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Determination of Air Quality index (AQI) of Aerosol Particles along Busy Roads in Karachi Metropolitan, Pakistan

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ABSTRACT

This study was carried out to determine the concentration of ambient air quality in terms of air born particulate matter (PM10) at 10 different monitoring locations along the busy roads of Karachi city. Concentrations of particulate matter were used to calculate the results in terms of Air Quality Index (AQI). At each location, the study was carried out continuously for a period of 08 hours in each month during the year 2013 to 2017. Results along the selected sites show that at most of the sites have very poor to hazardous AQI category regarding the PM10 Concentration, exceeds the permissible limits as specified by US-EPA. This high concentration of pollution is very harmful for human health to the residents.

Keywords: Karachi City; Air Quality Index; Ambient Air; Particulate Matter

Introduction

Air pollution is a global hazard and has immense effects on human health, metrology, climatic changes and ecosystem. In developing countries modernization and industrialization increases the use of fossil fuel in many ways and producing environmental damages especially in rapidly growing megacities [1,2]. According to the World Health Organization (WHO), urban air pollution is responsible for approximately 800,000 deaths annually around the globe [3]. At present Particulate matter pollution is one of the most important issue in urban cities, not only producing adverse health effects, reducing the atmospheric visibility and also affect the status of cultural heritages [4]. [5-7] show a strong association between elevated concentrations of inhalable particulate (PM10) and increased mortality and morbidity. Several researches associated with particulate matter pollution also show increase in hospitalizations, lung function disorder, asthma, bronchitis, other respiratory diseases and premature deaths (Sicard et al., 2011) [8-10].

The air quality index (AQI) is a scale to show or characterize the degree of ambient air pollution at a particular monitoring location during a certain monitoring period (e.g., one, 8 or 24 h) due to the concentration of human activities that occur in cities. The main aim of AQI calculation is to aware the public about the risk of pollution level day to day and to prepare for precautionary measurement and to regulate the safety measures for health hazards (Figure 1).

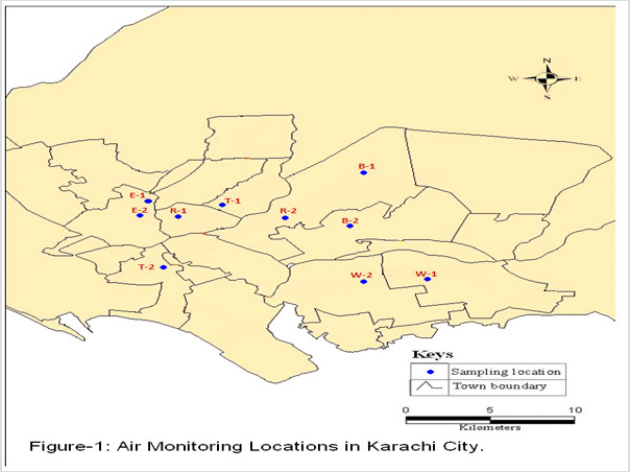

Figure 1: Air monitoring locations in karachi city.

Materials and Methods

Sampling was carried out at ten different locations consisting of main roads, side road, round about, and open places along the busy roads of Karachi during 2013 - 2017 for PM10. Selected locations were differentiated as Residential, Commercial and Industrial areas of the Karachi's environment. PM10 samples were collected on glass fiber filters (203×254 mm) by using high volume air sampler with an average flow rate of 1.0 m3/min. Eight hour sampling was done in duplicate at each location during the year 2013-2017. The high volume is considered a reliable instrument for measuring the weight of PM10 in ambient air (USEPA-Method 40 CFR).

Air Quality Index (AQI)

In this study AQI has been calculated with reference to the concentration of particulate pollution proposed by US-EPA (US-EPA, 2012). Following equation was used to calculate the AQI values by using the pollutant concentration data.

$$I_p = \frac{IHi - Ilo}{BPHi - BPLo}(C_p BPLo) + ILo$$

After compiling the data, the concentration of PM10 pollutant was converted in to an AQI value for each location, higher the AQI value, higher the level of air pollution and describe the associated health hazards, providing meaning full information to the citizens. The Table 1 shows the air quality index with the category of health risk. The air quality index zero to fifty is good for human health and indicate clean air, 50 to 100 indicate moderate air quality, 101 to 150 point toward unhealthy for sensitive group, 151 to 200 express unhealthy for all people, 200 to 300 very unhealthy, 301 to 500 hazardous and > 500 indicate sever hazardous (Table 1).

Table 1: AQI criteria and quality category.

AQI	AQI Category	Colour Show the Category
0 - 50	Good	Green
51 - 100	Moderate	Yellow
101 - 150	Unhealthy for Sensitive	Orange
151 - 200	Poor / Unhealthy	Red
201 - 300	Very poor / very unhealthy	Purple
301 - 500	Hazardous	Mahroon

Note: Source: US-EPA (2012) and Gurjar et al. [9].

Table 2: AQI values / Category of Aerosol Particles (PM10) at the selected locations in Karachi city.

Sr #	Locations		2013		2014		2015		2016		2017	
			AQI Value	AQI Category	AQI Value	AQI Category	AQI Value	AQI Category	AQI Value	AQI Category	AQI Value	AQI Category
1	Karimabad	C -1	122	unhealthy	145	unhealthy	180	Poor	167	Poor	200	Poor
2	Tibet Centre	C -2	178	Poor	210	Poor	226	V.Poor	200	Poor	188	Poor
3	Liaquatabad	C -3	147	Poor	186	Poor	210	V.Poor	173	Poor	162	Poor
4	PIB Colony	R -1	102	unhealthy	120	unhealthy	157	unhealthy	130	unhealthy	145	unhealthy
5	Nazimabad	R -2	108	Moderate	123	unhealthy	168	unhealthy	136	unhealthy	155	unhealthy
6	Gulshan-e-Iqbal	R -3	67	Moderate	100	Moderate	142	unhealthy	84	Moderate	127	unhealthy
7	Siemens Chorangi	I-1E	140	Poor	167	Poor	194	Poor	120	Poor	183	Poor
8	Naurus Chorangi	I-2E	127	unhealthy	161	Poor	179	Poor	110	unhealthy	150	Poor
9	Singer Chorangi	I-3W	90	Moderate	130	unhealthy	164	unhealthy	102	unhealthy	120	unhealthy
10	Chamra Chorangi	I-4W	110	unhealthy	139	unhealthy	154	unhealthy	106	unhealthy	130	unhealthy

Result and Discussion

Evaluation of the concentrations of ambient PM10 were determined on the basis of PM10 size fractions at the selected sites in Karachi city. Ambient AQI values has been calculated with the recorded pollutant concentration data of the selected sampling locations, showing the degree / intensity of ambient air pollution category at monitoring locations during a certain monitoring period (e.g., 1, 8 or 24 h) due to its surrounding metrology and human activities and its relation to health hazards. Table 2 shows the intensity of the pollution level according to AQI category. Yearly average concentration of PM10 shows rising trend during the year 2013- 2015 and then a little bit start decreasing / controlling for

specific period. The result suggested that rising trend during the year 2013 to 2017 may be due to civil works for overhead bridges and extension of roads and island at different locations in Karachi, again start rising after 2017 may be due to unplanned development, many fold increase in vehicles on poorly maintained roads and insufficient road spaces, less parking facilities, encroachment on roads and footpath, violation of traffic rules with an alarming traffic management strategy are the main issues of rising trend of urban air pollution. The calculated Air Quality Index values for PM10 shows moderate and unhealthy pollution level in residential areas, poor or unhealthy pollution level found at all the sampling locations in industrial areas, whereas Poor or very unhealthy pollution level has been recorded in commercial areas respectively.

Conclusion

The present study reveals that the concentration of suspended particulate matter exceeded the permissible standards in highly commercial areas, densely populated residential areas and in industrial areas. High concentration of particulate pollutants has a significant negative impact on the ambient air quality status of Karachi city as in terms of Air Quality Index. The main source of pollutant appears to be vehicular emission as its concentration is highest in the sites located in the busy commercial areas of the city with high traffic density. From the studies it is evident that development and planning of the transport system and social awareness can play a major role in improving the quality of air in the city.

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