

Evaluation and future predictions of air pollutants level in Karachi city

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Abstract. The purpose of this study was to determine the present air pollutant concentrations and predicted levels for next 30 years in urban environment of Karachi city. For that, a total of fifty measurements were made for each twenty selected locations of the city. The locations were selected on the basis of land use pattern such as residential, commercial, industrial settlements, open areas, congested traffic and low traffic areas for investigation of air pollutants variability and intensity. The measurements were taken continuously for six months period using PM Meter, Model AEROCET 531 and Ambient Air Quality Meter, Model AAQ 7545. The concentration of air pollutants were found higher at Al Asif Square and Maripur Road due to higher intensity of traffic and at Korangi Crossing because of industrial areas. The level of pollutants was lower at Sea View owing to lower traffic congestion and transportation of pollutants by sea breezes.

Keywords: air pollutants; carbon compounds; vehicle emissions; particulates matter; urban areas

1. Introduction

Air pollution and its consequences on the society in the urban areas have been known since long times. However, the approach towards solution of these problems was ambiguous. Even, air pollution was considered as a sign of progress and prosperity, and the endeavors to fight them were discrete and ineffective. In recent years, the public feels that pollution is detrimental to health and prosperity, especially in urban agglomerations. Major probable causes for air-quality deterioration in cities are urban population growth combined with change in land use pattern in urban areas because of migration of people from rural areas towards cities (Vera and Langlois 2007, Zhang *et al.* 2010). This population growth raised the rate of air pollutant emissions. Although, the emission rate per inhabitant of major air pollutants is presently higher in industrialized countries yet the tendency is obvious that this rate will be higher in developing countries in future.

The emission of air pollutants in cities are mainly caused by different source groups such as motor traffic, industry, power plants, trade, domestic fuel etc. It is reported that motor traffic contributes more than half of the air pollution in megacities (Mayer 1999, Baumbach 2012, Molina

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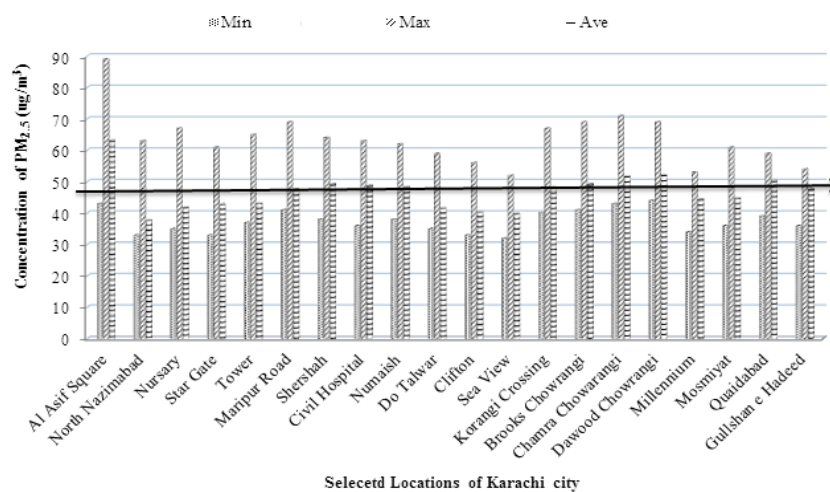


Fig. 1 Concentration of particulate matter, $PM_{2.5}$ at various locations of Karachi

out in different timings of the day like morning, afternoon, evening and night to explore the variations during different periods of time. The readings were taken on the three different days of the week, like Monday, Friday and Sunday to evaluate the pollutants difference between working days and weekends continuously for six months. The sites were selected on the basis of land use purpose such as residential, commercial and industrial settlements and open areas for investigation of air pollutants intensity. US EPA's standard method "Ambient Air Quality Surveillance Siting Criteria" was adopted using spectrometric direct equipment for the air pollutants measurement (Mukwana 2015, Ott 1977).

3. Results and discussions

The measured results of twenty different locations are presented first and then predictions were made based on the measured results for future fate of air pollutants in the city. Figs. 1 to 4 illustrates the current concentration level during study period and Figs. 5 to 8 predicted results of $PM_{2.5}$, PM_{10} , CO_2 and CO respectively. The horizontal arrow over the figures indicates the maximum permissible value of Ambient Air Quality Standards. The standards for particulate matter and carbon monoxide is set by Pakistan Environmental Protection Agency (PEPA), whereas, for the level of carbon dioxide the guideline value is given by World Health Organization (WHO), (Parekh *et al.* 2001, Gurjar *et al.* 2008).

3.1 Measurement of air pollutants

The recorded minimum, maximum and average values of Particulate Matter ($PM_{2.5}$) of various locations of Karachi city are shown in Fig. 1. It was found that maximum, minimum and average value of $PM_{2.5}$ was higher at most of the locations except Star gate, Clifton and Sea View. The maximum concentration of $PM_{2.5}$ was observed at Al Asif Square with $90 \mu g/m^3$, Maripur Road $68 \mu g/m^3$, Korangi Crossing $66 \mu g/m^3$, Brooks Chowranghi $68 \mu g/m^3$, Chamra Chowranghi $68 \mu g/m^3$ and Dawood Chowranghi $70 \mu g/m^3$, against the maximum permissible level of $35 \mu g/m^3$.

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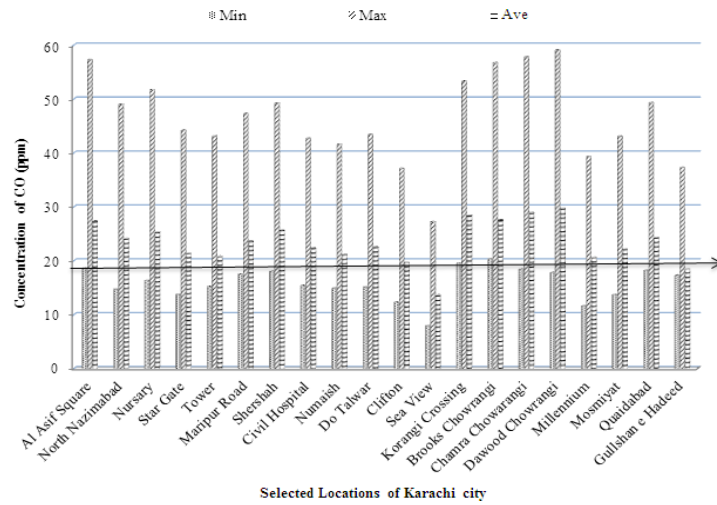


Fig. 4 Concentration of carbon monoxide at various locations of Karachi

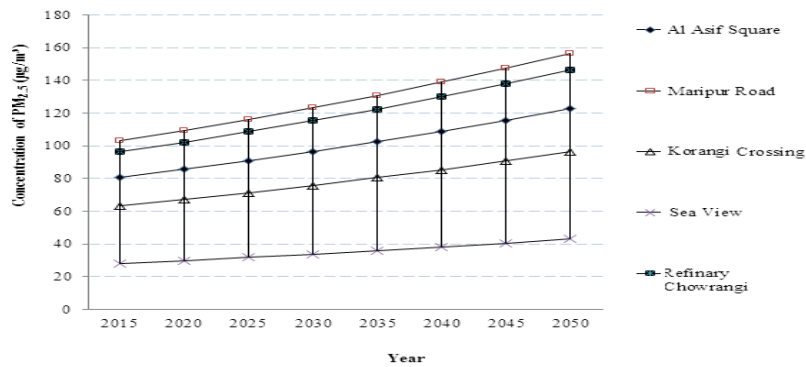


Fig. 5 Predicted concentration of particulate matter, $PM_{2.5}$ at various locations of Karachi

and average values of CO are higher at most of the locations. The maximum concentration of CO was observed at Al Asif Square with 57 ppm, Korangi Crossing 52 ppm, Brooks Chowrangi 56 ppm, Chamra Chowrangi 58 ppm, and Dawood Chowrangi 59 ppm against the maximum permissible level of 10 ppm.

3.2 Future predictions of air pollutants

Future predictions of air pollutants were made using measured data of air pollutants through OpenAir software. The OpenAir software is based on Artificial Neural Network (ANN) and is used by researchers for predicting the ambient air quality. It gives the status of ambient air quality, ranging from good to hazardous. The working of OpenAir Model which offers wide range of data analysis and statistical abilities has excellent graphics output. There are over 4000 packages that offer suitable analysis techniques (Mukwana 2015). In this research work the predicted results of $PM_{2.5}$ from year 2015 to year 2050 of various locations of the city are illustrated in Fig. 5. It was found that the growth rate of $PM_{2.5}$ varies from 1% to 4% in the city. The current average level of $PM_{2.5}$ at Al Asif Square, Manipur Road, Korangi Crossing and Sea View in year 2015 was 80.50

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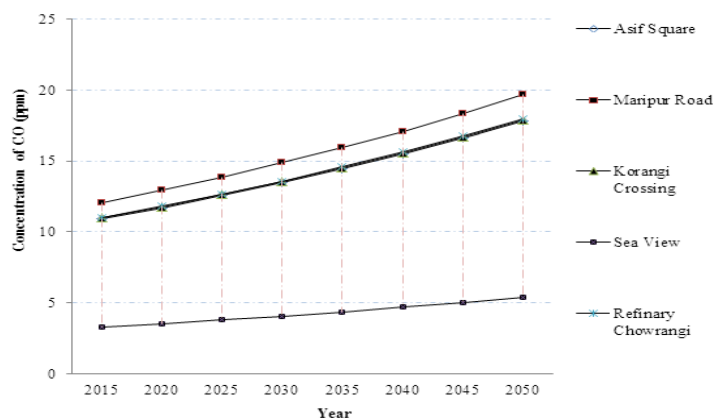


Fig. 8 Predicted concentration of carbon monoxide at various locations of Karachi

the year 2050 would be 17.80 ppm, 19.66 ppm, 17.90 ppm, and 5.38 ppm respectively. Since, it was assumed that the factors and sources contributing to the addition of particulates in the air are unchanged. Results revealed that the current level of $PM_{2.5}$ is higher at the Al Asif Square and Maripur Road locations due to higher intensity of road traffic, therefore the predicted values are also showing heavy concentration in year 2050. However, in case of Sea View, the current and predicted values of $PM_{2.5}$ are low as the location is quite free from traffic congestion as compared to that of other locations of Karachi.

4. Conclusions

The level of pollutants in ambient air was found higher at Al Asif Square and lower at Sea View as compared to other selected locations of Karachi city. At Al Asif Square location, the measured $PM_{2.5}$, PM_{10} , CO_2 and CO concentration was found $80.50 \mu g/m^3$, $325.56 \mu g/m^3$, 423.13 ppm and 10.91 ppm , whereas, the predicted values for the year 2050 were $122.51 \mu g/m^3$ and $495.48 \mu g/m^3$, 794.47 ppm and 17.80 ppm respectively. Similarly, at Maripur Road and Korangi Crossing, the level of air pollutants was found higher like at Al-Asif Square than other locations of the city. The level of air pollutants at Sea View were found lower with $28.16 \mu g/m^3$, $96.73 \mu g/m^3$, 378.30 ppm and 3.3 ppm and the predicted value for the year 2050 were $42.85 \mu g/m^3$, $147.21 \mu g/m^3$, 710.30 ppm and 5.38 ppm for $PM_{2.5}$, PM_{10} , CO_2 and CO respectively as compared to other examined locations, may be due to lower intensity of traffic.

It was concluded from the study that the concentrations of air pollutants were found higher at Al Asif Square and Maripur Road due to higher intensity of traffic and at Korangi Crossing owing to industrial settlements, whereas, the level of pollutants were found lower at Sea View due to lower intensity of traffic and movement of pollutants towards land area due to sea breezes.

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