In summer, the average hourly emissions of CO, NO_2, PM and SO_2 were 3175.54 g/h, 1.893 g/h, 137.09 g/h and 1.39 g/h respectively. In monsoon, the average hourly emissions of CO, NO_2, PM and SO_2 were 2845.48 g/h, 1.695 g/h, 119.04 g/h and 1.25 g/h respectively. In winter, the average hourly emissions of CO, NO_2, PM and SO_2 were 2845.48 g/h, 1.695 g/h, 119.04 g/h and 1.25 g/h respectively.

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