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RESEARCH ARTICLE

AIR QUALITY INDEX (AQI) OF ATMOSPHERIC POLLUTANTS IN DIFFERENT PARKS AND PLAY GROUNDS OF KARACHI CITY AND THEIR ASSOCIATED HEALTH HAZARDS

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ABSTRACT

Aim of this study was carried out to determine the concentration of ambient air quality of Karachi city in terms of Air Quality index (AQI). The data of air pollutants were collected from ten different parks and play grounds in residential, industrial and commercial areas of the city. The survey was carried out to evaluate the concentrations of atmospheric trace gases: sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO) and particulate matter (PM_{10}) by sampling for a period of 24 hours in winter season of the year, 2014. Sampling was done at ten different Parks and play ground i.e. PIB colony park(R-1), Nazimabad Cricket ground(R-2), Taleemi bagh (R-3) in residential areas, paramount cricket ground (I-1), Qyyum park (I-2), Naurus green belt(I-3), Siemens green belt (I-4) in industrial areas, Hill park (C-1), F.C area Cricket ground (C-2) and Zoological Garden(C-3) in commercial areas of Karachi city. Pollutants concentrations were used to calculate the Air Quality Index (AQI). Air quality index are used for local and regional air quality management in many cities of the world. The experimental results in this study obtained from different air quality categories according to national ambient air quality standard at different parks and play grounds, as Taleemi Bagh (R-3) in residential area though looks a clean area, falls under Good AQI category regarding the trace gases and moderate category regarding the PM_{10} pollution, as this is purely residential area with low traffic density whereas PIB colony park (R-1) and Nazimabad Cricket ground (R-2) shows moderate pollution AQI category regarding the trace gases pollution and unhealthy pollution, regarding the PM10 pollution with moderate traffic density. In commercial areas parks Zoological garden (C-3) falls under high pollution AQI category. This garden is situated in extremely congested commercial area with high traffic density and high commercial activities, F.C area Cricket ground (C-2) also falls under unhealthy AQI category, whereas Hill park (C-1) falls under moderate pollution level. In industrial areas parks and play grounds Paramount cricket ground (I-1), Qayyum park(I-2), Naurus green belt (I-3) show moderate pollution AQI values whereas, Siemens green belt (I-4) falls under unhealthy category may be due to industrial activities and high traffic density.

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INTRODUCTION

Air pollution is global environmental problem that influences mostly health of urban population. These days air pollution is well-known to be significantly aggravated by infectious atmospheric trace gases, liquid droplets and suspended solid particles (Kaldellis *et al*., 2012), that may be directly emitted (primary pollutants) and / or formed into the atmosphere (secondary pollutants). Primary pollutants emitted directly into the air both from human activities (e.g. agricultural activities, power plants, industrial processes, combustion of fossil fuels, burning of biomass, construction and demolition activities etc.) and from natural processes (e.g. plants' photosynthesis, forest fires, volcanic eruptions etc.). Whereas secondary pollutants, such as ground level ozone, not emitted directly but are formed into the atmosphere when primary pollutants react chemically with one another or with natural component of atmosphere (Panda *et al*., 2010). In Pakistan ambient air quality have increasingly deteriorated due to anthropogenic sources like industrialization, unplanned urbanization, rapid growth of population, open burning of waste and vehicular emission due to poor transportation system. Many decade scientist and researchers have provided undeniable data that the emission and deposition of air pollutants damage the life and quality of plants and animals, quality of water, degraded the soil, productivity of forest and hazards for human health. It becomes an important environmental risk factor for

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cardiopulmonary and cardiovascular diseases. High Particulate matter pollution is one of the most important issue in urban cities, not only affect the status of cultural heritages mainly affect the severe health hazards particularly pulmonary disorder, it can penetrate deep into the lungs and cause pulmonary disorder (Raina Pal, *et al*, 2014). Besides particulate matter, literature also suggests that there is a strong relationship between higher concentrations of SO_2, NO_2 and CO may exaggerate several health effects (AnnunziataFaustini, *et al*, 2014). As air pollution is one of the major problems of modern day societies, especially in urban areas. In order to control the intensity of air pollution and to avoid hazardous effects on human being and environment, scientist use mathematical models in order to define the overall status of the air quality in the area under investigation. 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., 1, 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. Generally it is related with the pollutants range and category describe as good, moderate, poor or hazardous in order to understand the meaning of AQI easily. In a simple way AQI shows that ambient air is how much polluted and what are the health hazards for the citizens (Kanchan *et al*, 2015). Airquality Index is the number used by the agencies to communicate to the public that how polluted the air is or howpolluted it will become ((USEPA, 2014), for an effective ambient air quality monitoring, meteorological dataof an area should also be recorded. Some of the similar study in the field of ambient air quality monitoring and AQI study are Sahu *et al*., 2015, Dash and Dash, 2015 a and b; Sahoo D., *et al*., 2017. United State Environmental Protection Agency (US-EPA) is using the AQI for five major “criteria pollutants” viz. ground level ozone, particulate matter, carbon monoxide, sulphur dioxide and nitrogen dioxide. For each of these pollutants EPA has set National Ambient Air Quality Standards (NAAQS) against the risk of pollution on human health and environment (US-EPA, 2012). The present study was carried out to estimate the level of atmospheric trace gases such as carbon monoxide, sulphur dioxide, nitrogen dioxide and particulate matter in the environment of Karachi city with reference to air quality index (AQI) in winter season for the year of 2014. This AQI study describes the range of air quality and its associated health hazards to provide public awareness.

MATERIALS AND METHODS

Study area

The present research has been focused on Karachi city, the provincial capital of Sind, Pakistan. Karachi has an area of 3,640 Km² and is located along the cost of Arabian Sea. Karachi is 5th largest of Pakistan. Its geographical co-ordinates are 24°45’N and 66°37’E. It is the largest metropolitan city of Pakistan. Karachi has moderately temperate climate with a generally high relative humidity that varies from 58% in December (the driest month) to 85% in August (the wettest month). In winter, the average temperature of the city is about 21°C while in summer it reaches up to 35°C. Karachi receives about 256 mm of average annual rainfall (Sajjad *et al*., 2010). Karachi is the financial and commercial capital of Pakistan as well as the major sea port. It plays an important role in the economy of Pakistan and is considered as the economic and financial gateway of Pakistan. Karachi has several large industrial zones such as Karachi Export Processing Zone, Sindh Industrial Trading Estate, Korangi Industrial Area, Landhi Industrial Trading Estate, Northern By-pass Industrial Zone, Bin Qasim and North Karachi industrial zone, located on the fringes of the main city (Sajjad *et al*., 2010). Its primary industries are textiles, pharmaceuticals, steel, and auto-mobiles. Due to industrialization, business activities and employment opportunities Karachi has been facing mass scale rural-urban migration from all over the Pakistan. The main object of this study was to monitor the air quality of some parks and play ground located in residential, industrial and commercial areas of Karachi city in order to explain the status of air quality in terms of Air Quality Index.

Air monitoring Locations

Sampling was carried out at ten different parks and play grounds of Karachicity during the year 2014 for gaseous pollutants and particulate matter. Selected locations were marked as residential (R), industrial (I) and Commercial (C) areas of the Karachi’s environment. The descriptions of the sampling sites are given in Table1. The concentrations of measured components varied between commercial, residential, industrial areas of Karachi during winter season, details of the experimental results were given in Tables 3. The air sampling areas were located in all directions and represented predominant urban areas associated with high, medium and low human activities. This was done with an intention to get better representation of the city. R-1, R-2 and R-3 (PIB colony park, Eid gah Cricket ground, Taleemi bagh) air monitoring areas located almost in the central region of the city represented the residential areas with high vehicular traffic. Industrial areas in East I-1E and I-2E (Siemens green belt and Naurus green belt) represents with high vehicular traffic and industrial emission whereas, Industrial areas in west I-3W and I-4W (Qyyum park and paramount cricket ground) represent industrial emission with moderate vehicular traffic. C-1, C-2 and C-3 (F.C area Cricket ground, Zoological Garden, Hill park) located the city core area having high rise commercial buildings and heavy vehicular traffic characterize at these areas.

Air monitoring instrument and method

Monitoring of gaseous pollutants were carried out by *UV Fluorescent SO_2 Analyzer Model AF22 M, NO-NOx Analyzer Model AC 32M and* Snifit CO Analyzer (Model 50). These analyzers are considered as reliable for monitoring the pollution level.

Monitoring of Trace gases

CO Gas Analyzer (Model 50)

Concentration of carbon monoxide is measured by Snifit CO Analyzer (Model 50). The Analyzer is ideal for measuring the level of carbon monoxide in ambient air and it samples the surrounding air and shows the detected concentrations of carbon monoxide in ppm. During all the measurements, the meter was kept at about 1.2 m above the ground level. At each site, level of CO in the ambient air was taken at an interval of 02 minutes and a set of various readings was noted.

UV Fluorescent SO_2 Analyzer Model AF22 M

Sulfur dioxide (AF22M) model analyzer capable of measuring sulfur dioxide up to the ppb level. Applied to SO_2 measurement, the universally known UV fluorescent principle consists in detecting the characteristic fluorescence radiation emitted by SO_2 molecules. In the presence of a specific wavelength of UV light (214 nm) the SO_2 molecules reach temporary excited electronic state. The subsequent relaxation produces a florescence radiation which is measured by a non-cooled photomultiplier tube (PM).

NO-NOx Analyzer Model AC 32M

The Chemiluminescent NO-NO_2-NO_X analyzer, model AC32M, capable of measuring nitrogen oxides at ppb levels. Applied to nitrogen oxides measurement, chemiluminescence corresponds to an oxidation of NO molecules by O_3 molecules. The return to a fundamental electronic state of the excited NO_2 molecules is made by luminous radiation, detected by the PM tube. The Model AC32M is a state-of-the-art single chamber – single photomultiplier tube design which automatically cycles between the NO and NO_X modes.The new electronics allow enhanced data storage of more than one month of 15 minute averages and total remote troubleshooting diagnostic capabilities via modem.

High Volume Sampler, Andersen Inc. Atlanta Georgia

High Volume Air Sampler collect particles over a wide size range up to approximately 50 micron. The collection efficiency is affected by both wind speed and direction. On a windy day in the presence of fugitive dust sources such as roads, unpaved parking lots or mineral and coal piles, significant and varying quantities of large particles are collected by Hi-volume Sampler. Because such large particles usually do not constitute a human health hazards and because they seriously affect the stability and accuracy of the high volume sampling method, EPA plans to promulgate a new size – specific primary ambient air quality standard. Most likely, the new standard will apply to PM-10 particles smaller than 10 microns in size. EPA states and industry are now intensively monitoring for size specific particulates in preparation for new standard.

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). These AQI values predict, evaluate and explained the air quality status and health concerns at the selected sites. As the air pollution increases, adverse health effect also increases. Following equation was used to calculate the AQI values by using the pollutant concentration data.

Table 1. Description of the sampling locations (parks and Play Ground) during the study period in Karachi

S. No.	Locations	Cod #	Lat	Long	Activities
	Residential Areas				
1	PIB Colony Park	R – 1	24.8947	67.0569	Moderate Traffic Density, exposed dump/exposed pit surface, domestic waste burning and residential activities.
2	Nazimabad Cricket Ground	R – 2	24.9714	67.0371	Heavy Traffic Density with transport on paved road and unpaved road, haul road and exposed dump/exposed pit surface, domestic waste burning and residential activities.
3	Taleemi Bagh	R – 3	24.9285	67.0719	Average Traffic Density with residential activities
	Industrial Areas in East				
4	Siemens Chorangi green Belt	I-1E	24.9031	67.0025	Vehicular emission due to heavy traffic density, waste incineration, Stack emissions and other industrial activities.
5	Naurus Chorangi green Belt	I-2E	24.9055	67.0163	
	Industrial Areasin West				
6	Qyyum park	I-3W	24.8291	67.1770	Vehicular emission due to average traffic density, waste incineration, Stack emissions and other industrial activities.
7	Paramount Cricket Ground	I-4W	24.8615	67.0091	
	Commercial Areas				
8	F.C. Area Ground	C – 1	24.9115	67.0499	Heavy Traffic Density with commercial activities etc.
9	Zoological garden	C – 2	24.8628	67.0218	
10	Hill Park	C – 3	24.8697	67.0706	

Monitoring of PM_{10}

PM_{10} samples were collected on glass fiber filters (203×254 mm) by using high volume air sampler with an average flow rate of 1.0 m^3/min. 24 h average sampling was done in duplicate at each location during the year of 2014. The high volume is considered a reliable instrument for measuring the weight of PM_{10} in ambient air (USEPA—Method 40 CFR). Analysis had been carried out by using Hi-Volume air sampler installed by Centre for Environmental Studies, PCSIR Labs complex, Karachi. Samples have been collected according to USEPA method Number US 40 CFR. 120 Samples of particulate matter (PM_{10}) have been collected from the selected locations in summer and winter season during the year of 2014.

$$I_P = \frac{I_{HI} - I_{LO}}{BP_{HI} - BP_{LO}}(C_P - BP_{LO}) + I_{LO}$$

Where
Ip = the index for pollutant p
Cp =the rounded concentration of pollutant p
BPHi = the breakpoint that is greater than or equal to Cp
BPLo = the breakpoint that is less than or equal to Cp
BPHi =the breakpoint that is greater than or equal to Cp
IHi =the AQI value corresponding to BPHi
ILo = the AQI value corresponding to BPLo

After compiling the data, the concentration of Trace gases sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO) and particulate matter (PM_{10}) 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 - 2 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 - 2).

Table 2. AQI Criteria and Quality Category

AQI	Category
0 – 50	Good
51 – 100	Moderate
101 – 150	Unhealthy for sensitive
151 – 200	Poor (Unhealthy)
201 – 300	Very Poor OR Very Unhealthy
301 – 400	Hazardous
401 – 500	Very Hazardous
>500	Very Critical
US EPA Standards	150

Source: US-EPA (2012) and Gurjar *et al*. (2008)

RESULTS AND DISCUSSION

Present study was carried out for the assessment of the concentrations of atmospheric trace gases: sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO) and particulate matter (PM_{10}) in ambient air by using Air Quality Index (AQI) in Karachi city. The average concentrations of atmospheric trace gases and airborne PM_{10}at all selected parks and playgrounds along the busy roads were measured in winter seasondetails of the experimental results were given in Tables 3. Results show that the average concentrations of PM_{10} in winter season i-e. in Residential areas parks and playgrounds were 154.0 µg/m^3 at R-1, 150.0 µg/m^3 at R-2, 130.0 µg/m^3 at R-3, in industrial areas parks and playgrounds were 206.0 µg/m^3 at I-1W, 173.1 µg/m^3 at I-2W, 328.0 µg/m^3 at I-3E and 346.0 µg/m^3 at I-4E and in Commercial areas parks and playgrounds were found 250.0 µg/m^3 at C-1, 334.0 µg/m^3 at C-2, 353 µg/m^3 at C-3respectively. The average concentrations of SO_2 inwinter season i-e. in Residential areas parks and playgrounds were 19.5 µg/m^3 at R-1, 37.2 µg/m^3 at R-2, 15.5 µg/m^3 at R-3, in industrial areas parks and playgrounds were 33.0 µg/m^3 at I-1W, 37.5 µg/m^3 at I-2W, 41.5 µg/m^3 at I-3E and 49.5 µg/m^3 at I-4E and in Commercial areas parks and playgrounds were found 35.0 µg/m^3 at C-1, 51.0 µg/m^3 at C-2, 60.0 µg/m^3 at C-3respectively. The average concentrations of CO in winter season i-e. in Residential areas parks and playgrounds were 1.8 µg/m^3 at R-1, 2.6 µg/m^3 at R-2, 1.4 µg/m^3 at R-3, in industrial areas parks and playgrounds were 3.5 µg/m^3 at I-1W, 3.4 µg/m^3 at I-2W, 3.6 µg/m^3 at I-3E and 4.8 µg/m^3 at I-4E and in Commercial areas parks and playgrounds were found 3.2 µg/m^3 at C-1, 4.5 µg/m^3 at C-2, 5.1 µg/m^3 at C-3respectively. The average concentrations of NO_2 in winter season i-e. in Residential areas parks and playgrounds were 53.0 µg/m^3 at R-1, 91.0 µg/m^3 at R-2, 52.0 µg/m^3 at R-3, in industrial areas parks and playgrounds were 88.0 µg/m^3 at I-1W, 92.0 µg/m^3 at I-2W, 98.0 µg/m^3 at I-3E and 100.0 µg/m^3 at I-4E and in Commercial areas parks and playgrounds were found 88.0 µg/m^3 at C-1, 104.0 µg/m^3 at C-2, 130.0 µg/m^3 at C-3respectively. In general, the average trace gases and PM_{10} concentrations were higher in commercial and industrial areas parks and play grounds with high traffic density than the residential sites parks and play grounds. Most of the sites of parks and grounds having trace gases and PM_{10} concentrations exceeded the specified permissible limits by US-EPA (US-EPA, 2012). The highest mean concentrations of $PM_{10}$and trace gases were observed at C-3followed by I-4E. Location I-4E is an industrial site having industrial clusters on both sides of the road. This site also exhibited high traffic congestion mainly due to heavy duty diesel vehicles like trucks, tractors, trailers, vans, buses and minibuses. At this location I-4E the roads are also poorly maintained, unpaved and dusty with limited vegetation along the sides. The industrial processes especially combustion boilers fueled by heavy duty diesel, and heavy electric generators also fueled by diesel are the main source of PM_{10} pollution and trace gases emission, Whereas, location C-3 is commercial area having narrow road with heavy traffic density and surrounded by high rise buildings for commercial activities on both side of the road producing tunnel effect where the pollutants are suspended for long time and it is associated with potential health effects for the resident specially for infant and old age group/ sensitive residents.

The ambient AQI values in winter season has been calculated with the recorded pollutant concentration data of the sampling parks and playgrounds presented in Table – 3 and graphically represented in Graphs– 1, 2, 3 and 4. The calculated Air Quality Index values of $PM_{10}$and trace gases inwinter season at the selected parks and grounds vary between a maximum of 204.0 and a minimum of 88.0 respectively. Results of the calculation of AQI values for PM_{10}at the sampling parks and grounds show moderate pollution in residential areas parks & ground and poor or unhealthy pollution in commercial and industrial areas parks & playgrounds (Graph-1). Whereas, calculated Air Quality Index values for SO_2 vary between a maximum of 81.0 and a minimum of 22.0 (Graph-2) respectively, for CO vary between a maximum of 57.0 and a minimum of 14.0 (Graph-3), for NO_2 vary between a maximum of 107.0 and a minimum of 49.0 (Graph-4) respectively.

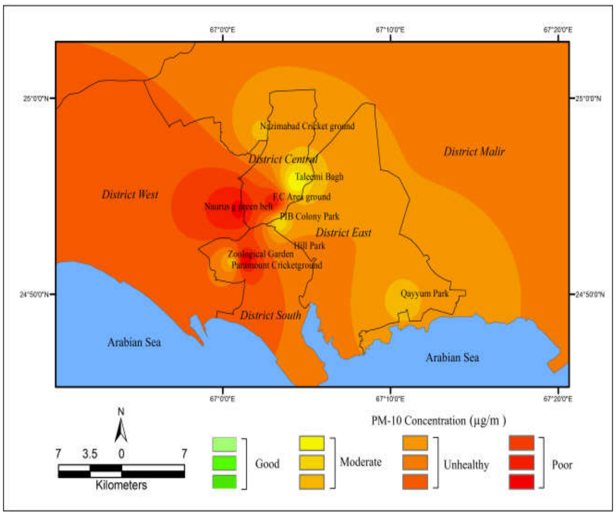
The results of air quality monitoring show that the pollution concentrations were highly variable at different sampling parks and grounds. This is expected as the extent of air pollutants in a site depend on the active mobile and stationary pollutant emitting sources and is influenced by meteorological factors. It can also be seen that the concentration of particulate PM_{10} pollutants exceeded the allowable standard limit at all the locationexcept Taleemi Bagh, a purely residential area park with controlled emission from transport vehicles. The concentration of gaseous pollutants was observed to be within permissible limits in all the selected parks and playground.Results of the calculation of AQI values for trace gases (SO_2, CO and NO_2) at the sampling parks and grounds show moderate pollution in the parks & ground situated in residential areas whereas poor or unhealthy pollution in the parks & playgrounds of commercial and industrial areas.

Health Hazards

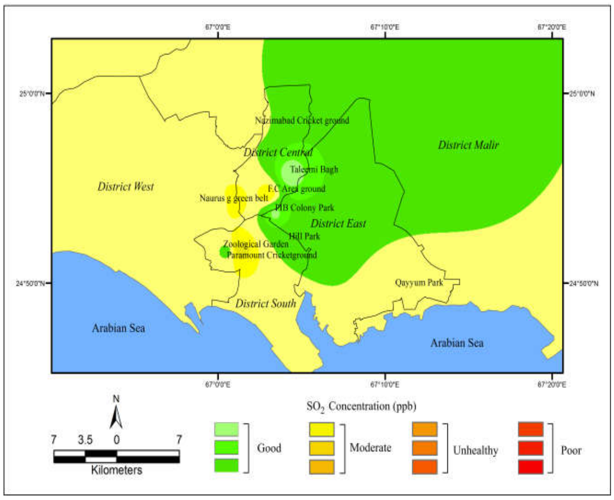
Particles smaller than 10 micrometers in diameter can cause or aggravate a number of health problem and have been linked with illnesses and deaths from heart or lung disease. These effects have been associated with both short-term and long-term exposures.

Table 3. Air quality index and air quality category during winter season at selected parks and playgrounds

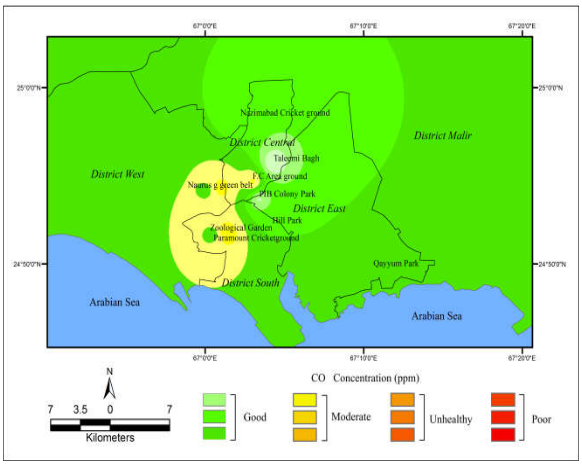
Locations	Code #	AQI Value	AQI Category	AQI Value	AQI Category	AQI Value	AQI Category	AQI Value	AQI Category
		PM10		SO2		CO		NO2	
PIB colony Park	R-1	100.0	Moderate	28.0	Good	20.0	Good	50.0	Good
Nazimabad Cricket Ground	R-2	98.0	Moderate	53.0	Moderate	30.0	Good	90.0	Moderate
Taleemi Bagh	R-3	88.0	Moderate	22.0	Good	14.0	Good	49.0	Good
paramount Cricket ground	I-1W	126.0	unhealthy	47.0	Good	40.0	Good	87.0	Moderate
Qayyum Park	I-2W	130.0	unhealthy	53.0	Moderate	39.0	Good	91.0	Moderate
Naurus green belt	I-3E	187.0	Poor	58.0	Moderate	41.0	Good	97.0	Moderate
Siemens green belt	I-4E	196.0	Poor	68.0	Moderate	54.0	Moderate	100.0	Moderate
Hill Park	C-1	148.0	unhealthy	50.0	Moderate	35.0	Good	87.0	Moderate
F.C. Area Cricket ground	C-2	190.0	Poor	70.0	Moderate	51.0	Moderate	102.0	unhealthy
Zoological Garden	C-3	204.0	poor	81.0	Moderate	57.0	Moderate	107.0	unhealthy



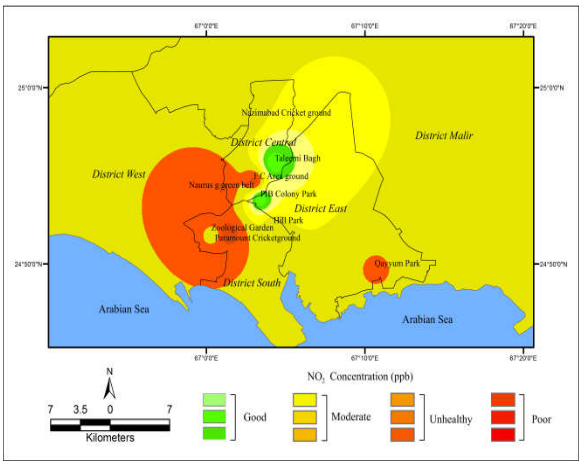
Graph-1:- AQI Concentration of PM10 at Selected Parks and Play grounds



Graph-2:- AQI Concentration of SO_2 at Selected Parks and Play grounds



Graph-3:- AQI Concentration of CO at Selected Parks and Play grounds



Graph-4:- AQI Concentration of NO_2 at Selected Parks and Play grounds

Sensitive groups for particle pollution include people with heart or lung disease (including heart failure and coronary artery disease, or asthma and chronic obstructive pulmonary disease), older adults (who may have undiagnosed heart or lung disease), and children. The risk of heart attacks, and the risk from particle pollution, may begin as early as the mid-40s for men and mid-50s for women (US Environmental protection Agency (EPA), Office of Air Quality Planning and Standard, Out reach and Information Division, Research Triangle Park, NC. February 2014. EPA-456/F-14-002, Air Quality Index, A Guide to Air Quality and your Health). Carbon monoxide is highly toxic gas but it can not easily detected by olfactory senses. It can seriously affect human aerobic metabolism owing to its high affinity for hemoglobin, the component of the blood responsible for the transport of the oxygen. CO react with heamoglobin (Hb) to give carboxy-heamoglobin (COHb), thus reducing the capability of the blood to carry the oxygen to body tissues such as heart and brain. The effects of CO depend on concentration, exposure time, and health status of people, their age and activity. Long-term exposure to low concentration of CO can have similar effects to short-term exposure with high concentration. People with cardiovascular disease, such as coronary artery disease, are most at risk. The symptoms of exposure to CO start with headache, tiredness, dizziness, nausea, vomiting and drowsiness and in very acute situation; unconsciousness and death will follow (Daya *et al*., 2009). Main source of sulfur dioxide is the burning of sulfur-containing fuels such as coal and oil. Generally, the highest levels of sulfur dioxide are found near large industrial complexes. Major sources include power plants, refineries, and industrial boilers. Sulfur dioxide is an irritant gas. People with asthma, experiences the narrowing of the airways (called broncho-constriction). This may be accompanied by wheezing, chest tightness, and shortness of breath, which may require use of medication that opens the airways. Symptoms increase as sulfur dioxide levels or breathing rate increases (US Environmental protection Agency (EPA), Office of Air Quality Planning and Standard, Out reach and Information Division, Research Triangle Park, NC. February 2014. EPA-456/F-14-002, Air Quality Index, A Guide to Air Quality and your Health).

Conclusion

The present study reveals that the concentration of suspended particulate matter exceeded the permissible standards in highly commercial areas, densely populated residential areas, industrial areas and in the residential areas located near highly commercial areas. The presence of 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 the pollutants 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 thequality of air in the city.

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