Air pollution levels in major urban cities in the Western Province in Sri Lanka

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**ABSTRACT:** Air pollution is a worldwide growing threat to the human being and the urban environment. Major urban centers in Sri Lanka also encounter this problem due to high urbanization rate and increasing vehicular population. Urban centers in the Western Province in Sri Lanka are the cities most vulnerable to air pollution problem since most administration and economical capitals and industrial activities are within the province and is growing rapidly and all three district centers of Colombo, Gampaha and Kaluthara are undergoing rapid development. Air pollution monitoring data in the major urban areas within the province indicates, that the cities are encountering air pollution problem especially due to the vehicular emission.

Annual average of NO$_2$ level in 2014 at major city centers within the province such as Colombo, Kaluthara, and Gampaha exceeded the annual guideline values recommended by the World Health Organization (WHO) 2005 while SO$_2$ values exceeded the 24 hour guideline value. However, the pollution trends in each city shows decreasing trend from 2012 to 2014. The pollutant levels at traffic congested areas of each urban area are comparatively higher than that of surrounding areas. The highest pollution levels within the province were recorded at Colombo and lowest was recorded at Gampaha city.

1 INTRODUCTION

The Western Province of Sri Lanka is functioning as the capital province with respect to both administration and commerce in the country. Most of the government institutions and administration centers, commercial and industrial activities, residential houses, schools and other educational institutions, base hospitals etc. are located within the area (Premasiri et al,2004). The total land area of the province is about 3683 square kilometers accounting to 5.7% of the total land area of the country. About 27% of the total population in the country is living within this area. The population density of the province varies from 1400 to 1500 persons/sq.km and it is mostly concentrated in urban centers due to migration from rural areas for economic benefits (Dept. census & Statistics). About 60% of the vehicular fleet in Sri Lanka operates within the Western Province and the vehicular population growth is approximately 12% per annum. About 70% of industries are also located in the Province including high polluting industries such as thermal power plants, iron smelting, petroleum refinery etc. Accordingly, about 85% of fossil fuel used in Sri Lanka is consumed within the Western Province. Air pollutants released from industrial, transportation, commercial and domestic sectors, power plants and incinerators etc. within the province contribute to air pollution within the area. Air quality studies results have shown that the Western Province is the most polluted province among the 9 provinces in Sri Lanka. The estimated load of air pollutants released to the atmosphere in the area is increasing due to the growth of vehicular population, urbanization and increasing demands on other sectors (Premasiri et al, 2009).

Western Province has three districts Colombo, Gampaha and Kalutara and instead of industrial activities scattered in the district most of other activities are concentrated in the district centers of Colombo urban area, Kaluthara urban area and Gampaha urban area. The statistical data in three district centers indicates that the population density, vehicular population, commercial and industrial activities etc. vary from city to city (Premasiri et al,
For instance, the population density of Colombo, Gampaha and Kalutara urban area are about 179.59, 20.7 and 36.36 persons/sq.m respectively. The number of registered vehicles in Colombo is about 656,026, in Gampaha it is about 381,749 and in Kalutara is about 146,400 according to the census 2012. (Statistical data sheet Sri Lanka, 2012). In addition, the environment of each urban centers shows varying conditions. The Colombo is a coastal highly urbanized area surrounded by sub-urbans and significant number of vehicles and having communities reach from outside. Whereas, Gampaha is an isolated city within in the sub-urban of Colombo and only selected number of vehicles and people travel to city. Kalutara urban area is also a coastal city where considerable number of vehicles pass through the city to other areas.

Due to variations in population, vehicle fleets and environmental condition, the air pollution levels in each city area may differ from city to city. Since most of air pollution studies are concentrated to Colombo, this paper discusses the air pollution levels in two other major urban centers of Gampaha and Kalutara district and data are compared with Colombo the capital city.

2 METHODOLOGY

Since there are high variations in other pollutant sources around the cities, Municipal Council areas Colombo, Gampaha and Kalutara were selected for the study of air pollution levels that are mainly influenced by vehicular emissions. Air pollution sampling locations were selected to represent different environmental conditions in each urban center. Air sampling was done to capture monthly average exposure levels of Sulfur Dioxide (SO₂) and Nitrogen Dioxide (NO₂) from total of 35 sampling locations, 19 locations in Colombo, 11 locations, in Gampaha and 5 locations in Kalutara urban area by considering spatial extent in each area. Sampling locations in Colombo, Gamph and Kalutara urban areas are presented in Figure 1, 2 and 3 respectively.
The low cost passive sampling technique was used for the collection of monthly average exposure level of Sulfur Dioxide (SO$_2$) and Nitrogen Dioxide (NO$_2$). Samples were prepared and analyzed using validated standard test methods. At each location, passive sampling apparatus were installed and exposed to atmosphere in open air with a minimum distance of 3 m from any structure and at 3 m height from the ground level. Exposed samples were collected and replaced with new set of samples after one month period to collect monthly data. The samples were then analyzed in the laboratory by using SHIMADZU UV1650 PC Spectrophotometer for NO$_2$ and DIONEX ICS-90 ion chromatograph for SO$_2$. A set of blank samples and standard samples were also analyzed with each set of samples for assuring quality control level of the analytical method.

3 RESULTS AND DISCUSSION

Variation of monthly average NO$_2$ levels at each location in Colombo urban area is presented in fig. 4 and it shows that the pollutant levels in high traffic congested areas were high and levels decrease from the traffic area and in high elevated areas. The similar variation is observed in Gampaha and Kalutara urban areas as shown in Fig. 5 & 6 respectively. The SO$_2$ levels in all three urban areas also follow the same pattern.
Figure 6: Spatial variation of NO2 in Kaluthara Urban Area

Monthly average pollutant levels in each city from October 2012 to December 2014 are given in figures 7, 8 and 9 respectively. The results indicated that the pollutant levels are highly subjective to the seasonal climate in the area where high levels were observed in North-East monsoon when compared to the South-West monsoon.

Figure 7: Seasonal variation of SO2 in Colombo Urban Area

Figure 8: Seasonal variation of SO2 in Gampaha Urban Area

Figure 9: Seasonal variation of NO2 in Kalutara Urban Area

The results of each city indicate that the monthly average levels of SO2 and NO2 in 2014 at each location were within the 24 hour average national ambient air quality standard levels (100 μg/m³ for NO2 and 80 μg/m³ for SO2). However, 2014 annual average air pollution levels with respect to NO2 indicate values higher than that of the WHO annual guideline values specially at highly traffic congested areas in all the three cities, Colombo, Gampaha and Kalutara as presented in figures 10, 11 and 12.

Figure 10: Annual Average NO2 levels in Colombo Urban Area in 2014
When annual average pollutant levels are concerned, the pollutant levels in most of the locations in all 3 cities have increased from 2012 to 2013. However, the levels have decreased in 2014 as shown in figures 13, 14 and 15.

The results indicate that out of three urban areas, the Colombo Urban area shows the highest pollution with respect to $SO_2$ while Kalutara and Gampaha are second and third respectively. The Colombo Urban area has highest pollution with respect to $NO_2$ and Gampaha and Kalutara have equal levels.
4 CONCLUSION

In all the three urban areas, the pollutant level are comparatively high in high traffic congested areas and pollution level decreases gradually outwards from the high traffic areas. Pollutant levels are highly subjective to the seasonal climate of the area where impact of relatively high North-East monsoon is strongly felt when compared to the South-West monsoon.

The pollutant levels in all three urban areas are related to vehicular density and the highest pollution levels are shown in Colombo urban area while placing Kaluthara and Gampaha as second and third place respectively.

The measured monthly average levels of SO$_2$ and NO$_2$ in each cities Colombo, Gampaha and Kaluthara were below the 24 hour average national ambient air quality standard whereas NO$_2$ levels exceeded the WHO annual guideline value in 2014 especially at highly traffic congested areas.

The urban air pollution has become a serious environmental issue. Despite of continuous efforts taken to reduce the pollutants in emissions studies have shown that air pollution is linked with number of serious health problems.

The three cities coincided in the study come under Western Province where mega polis city development plan is proposed. The proposed development is expected to increase the air pollutant emissions by several fold and hence EMPS should pay special emphasis to central potential impacts of increased air pollution due to proposed mega development project.

5 REFERENCES