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Environmental Impact Assessment of Air Pollution in Different Areas of Karachi

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Measurements of major ambient air pollution components such as O_3, SO_2, CO, NO, and NOx were carried out to obtain baseline data for some selected areas in Karachi. These areas have been categorized on the basis of traffic congestion. Total average concentration of O_3 in Zone - A was 20.80 ppb. In Zone - B 20.36 ppb and in Zone - C 19.10 ppb. Concentration of SO_2 in Zone - A was determined to be 7.30 ppb, in Zone - B 11.60 ppb and in Zone - C 44.30 ppb. Similarly, concentration of CO in Zone - A was 0.96 ppm, in Zone - B 2.50 ppm and in Zone - C 3.49 ppm. Whereas, average concentration of NO and NOx was 13.00 ppb and 23.50 ppb in Zone - A, 2.73 ppb and 5.70 ppb in Zone - B, 69.90 ppb and 83.50 ppb in Zone C. The main contributors of pollutants in these areas are vehicular traffic and industries. A survey of local hospitals was also conducted to correlate the prevailing diseases with air pollution levels. The survey showed that 70% of the patients were suffering from air pollution related diseases, like chronic bronchitis, pulmonary edema and pulmonary emphysema. The data further reveals that the ratio of male to female patients is 2:1.

Key words**:** Ambient air, Impact of pollutants , Health effect.

Introduction

The proportion of the world's population living in the large town or cities has grown from around 5% to 50% over the past two centuries, Demographers estimate that by the year 2030 approximately two third of the world population will live in large town or cities (Anon 2000).

The high rise of urbanization has created a number of environmental problems such as inadequacy of water supply and sewerage system, over congestion, inadequate transport, slums, haphazard and unplanned development, particularly for the metropolitan areas such as Karachi.

The main environmental problems of Karachi are water pollution, marine pollution, disposal of solid waste and air pollution. Among these environmental degradation, air pollution is a major concern, which is affecting the urban areas of Karachi. The pollutants are being discharged in to the atmosphere from a number of sources but the vehicular traffic and industries are the major contributors.

A few decades ago traffic did not play an important role in air pollution. Today it is the main source of contaminant in the developed and industrialized countries. With an improved standard of living and increased demand on the transport sector, automobile related pollution is fast growing into a problem of serious dimension in our cities. This is caused not only by rapid rise in number of automobiles but also due to narrow roads, slow moving traffic, unfavorable driving cycles, poor enforcement of the laws relating to vehicles road worthiness and poor emission control measures etc.

Traffic introduces dust, soot, carbon dioxide, carbon monoxide, sulphur dioxide, oxides of nitrogen and hydrocarbons in to the air. There are more than one million different types of registered motor vehicles consisting of three wheelers (autorickshaws), cars, buses, motor bikes, etc. plying on the roads of Karachi and discharging toxic gases into the atmosphere.

In USA, about 140 to 150 million tons of pollutants are given off to the air every year. Industries account for 20 to 30 million tons, space heating 10 to 15 million tons, refuse disposal 5 to 10 million tons and motor vehicles 90 million tons or more (Mehboobani 1991). Absence of legislation, lack of public awareness towards conservation of nature and control of pollution has created such a situation, which demands stringent control over pollution emitting sources.

Main object of this study was to assess the existing environmental impact of air pollution components in different areas of Karachi. The generated data could be used for implementation of appropriate measures against hazardous effects of air pollution.

Experimental

Monitoring of ambient air pollution component was carried out for some selected areas to measure the impact of air

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pollutants in Karachi. The areas that have been categorized are as follow:

1. Moderately populated area with low vehicular traffic (Zone - A).
2. Densely populated area with heavy vehicular traffic (Zone - B).
3. Industrial area with different types of industries (Zone - C).

The ambient air quality measurements were performed by an Air Pollution Monitoring Mobile Laboratory design and fabricated by environmental S.A. France. This Mobile Laboratory is fully equipped with ambient air and particulate monitors designed to measure low concentration of gases, such as O_3, SO_2, NO, NOx, CO, and inhalable particulate in suspension SPM (PM10). It is also equipped with meteorological sensors mounted on a telescopic mast. These advanced technology instruments are microprocessor regulated and define a homogenous and coherent range. An intelligent data logger SAM32 records spot concentrations every second and accumulates these to provide 15-min averages. The logger also monitors instrument alarm and diagnostic functions and controls daily instrument zero/span response checks. Calibrations were made by NO_2 / SO_2 permeation tube oven and zero gas generator. Ozone analyzer $O_3$41M has its own ozone generator for span gas. CO11M was calibrated by standard CO span gas supplied and certified by M/s. Alphagaz, France. A SCANAIR software was used for acquisition, editing and recording logical and analogical data from SAM 32.

Continuous measurement of major ambient air pollution components such as O_3, SO_2, CO, NO, NOx were carried out in the month of February during the year 1998. Fifteen minutes average data of selected areas from Zone - A, Zone - B and Zone - C are presented in the form of Graph I, II, III, IV and V.

A survey of hospitals located in the study area Zone - C was carried out and data was obtained regarding the patients suffering from air pollution related diseases like chronic bronchitis, pulmonary emphysema, pulmonary edema etc. Data for heart diseases was also obtained to search for a relationship with the nature of air pollution to that of heart ailment. Results are provided in Table 1.

Table 1
Number of patients suffering from air pollution related diseases in study areas hospital

No. of Hospital	Diseases	No. of Cases			Male & Female Ratio
		Male	Female	Total	
1	T.B.	3735	1701	5436	2.2:1
	Air pollution related diseases	9452	4876	14328	1.9:1
	Chest cancer	372	232	604	1.6:1
	Heart diseases	8114	4206	12320	1.9:1
2	T.B.	680	340	1020	1.2:1
	Air pollution related diseases	1265	625	1950	1.8:1
	Chest cancer	316	149	465	2.1:1
	Heart diseases	708	392	1100	1.8:1

Results and Discussion

The subtropical city of Karachi is located in a semi arid zone. It is the biggest industrial and commercial center in Pakistan. According to 1998 census, Karachi has a population of 9.2 million, whereas at the time of the independence in 1947 it was only 0.3 million (Anon 1998). Karachi has also been declared as megacities among 20 megacities of the world (Zarski 1993) the majority of the world's megacities are facing environmental problems. Growing number of urban population, level of industrialization and traffic congestion are the main causes of air pollution in Karachi. Therefore, pollution measurements were carried out to obtain baseline data for some selected areas in Karachi. These areas have been categorized on the basis of traffic congestion.

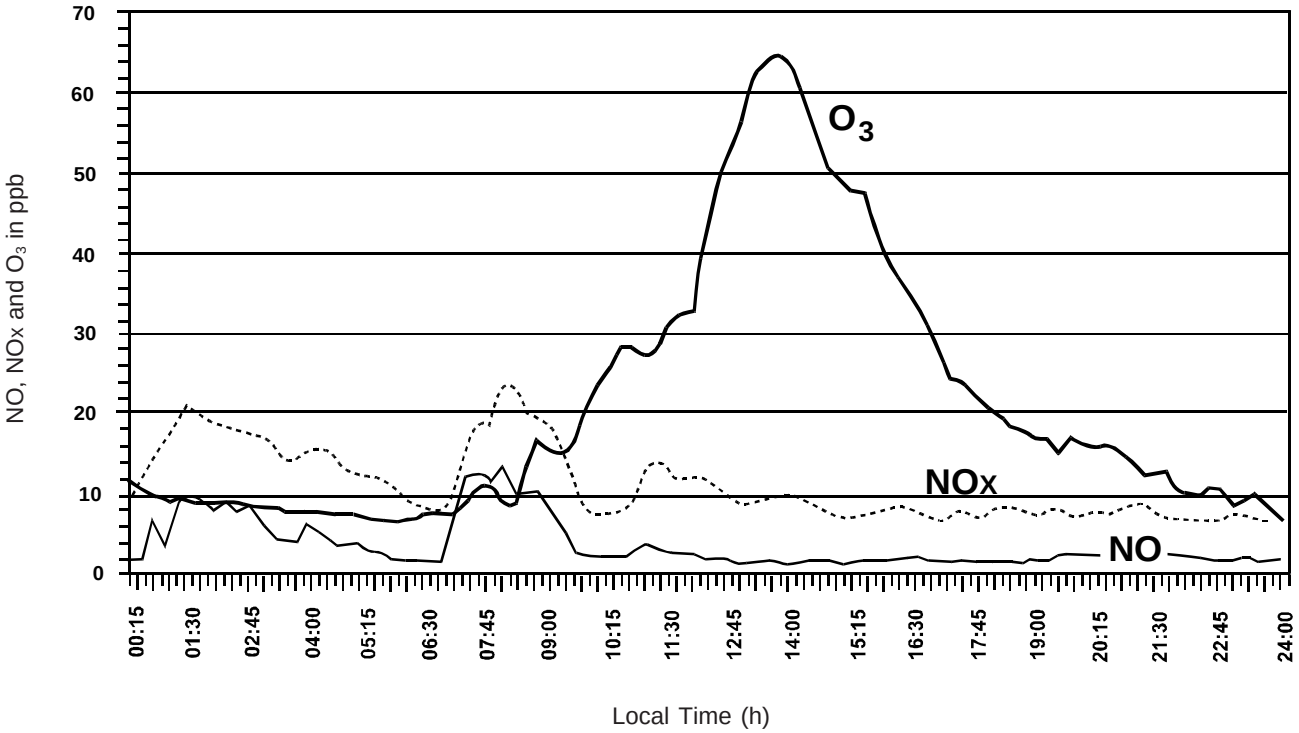
A Scanair software was used for acquistion, editing and recording logical and analogical data from data logger. Continuous measurements of major ambient air pollution components such as O_3, SO_2, CO, NO and NOx were carried out for eight days in the month of February 1998. Fifteen minutes average concentration of ambient pollutants at Zone - A, B and C are presented in the form of Graphs I to V.

The data obtained through this study indicates that almost all the pollutants are well with in WHO limits but a serious situation of air quality degradation is developing in Karachi. There is an urgent need to monitor the air quality over the whole city and adopt suitable control strategies.

Zone - A: Urban background site with moderately populated area having low vehicular traffic density. This sampling site is located at latitude 24°71′ and longitude 67°08′. The site is 390 km away from the main super highway. The area around the sampling site is very sparsely populated. At this sampling site Zone - A, during measurement period, the average wind speed was 1.5 m / sec, wind direction 200.7 degrees, humidity 75.1 %, temperature 19.7°C and barometric pressure 1014.5 m. Bars and solar flux was 196.1 W/m^2.

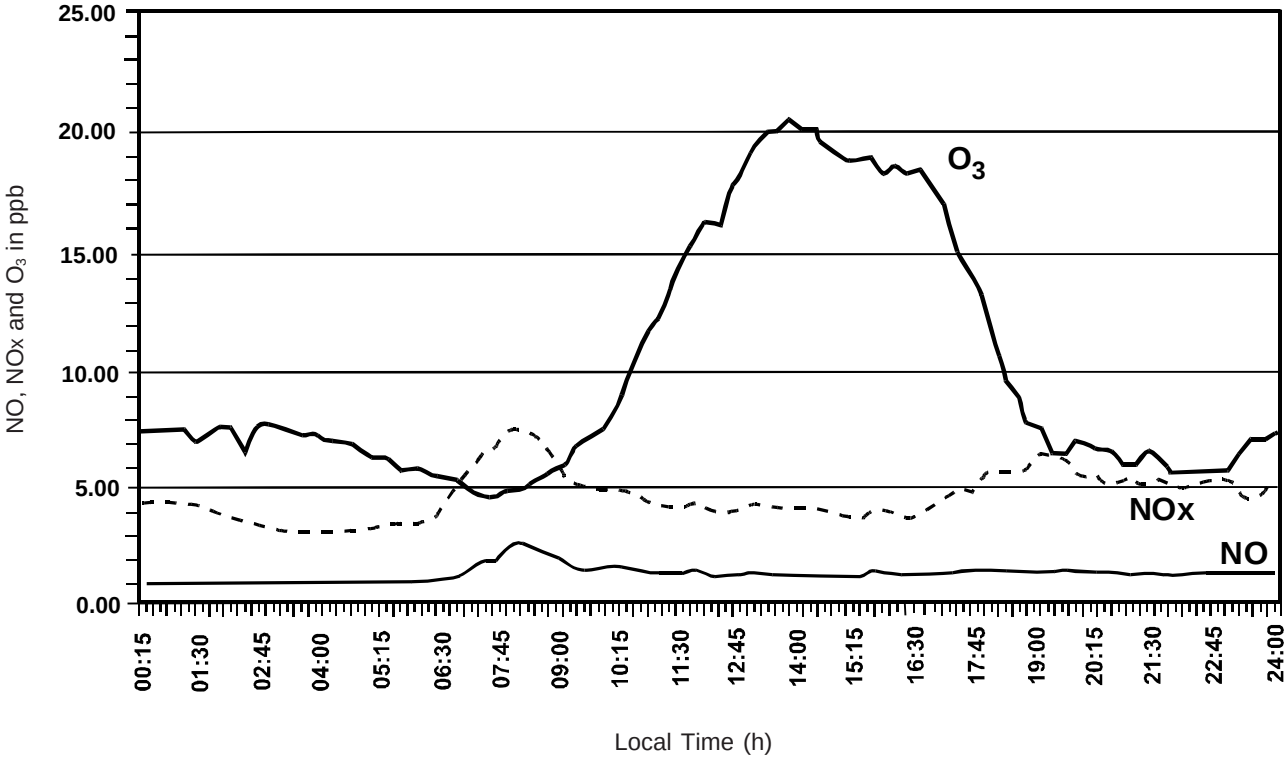
Graph - I

Weekly average concentration of photochemical oxidants in urban background site Zone - A



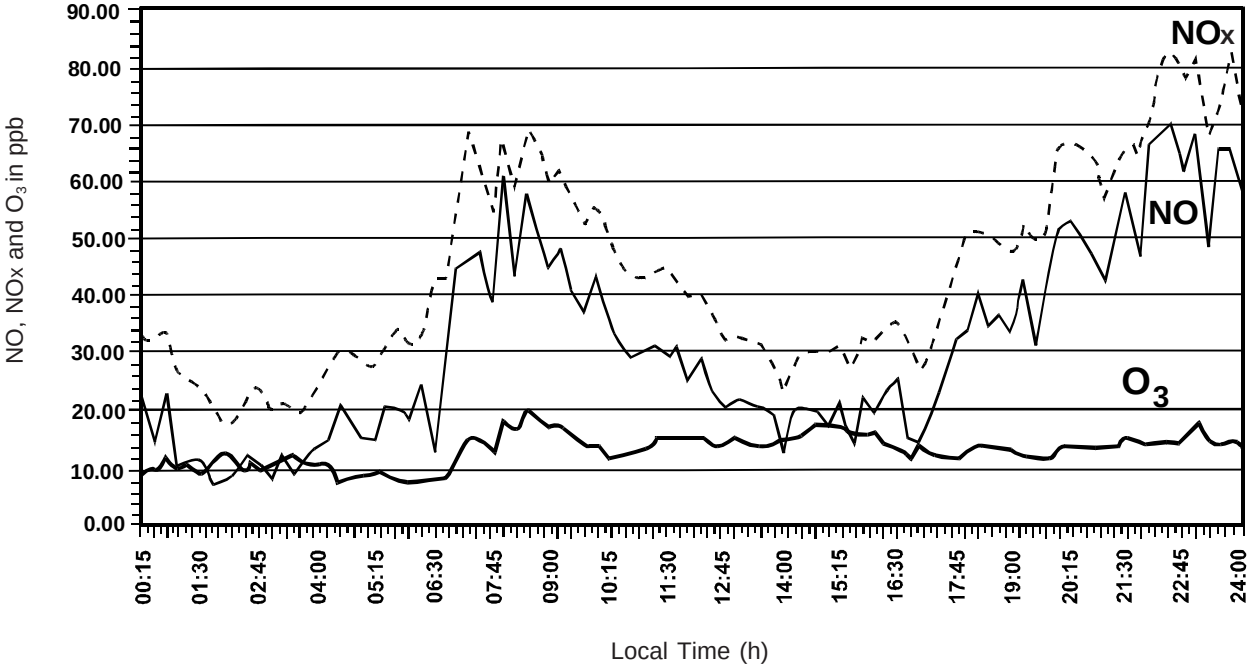
Graph - II

Weekly average concentration of photochemical oxidants in densely populated area Zone - B



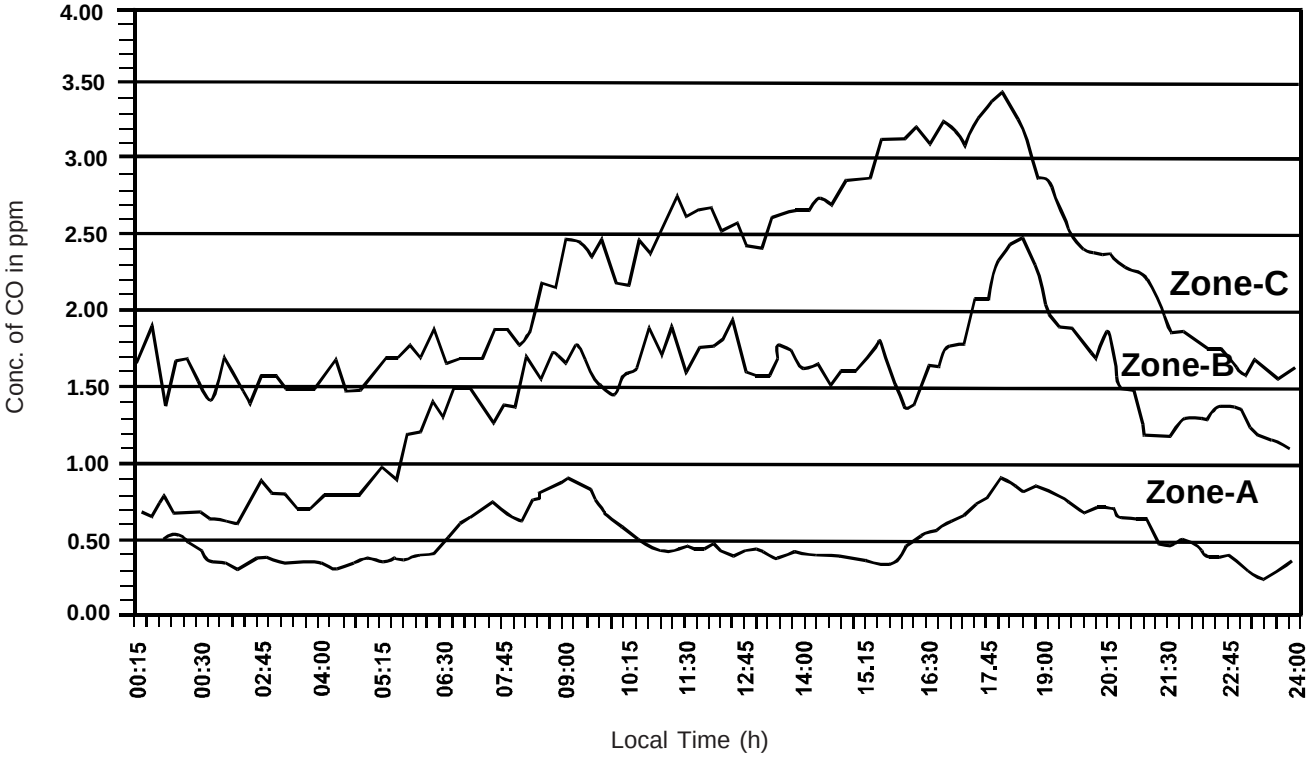
Graph - III

Weekly average concentration of photochemical oxidants in industrial area Zone - C



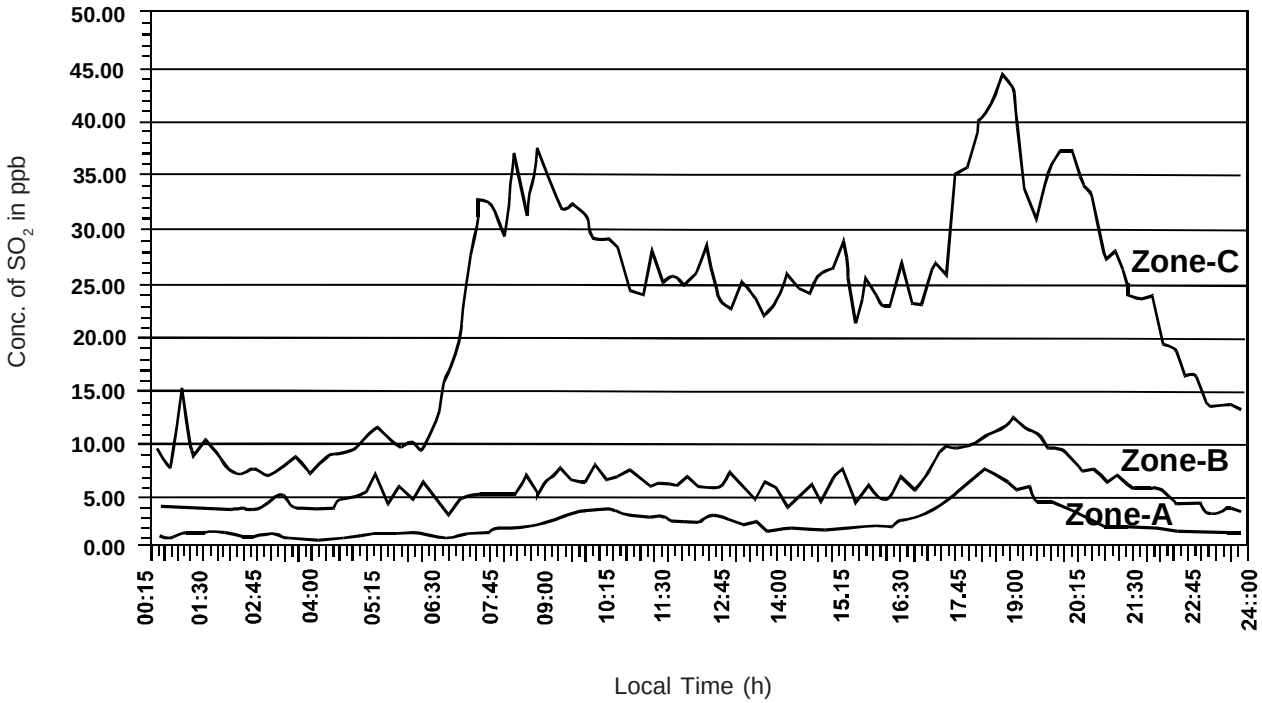
Graph - IV

Weekly average concentration of CO in Zone - A, B & C



Graph - V

Weekly average concentration of SO_2 in Zone - A, B & C



Zone - B: Sub urban site with densely populated area having high traffic density. This sampling site is located at latitude 24˚53′and longitude 67˚06′. The site is relatively open place and is surrounded by the residential area. In 320˚ NW to 240˚ SW there is a main university road about 1km away from sampling site having traffic density of 323245 vehicles per day (Anon 1993). The population living around the site belongs to the middle and high-income group. During measurement period, in Zone - B, the average wind speed was 2.75 m / sec. Wind direction 194.6 degrees, humidity 63.71%, temperature 24.1˚C and barometric pressure 100.4 m. Bars and solar flux was 228.8 W/m^2.

Zone - C: Industrial area having different types of industries. This sampling site is located at latitude 24˚54′and longitude 67˚10′ in south district. The site has nearly 2000 different types of industries. Approximately 60 percent of these industries are textile mills, while others involve pharmaceuticals, chemicals, detergents, iron and steel sulphur refining, vegetable oil, beverages and food products. The daily average traffic density at this sampling site was 39743 vehicles per day (Anon 1993). The average wind speed in this zone during the period of measurement was 2.2 m/sec, wind direction 169.6 degrees, humidity 45.2 %, temperature 22.6˚C and barometric pressure 1014.4 m. Bars and solar flux was 215.0 W/m^2.

Graph-I shows the weekly average concentration of photochemical oxidants at urban background site (Zone - A). Maximum average concentration of NO was 13.0 ppb and NOx was 23.5 ppb was found to be at 8:15 h local time. Whereas, maximum average con-centration of O_3 was found to be 64.5 ppb at 13.45 h local time.

It can be seen from the Graph - I that the balance among NO, NO, and O_3 is shifted in the favour of net ozone production. The formation of ozone is evident during day time and highest concentration of ozone was found when solar radiation was also high. The sampling site is located 20 km down wind from the city center and diurnal pattern was clearly observed. The masses were coming from the university road. The main contributor of photochemical oxidants at this location may be due to motor vehicles.

Graph-II shows the weekly average concentration of photochemical oxidants at densely populated area (Zone - B). Maximum average concentration of NO 2.73 ppb and NOx 7.5 ppb was found at 08:00 h local time. Whereas, the maximum average concentration of O_3 was found to be 20.36 ppb at 13:45 h local time. It can also be seen from the Graph - II that the balance between NO, NOx and ozone shift in favour of net ozone production due to photochemical dissociation of NO_2, resulting in the maximum concentration of ozone in the mid afternoon. The main contributor of photochemical

oxidants at this location is also main road that has very high traffic density. A some what photo stationary state may exist at this location.

Graph-III shows the weekly average concentration of photochemical oxidants at industrial area Zone - C. Maximum average concentration of NO was found to be 69.9 ppb and NOx was 83.5 ppb at 22:15 h local time, whereas, maximum average concentration of O_3 was found to be 19.9 ppb at 8:45 h local time. It can be seen from the graph that ozone concentration is less than NO and NOx concentration. It has been reported that at typical ambient air and NO concentration, the reaction of photochemical oxidants has a time scale of one to a few minutes (Clark 1988). A power generation plant and boiler of pharmaceutical industry was located only 50 - 75 meters away from the receptor. It shows that most of NO and NOx were coming from combustion sources. Graph-III also shows that in recently emitted plume, the reaction of NO with O_3 is even more rapid having a time scale of only few seconds. So, the chemical reaction between two mixing species was not completed due to time lag and thus low concentration of ozone was observed at this site.

The incomplete burning of carbon containing fuels produce carbon monoxide. It is almost entirely a man made pollutant. Carbon monoxide is most hazardous to human at concentration of 100 ppm or more if experienced over a period of several hours (Bassow 1989). It is estimated that motor vehicles contribute to more than 80 % man made global carbon monoxide emission, with a smaller amount resulting from other combustion processes (Baig 1993).

Graph-IV shows the concentration of carbon monoxide in zone A, B and C. The maximum average concentration of carbon monoxide in Zone - A, (urban background site) was found to be 0.96 ppm at 18.00 h local time, in Zone - B (densely background site) was 2.50 ppm at 18:30 h local time whereas, in Zone - C (Industrial Area) the maximum average concentration of carbon monoxide was 3.49 ppm at 18:00 h local time. In the morning hours, the movement of traffic is towards down town and is the reverse in the evening. The variation in the concentration of carbon monoxide shows that the concentration gradually increases till 9:00 h and then comes down at 13:00 h and again increase around 18:00 h, the rush hours. In Zone - A and B the air pollution being generated by vehicular traffic. The study further shows that the level of carbon monoxide in industrial area (Zone - C) is relatively higher than densely populated area Zone - B. The pollution in industrial area is mainly due to industrial processes.

Graph-V shows the concentration of SO_2 in the selected zones A, B and C. The major sources of SO_2 are combustion of fossil fuels, coke ovens, metal smelting, wood and pulp production, petroleum refining and brick manufacture. The estimated background concentration of SO_2 is 0.2 ppb and calculated atmospheric residence time is 4 days (Kenneth and Cecil 1976). Short term high level of SO_2 may increase respiratory diseases, lung function disturbance and mortality in adult and children (Wieslaw 1995). The maximum average concentration of SO_2 at urban background site (Zone - A) was found to be 7.30 ppb at 18:15 h local time, at densely populated area (Zone - B) was 12.60 ppb at 19:00 h local time while at industrial area (Zone - C) was found to be 44.3 ppb at 18:45 h local time.

The variation in the concentration of SO_2 indicates the same pattern as carbon monoxide concentration in Zone - A, B and C, whereas the concentration of SO_2 in zone C is higher than Zone - A and B due to the combustion process in industries. The average concentration of SO_2 in all the selected areas are well with in WHO limits (40 - 60 $\mu g / m^3$) (WHO 1987). The low level of SO_2 may be due to the fact that the use of coal in Karachi is negligible and almost 99 percent of the population and factories use natural gas (Sui gas) as a fuel, which is sulphur free.

Hospital survey. A hospital survey was carried out to assess the impact of pollution on human health (Table 1). This survey revealed that a total 6456 cases of tuberculosis were reported during last two-year, out of which 4415 were males and 2041 were females.

A total number of 16078 patients were suffering from air pollution related diseases consisting of 10577 males and 5501 females.

A total of chest cancer cases 1069 attributed to air pollution, out of which 688 were males and 381 were female patients. The hospital data indicates the trend of cancer shifting from old age group of middle age group, which is an indicator of deteriorating air environment.

The heart ailment cases of 13420 were reported during the same period, 8822 were males and 4598 were females.

The degrading effects on human health can also be seen from the increasing number of patients in the hospitals suffering from air pollution related diseases. Air pollution has become a world wide public health problem, particularly in large cities of the developing countries. An estimated 130,000 premature deaths and 50 - 70 million incidents of respiratory illness occur each year due to episodes of urban air pollution in developing countries, half of them in East Asia (Maddison 1997).

Air pollution increases the risk of chronic obstructive pulmonary diseases and acute respiratory infections in

childhood, lung and chest cancer, tuberculosis, prenatal out comes including low birth weight and eye diseases.

Survey of hospitals show that the number of patients suffering from air pollution related diseases to that of tuberculosis is about 3:1. The number of male cases as compared to female regarding air pollution related chest diseases, are in the ratio of 2.1:1. This may be due to an extensive exposure of males to the polluted ambient air and professional hazards as compared to females who are housewives and remain indoor.

Few decades ago, only tobacco smoke was considered as an important risk for lung cancer but now a days polluted air is the most important factor for lung cancer. People in developing countries are commonly exposed to very high levels of pollution for 3 - 7 h daily over many years (Engel and Hartodo 1998). The number of lung cancer cases by air pollution are also on the increase and mostly male cases due to their exposure to air. The worst effected age group is between 50 - 60 years but now this is reducing up to 45 - 60 years. This is mainly because of increasing air pollution level but some other factors are also involved like personal hygiene, social activity, socio-economic condition, mental worries and smoking etc.

The cases of heart diseases are also on the increase. This is mainly due to the increase of ambient air pollution. The male and female ratio of heart diseases is approximately 2.1:1, indicating that men suffer more than women due to exposure in society. The worst effected age group of heart patients is between 40 - 50 years, which can be attributed to the exposure. Effect of air pollution on human health varies according to both the intensity and duration of exposure and health status of exposed population.

Conclusion

The baseline data for ambient air pollutants in selected areas of Karachi reveals that the average concentration of O_3, SO_2, CO, NO, and NOx are well with in WHO limits, But the variation indicates a rising trend due to multiple factors like growth in population, motor vehicles and industries etc. The observed values of NO_2 and NOx during the survey indicate that these pollutants originate from the combustion of fuel in motor vehicle power generation plant and boiler of industries. It was also observed that O_3, SO_2 and CO are mainly emitted from motor vehicles and from Industrial processes. The generated data has the potential to lay the foundation for implementation of appropriate ambient air quality standards.

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