STATUS OF AMBIENT AIR IN THREE AREAS AND ITS EFFECTS ON RESIDENTS OF KARACHI.

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خلاصہ

اس تحقیقات کا بنیادی مقصد کراچی کے موجودہ تین علاقوں کا ہوائی آلودگی کے بارے میں بتانا ہے۔ اُمید ہے کہ اس تحقیق کی بنا پر ہوائی آلودگی پر قابو پانے کے لئے بہتر منصوبہ بندی کی جاسکے گی۔ کراچی اٹھارہ ملین سے زیادہ آبادی پر مشتمل ہے، جو تیزی اور مستقل مزاجی پر مشتمل ہے۔NO، NO_2، NOx، SO_2 ، CH_4 کا مشتق مختلف ذرائع سے تیار کیا گیا ہے۔ محیطی ہوا کے مقداری تجزیہ اور انسانی آبادی پر اس کے ممکنہ اثرات کا مطالعہ کرنے کے لئے کراچی کے تین 03 مقامات سے محیط ہوا کے پندرہ ذرات کے نمونے لئے گئے ہیں۔ اس مقصد کے لئے، ہوائی نمونے لینے کا معیار مختلف علاقوں جیسے سہراب گوٹھ، نارتھ ناظم آباد اور ڈیفنس میں محیطی ہوا کے معیار کے نمونے لئے گئے۔ کل دس مختلف گیسیں اور پانچ ماحولیاتی پیرامیٹرز کا تجزیہ کیا گیا۔ محیطی ہوا کی آلودگیوں کی تعداد عام طور پر سردیوں میں زیادہ پائی جاتی ہے جبکہ موسم گرما کے موسم میں اعتدال پسند ہے۔ تجزیہ کردہ کاربن مونو آکسائیڈ (CO) اور اوزون (O_3) کے پیرامیٹرز مقرر کردہ NEQS کی حد سے نیچے پائے جاتے ہیں جبکہ SO ، 95.75 $\mu g/m^3$ کی اسوسط جون کے مہینے میں ریکارڈ کی گئی قومی ماحولیاتی معیار (NEQS) کی حد سے تجاوز کیا گیا ہے۔ سب سے زیادہ اوسط قیمت 6527.59 $\mu g/m^3$ ، 9565.31 ppb اور 81.71 $\mu g/m^3$ میتھین (CH_4) نان میتھین ہائیڈروکاربن (NMHC) ٹوٹل ہائیڈروکاربن (THC) اور میتھین کاربن (MC) کی دسمبر، اگست، مارچ اور فروری کے مہینوں میں پائے گئے ہیں۔ ہوا کی رفتار اور درجہ حرارت کی اوسط قیمت اکتوبر اور دسمبر کے مہینوں میں ریکارڈ کی گئی ہے۔ سہراب گوٹھ میں۔ نائٹرک آکسائیڈ (NO)، نائیٹروجن ڈائی آکسائیڈ (NO_2) آکسائیڈ آف نائیٹروجن (NOx) اور سیلفر ڈائیو آکسائیڈ (SO_2) 91.41 $\mu g/m^3$ ، 87.18 $\mu g/m^3$ ، 113.03 ppb، 171.18 $\mu g/m^3$ کے تینوں شعبون کے درمیان سب سے زیادہ اوسط قدر ملتی ہے جو کہ NEQS کے اوپر ہے۔ جبکہ ڈیفنس میں میتھین ہائیڈروکاربن (CH_4) 6527.59 $\mu g/m^3$ سہراب گوٹھ میں نان میتھین ہائیڈروکاربن (NMHC) کا 3870.37 ppb اور نارتھ ناظم آباد میں ٹوٹل ہائیڈروکاربن (THC) 10244.64 ppb بھی ڈیفنس اور سہراب گوٹھ کے مقابلے میں زیادہ پایا گیا ہے۔

Abstract

The purpose of present investigation is to describe present status of air pollution in three (03) different areas of Karachi. It is hoped that information will provide of this better planning for pollution control. Karachi comprises of more than eighteen million population, who lives in acute and continual condition. NO, nitrogen dioxide (NO_2), oxide of nitrogen (NOx), carbon monoxide (CO), sulphur dioxide (SO_2), methane and its derivative are generated from different sources. Fifteen particles of ambient air have been sampled from three (03) locations of Karachi in order to study the quantitative analysis of the ambient air and its possible effects on the human population. For this purpose, air sampling quality was done in various areas such as Sohrab Goth, North Nazimabad and Defence to sample ambient air quality. Total ten (10) different gases and five (5) environmental parameters were analyzed. The concentrations of the pollutants of the ambient air usually found high in winter while moderate in summer season. The parameters of carbon monoxide (CO) and ozone (O_3)analyzed for three years are found below the NEQS while the highest mean average level of SO2 95.75 µg/m³ which is above the National Environmental Quality Standard (NEQS) recorded in June only. The highest mean average value 6527.59 µg/m³, 3743.18 ppb, 9565.31 ppb, 81.17 µg/m³ of methane (CH_4), non methane hydrocarbon (NMHC), total hydrocarbon carbon (THC) and methane carbon (MC) are found in the months of December, August, March and February. The highest mean average value of Wind Speed (WS) and Temperature (Temp) are recorded in the months of October and December. The highest mean average value among all three areas of NO, nitrogen dioxide (NO_2), oxide of nitrogen (NOx) and sulphur dioxide (SO_2)91.41 µg/m³, 87.18 µg/m³, 113.03ppb, 171.18 µg/m³ are found in Sohrab Goth which is above the NEQS. While 6527.59 µg/m³ of methane (CH_4) in Defence, 3870.37 ppb of non methane hydrocarbon (NMHC) in Sohrab Goth and 10244.64 ppb of total hydrocarbon carbon (THC) in North Nazimabad are also found higher as compared to Defence and Sohrab Goth.

Key words: Ambient Air, Air Pollution, Parameters , Pollutants, Locations

Introduction

Karachi is the most thickly populated city of Pakistan with a population of over 25 million. It is the biggest hub of industrial activity having more than 8000 industries. Karachi is one of the biggest cities of Pakistan inhabited by over 15 million people. There has been a breakdown of conservancy services which has made it one of the polluted city of the world. The soil, water and air of Karachi have become highly polluted and contaminated resulting in unhygienic condition. This appalling situation has increased the incidence of soil, water and air borne diseases in the city (Afzal *et al.*, 2005).

The atmosphere of the earth is a thin layered collection of gases, water vapor and particles having most living creatures in the atmosphere (Stephan, 2011). Major man-made sources of ambient air pollution include industries, automobiles and power generation which released toxic gasses continuously in to atmosphere while indoor environments emit tobacco smoke, combustion of solid fuels for cooking and heating (Vinod, 2003). Some ambient air pollution is also contributed by natural activities such as forest fires, volcanic eruptions, decay of vegetation, winds and sand or dust storms (Zeger *et al*., 1999). The magnitude of the air pollution in Karachi has increased alarmingly due to population explosion, industrialization, urbanization, automobiles and other human proclivities. The poverty, poor hygienic condition and sub standard nutrition, water, soil and air pollution are responsible for the various blood related deficiencies and diseases in the population of Karachi (Ahmed *et al*. 2011). Some researchers (Leghari *et al*., 2003) calculated air pollution tolerance index of various plants in Quetta explained by (Khan *et al*. 2002).The diesel exhaust contains several gaseous compounds releasing carbon monoxide, nitrogen oxides, sulphur dioxide and organic vapors (Michael, 2000). Population is affected by air pollution in different ways such as poor people, under nourished people, very young, very old, and people with pre existing respiratory disease and other ill health are more at risk. Poor also tend to be more malnourished, more likely to suffer from ill health and disease and have less access to health care (Rao *et al.*, 2011). Long term effects of air pollution might slightly change the survival curve (ageing) of a population (Tims *et al*., 2006). Diesel emissions may also be a problem for asthemics, people with asthma who live near roadways with high amounts of diesel truck traffic have more asthma and use more asthamatic for patients medication (Brook *et al*. 2002). Nitrogen dioxide, nitrogen oxides, carbon monoxide were the pollutants most often linked with coronary heart disease (Ann *et al.*, 2006).

Materials and Methods

On the basis of poverty, amount of traffic and lifestyle of the area following (Rao, 2013. and Ahmed 2017), three (03) different areas were selected in Karachi city. Fifteen parameters of ambient air were determined to three years from each area. Using mobile analyzing equipments i.e. AP-370 series for NOx and NO, APNA-370 for Sulphur dioxide, APSA-370), for total hydrocarbon, methane and non-methane hydrocarbon, used APHA-370, carbon monoxide by APCA-370 while for ozone gas, APOA-370 was used. Further details were given in Ahmed (2017).

To investigate the overall picture of 03 areas of Karachi, three years data of each location was subjected to analysis of variance, ward cluster analysis and two dimensional NMS ordination (non-parametric multidimensional sealing) were used following Kruskal (1964) and Mccune and Mefford, (2005). Data of blood samples and common epidermis was also recorded (Ahmed, 2017) .

Table 1,2,3 shows the results of ANOVA for the different particles of ambient air from 03 areas of Karachi. Fig 1 and Fig 2 are the cluster analysis and the NMS two way ordination of ambient air particles from three areas of Karachi, respectively. Above analysis were based on three years (August to July) data to find out significant variation among the months.

Results and Discussions

A) ANALYSIS OF AMBIENT AIR:

Area of Defence: The overall results (Table 1) show that the higher intensity of radiation (341.2 w/m^2) was obtained in the month of August, while the lowest mean of the intensity of radiation (158.31 w/m^2) was found in the month of December but there is no significant difference among means. In the month of September the maximum mean values of MC (81.17$\mu g/m^3$) and wind direction (281.55 degree) were found significantly higher ($P<0.001$), while the lowest mean values of these parameters (23.82 $\mu g/m^3$ and 118.56 degree) were recorded in the months of March and December respectively. The significantly higher mean of total hydrocarbon (THC) (9565.31 ppb), $P<0.001$ was found in the month of October, while the minimum (3556.83 ppb) was recorded in the month of July. In November the maximum mean of nitric oxide (NO) (85.81 $\mu g/m^3$), $P<0.001$ was found significantly higher as compared to other months, however the minimum (17.13 $\mu g/m^3$) was estimated in the month of June. Nitrogen dioxide (NO2) (86.08 $\mu g/m^3$) and nitrogen oxide NOx (111.54 ppb) were recorded

significantly maximum P<0.001 in the month of December, while the minimum (21.07 µg/m^3) and (24.43 ppb) respectively were found in the month of June. The mean of sulphur dioxide (SO2) (95.75 µg/m^3) was recorded significantly higher P<0.001 in the month of January, while the lowest (7.21 µg/m^3) was calculated in the month of June. In the month of March, the estimated mean value of non methane hydrocarbon (NMHC) (3743.18 ppb) was found significantly higher among the months, while the minimum (695.91 ppb) was recorded in the month of August, similarly carbon monoxide (CO) (1.59 mg/m^3) was also found higher in March but no significant difference was found among months. Ozone (O_3)(48.78 µg/m^3) was found significantly higher P<0.001 in the month of April, while the lowest (9.41µg/m^3) was recorded in the month of August. The significantly higher mean values of wind speed (4.13 m/s) and RH (81.13%), P<0.001 were recorded in the month of May, while the minimum of these parameters 2.33± m/s and 47.71± % were estimated in the months of October and January respectively. The mean value of methane (CH4) (6527.59 µg/m^3) and Temperature (32.93 ^{O}C) P<0.001 were recorded significantly higher in July among the months, however the lowest values (2132.78 µg/m^3) and (10.66 ^{O}C) were found in both months of May and January respectively. Ahmed *et al* (2014) and Ahmed (2017) also reported similar results.

Area of North Nazimabad: Table 2.shows the result of the analysis of variance of the ambient air quality of North Nazimabad. The presented results of various parameters of the air recorded during August 2013 to July 2016. The highest mean of nitric oxide (NO) (31.41 µg/m^3) and total hydrocarbon carbon (THC) (7150.62 ppb) were recorded in the month of October with no significant variation among means, while the lowest value of nitric oxide (NO) (8.22 µg/m^3) and total hydrocarbon (THC) (2398.18 ppb) were found in both months of May and February respectively. The significantly higher mean of nitrogen dioxide (NO2), Oxide of Nitrogen (NOx) and carbon monoxide (CO) (61.74 µg/m^3, 52.95 ppb and 1.14 mg/m^3), P<0.001 respectively were estimated in the month of November as compared to others, while the lowest means of these parameters (20.85± µg/m^3, 17.31 ppb and 0.33 mg/m^3) respectively were found in the month of June. The estimated mean of methane (CH4) (5170.66 µg/m^3) was found significant P<0.001 in the month of January, while in the same month, methane carbon (MC) (84.44 µg/m^3) was recorded higher but no significant difference was observed among means, however the lowest mean value of methane (CH4) (1596.71 µg/m^3) was estimated in the month of May. The significantly higher mean of non methane hydrocarbon (NMHC) (3310.22 ppb), P<0.001 was recorded in the month of March, while the lowest mean (592.50 ppb) was found in the month of August. The mean of ozone (O3) (34.25 mg/m^3) was found highest in the month of April, but no significant difference was recorded among mean. In the month of May the mean of radiation (RAD) (280.68 w/m^2), P<0.001 was found significantly higher among months, while the minimum mean (147.43 w/m^2) was recorded in the month of January. The significantly higher values of Wind Direction (WD) and Temperature (Temp) (285.29 degree and 32.26 ^{o}C), P<0.001) respectively were estimated in the month of June, while the lowest means of these parameters (159.68 degree and 18.76 ^{o}C) were calculated in the months of December and January respectively, however the highest mean of wind speed (WS) (2.46 m/s) was also found in the month of June but no significant difference was recorded among means. Similarly, sulphur dioxide (SO2) (43.19 µg/m^3) was recorded maximum in the month of July but no significant difference was found among the means. Although, significantly highest mean of Relative Humidity (76.52 %), P<0.001 was also recorded in the same month, while the lowest value of relative humidity (RH) (53.65 %) was estimated in the month of December. These results are with in the range of Ahmed *et al* (2014) and Ahmed (2017) findings.

Area of Sohrab Goth: Table 3.shows the results of ANOVA for the various parameters of the ambient air quality of Sohrab Goth. The analysis of variance was applied on three (03) years data during August 2013to July 2016 to find out the variations among months. The overall results shows that the higher intensity of radiation (RAD) (316.08 w/m^2, P<0.001) was obtained in the month of September, while the lowest mean 166.45 w/m^2 was found in December. In October the maximum mean value of nitrogen dioxide (NO2) (87.18 µg/m^3), P<0.001 and total hydrocarbon carbon (THC) (10244.64 ppb), P<0.05 were significantly higher as compared to others, while the lowest values of these parameters (32.68 µg/m^3)and (3278.29 ppb) were recorded in the months of August and April respectively. The significantly higher mean value of nitric oxide (NO) (9.41 µg/m^3), P<0.001, methane (CH4) (5824.25 µg/m^3), P<0.01 and Temperature (Temp) (41.2 ^{0}C,) P<0.05 were found in November, while the minimum mean of these parameters (32.1 µg/m^3, 1982.43 µg/$m^3$and 11.85 ^{0}C) were recorded in the months of September, May and January respectively. In the month of December the maximum mean of Oxide of Nitrogen (NOx) (1113.03 ppb), P<0.001 was found significantly higher than others, while the minimum (40.11 ppb) was recorded in the month of June, however the mean of methane carbon (MC) (77.97 µg/m^3) was also found higher but no significant difference was recorded among the means. Non methane hydrocarbon (NMHC) (3870.37 ppb), P<0.01 and sulphur dioxide (SO2) (171.18 µg/m^3), P<0.001 were recorded significantly minimum in the both months of February and April respectively, while the minimum mean of non methane hydrocarbon (NMHC) (502.31 ppb) and sulphur dioxide (SO2) (19.82 µg/m^3) were estimated in April and August respectively. The significantly higher mean of wind speed (WS) (4.55 m/s), wind

direction (WD) (275.32 degree) and Relative humidity (RH) (83.03 %), P<0.001 were recorded in the month of July, while the minimum mean of these parameters (2.16 m/s), 121.09± degree and (51.43 %) were found in the months of November, December and January respectively. However, the highest mean of carbon monoxide (CO) (1.71 mg/m^3) and O3 (36.16 µg/m^3) was also recorded in July but no significant variation was calculated among means.

The concentration of some of the parameters of ambient air has been gradually increasing in three (03) years in each areas. According to statistic, Nitric oxide (NO) in Defence continuously increased from September to June while in North Nazimabad it is decreasing from February to July. In Sohrab Goth area, the concentration of nitric oxide (NO) gradually increased only in the month of April and gradually decreased in the month of May in three years while the concentration of nitrogen dioxide (NO_2) remain constant in the month of December in all three years. Most of the pollutant in various months of 2013 is found less as compared to year 2013 and 2015. As results describe that the strength of pollution (nitrogen dioxide (NO_2), Oxide of Nitrogen (NOx) and sulphur dioxide (SO_2) of Defence area increasing gradually with passage of time. Even not a single parameter decreased gradually though it is considered as a well-developed area of Karachi but major man-made sulphur oxide (SOx) pollution is concentrated in urban and industrial areas. The urban atmospheric pollution may impact on severe and unrelieved disease analysed air pollution and it affect the cardio respiratory disease according to (Anne *et al*., 2006); (Rao *et al*., 2011a, 2011b), (Ahmed *et al.*, 2014).

B) Multivariate Analysis:

Cluster Anaysis: According to Clarke (1993), multivariate analysis provides impatent information. Cluster analysis (Fig.1.) of three locations revealed two main groups, Group I and Group II. Group I is a group of all the air pollutants ranging between Nitrous Oxide (NO), Nitrogen Dioxide (NO_2), Oxide of Nitrogen (NOx), Sulphur Dioxide(SO_2),Methane Carbon (MC), Relative Humidity (RH), Carbon Monoxide (CO), Ozone (O_3), Temperature (Temp), Wind Direction (WD), Radiation (Rad) and Non Methane Hydro Carbon (NMHC) ranked first with its combination with other pollutants. First component explained the highest percentage of total variance, while each study area eigenvector coefficients showed different groups of associated pollutant. Percentage of variance ranged from 81 to 89% in component one which determined the most dominant and widely distributed group of pollutants in three different locations. Group II consisted of two pollutants Methane and total hydro carbon found higher throughout the study period at all locations.

Two dimensional ordination: Fig.2. diagrams identified two similar groups with same combination as shown by combined cluster analysis. Two axes showing increasing pollution gradient from left to right side of the ordination spaces. Level of air pollutants showed that these are spreading in almost similar number. Although, area of Defence is less congested with less traffic flow, having better hygienic situation, more income and better life style of the people. But air pollutants attacked significantly to the people in the areas of Defence, Sohrab Goth and North Nazimabad population, there results also agree with Rao (2013). It is reported that a large number of children suffered with upper respiratory infection in February, March and April while diarrhoea frequency was highest in June and August (Anjum *et al.*, 2006) and Rao *et al.*, (2011 ab), these results also agreed with our findings. Since no boundary or any barrier can be placed in atmosphere and airborne microorganisms, microbes, fungi, bacteria and other toxic particles produced in one place may travel long distances and may cause epidemics even in better planned area too. (Rao, 2013).

Hydrocarbon are emitted into the atmosphere by natural biological activity as well as anthropogenic sources such as automobiles exhausts burning of coal, oil, wood and refuse and solvent evaporation. Chronic exposure to current outdoor air pollution levels, to which road traffic emissions are a major contributor, may have even larger impacts on mortality than acute exposure (Ravi *et al.* 2005). The effect of ozone on people includes (1) irritation of the nose and throat, (2) increased mucus production and tendency to cough (3) eye irritation and headaches for some (Michael, 2000). Anthropogenic sources account for about 15% of the total hydrocarbon emissions in the atmosphere. The gases act like a blanket where ever their concentration increases, local concentration increase local heat and increases differences between hotter and colder regions drives weather events in to more extreme ranges (Stephan, and Gislason 2011).

Methane is the main component of hydrocarbon (HC) released in to the atmosphere by natural activities as well as artificial activities accountable to anaerobic decomposition of organic matter in H2O, soil and sediments by micro organism. Extreme levels of pollution may cause markedly increased mortality rates which refers to the meuse valley fog of 1930 or the London Smog of 1952 (Goldberg *et al.* 2001). Methane is although non toxic, but it reduces the amount of oxygen in the air which is essential to life to support. Methane is usually produced by mining/distribution livestock and landfills. Any type of handling, transportation (Through pipeline or truck delivery) or refinement there are additional methane emissions created for every type of fossil fuel (Stephan and Gislason, 2011). Manure landfills and open garbage dumping sites are full of organic matter like food scraps, newspaper, cut grass and leaves. Many times new garbage comes in it is pilled over the old garbage

often gets trapped in conditions where there is no oxygen (anaerobic) and because of this huge amounts of methane is flourished. Various domestic animals places, unsheltered and scattered garbage and their collection and dumping sites in the city and areas around the city are best places to produce methane in Karachi (Ahmed 2017).

Data of abnormal blood particles and common epidermis (Rao 2013; Ahmed, 2017) not presented here but most of the people effected by illegal practices of dumping and burning of garbage responsible to the excitation, rapid breathing, headache and irritating to the respiratory tract and mucous membranes. Constant exposure to current outdoor air pollution levels, to which road traffic emissions are a major contributor, may have even larger impacts on mortality than acute exposure (Haining *et al*., 2003). When organic matter decomposes an aerobically great quantities of methane are produced (Stephan, 2011). High concentrations of nitric oxide gas may cause an oxygen deficient atmosphere. The nitric oxide has an ability to react in the body to oxidize hemoglobin to met hemoglobin in the blood. Coma and death can ensue when met hemoglobin levels reach 70% (Pekkanen *et al*., 2002). Ozone is a powerful oxidant and has many industrial and consumer purpose related to oxidation. This has high oxidising potential, which damage mucous and respiratory tissues in human life.

The area of North Nazimabad which is nearby to the industrial region received untreated air particles in which the quality of the air is deteriorated with passage of time. The untreated industrial effluent, unprocessed air emission from generators and boilors and improper disposal and burning of solid and hazardous waste together with hospital waste is responsible for headache, nausea and fatigue to the local resident (Ahmed, 2017). Severe over exposure may cause hemoglobinemia cyanosis, mental confusion and death. (Tims *et al*., 2006). Most of the air pollutants interfere with the function of blood, which results in detrimental effects on whole body (Ahmed, 2017), like hemoglobin that carries oxygen from the lungs to the tissues of the body (Vicki, 2005).

The effect of air pollution on negative impact of residence of Karachi was also described by (Ahmed *et al* 2010). The current study also agreed with (Rao, 2013) that the sanitary condition of these areas is unsatisfactory while the lifestyle of the people, income level, poverty level and education level of the area is very low as well as compact congestion development also enhance the pollution level. Urban atmosphere pollution has a well known impact on acute and chronic respiratory disease, where as it effect on cardio respiratory disease has been analyzed more recently (Schwartz, 1994). Most of the carbon monoxide (CO) in the atmosphere is due to human activities such as automobile exhausts which accounts for 60% of carbon monoxide (CO) in the atmosphere and city has about more than 1 million automobiles. However, higher amount of CO is contributed in the city by open garbage burning in hundreds of places and dumping sites (Ahmed *et al*., 2014). According to (Michael, 2000) reported industrial operations such as electric and blast furnaces in iron and steel industry, petroleum refinery, paper industry, gas manufacture (which constitutes about 9.6% of CO in the atmosphere). Inhaling carbon monoxide reacts very rapidly with hemoglobin in the blood, preventing uptake and transportation of oxygen. (Ahmed *et al.,* 2011) About 99% of the sulfur dioxide comes in air from human sources. The major source of sulfur dioxide in the atmosphere is due to the industrial activities, generation of electricity from coal, oil or gas that contains sulfur. Some mineral ores also contain sulfur, and sulfur dioxide is released when they are processed. Furthermore, industrial activities that burn fossil fuels containing sulfur can be important sources of sulfur dioxide (Ahmed *et al.,* 2014). Short-range exposures of SO_2 are harmful to the human respiratory system and make breathing difficult. Multivariate studies also suggested that children, the elderly, and those who suffer from asthma are particularly sensitive to effects of SO. NO and NO_2 are more significant from air pollution point of view and they are usually represented together as NOx (Tim, 2006). In addition, there should be technically suitable landfill sites with proper garbage collection system in the city. Smoke spreading or discharging vehicles should be totally banned. Water damaged buildings should be properly repaired. Sewerage system should be monitored for overspill. More incineration places should be provided, plants should be installed particularly near hospitals. Garbage burning inside Karachi city and dumping in open areas should be banned. These are the possible measure that can be taken to control or minimize these epidemics in Karachi city. The present study will help to find out possible measures to overcome rate of pollution which has become a major risk for population health.

Table 1. Showing the ANOVA of the Ambient Air Quality of Defence area recorded during three years.

Months	NO	NO2	NOx	CH4	NMHC	THC	CO	SO2	O3	MC	W.S.	W.D.	Temp	RH	RAD
	µg/m^3	µg/m^3	Ppb	µg/m^3	ppb	ppb	µg/m^3	µg/m^3	µg/m^3	µg/m^3	m/s	degree	˚C	%	W/m^2
Aug	42.05 c	29.79 ef	48.72 def	3662.67 cd	**659.9* e**	6079.07 de	**0.59* a**	11.16 d	**9.41* e**	55.21 bc	3.72 abc	269.43 a	29.90 ab	77.18 ab	**341.25# a**
Sept	33.74 cd	36.96 e	62.09 cd	3668.31 cd	1121.02 de	5760.21 de	1.40 a	17.03 cd	2.62 e	**81.17# a**	3.87 ab	**281.55# a**	30.81 ab	75.68 ab	297.45 ab
Oct	59.03 b	54.02 d	57.61 de	4405 bc	1439.37 cde	**9565.3# a**	1.46 a	23.06 de	18.24 de	69.46 ab	**2.33* d**	245.51 a	30.47 ab	62.10 c	254.25 abc
Nov	**85.8# a**	56.79 cd	85.90 b	5495.71 ab	990.45 de	6186.81 de	1.49 a	40.04 c	24.22 cd	54.32 bcd	2.47 d	203.51 b	29.45 ab	59.1 cd	176.55 bc
Dec	78.63 a	**86.08# a**	**111.54# a**	4787.89 bc	1142.79 de	7130.21 c	1.25 a	71.58 b	30.90 bc	55.63 bc	2.48 bcd	**118.56* c**	17.23 d	59.83 cd	**158.31* c**
Jan	75.67 ab	80.06 ab	109.33 a	5374.52 ab	1253.34 cde	8226.85 b	1.27 a	**95.75# a**	37.05 b	71.86 ab	2.51 d	140.09 c	**10.66* e**	**47.71* e**	178.45 bc
Feb	60.87 b	68.44 bc	84.16 b	5760.76 ab	2850.81 ab	6423.57 d	1.23 a	70.84 b	27.93 bcd	61.32 abc	2.51 d	271.60 a	14.27 de	51.61 de	219.33 abc
Mar	60.55 b	65.33 cd	80.73 bc	4828.91 bc	**3743.1# a**	5563.7 e	**1.59# a**	40.41 c	16.27 de	**23.82* e**	2.67 cd	263.74 a	22.07 c	59.49 cd	278.03 abc
Apr	32.52 cd	36.05 e	36.79 efg	2388.35 de	1858.84 bcde	4497.02 f	0.79 a	24.08 cd	**48.78# a**	46.58 cd	3.29 abc	267.30 a	27.78 b	67.47 bc	292.80 ab
May	21.04 d	25.26 ef	32.41 efg	**2132.7* e**	2380.40 bc	5909.47 de	0.99 a	7.69 d	38.69 ab	32.83 de	**4.13# a**	257.76 a	31.93 ab	**81.13# a**	256.55 abc
Jun	**17.1* d**	**21.07* f**	**24.43* g**	3639.69 cd	1608.96 cde	4272.12 f	0.76 a	**7.21* d**	23.43 cd	45.91 cd	4.06 a	267.64 a	32.56 ab	76.71 ab	258.39 abc
Jul	27.59 cd	27.54 ef	37.61 efg	**6527.5# a**	2043.68 bcd	**3556.8* g**	0.91 a	7.96 d	20.42 cde	53.95 bcd	3.79 ab	268.80 a	**32.93# a**	78.21 a	254.25 abc
LSD	15.80	12.51	20.12	1270.95	1044.68	696.15	1.30	23.01	10.90	19.81	0.99	35.58	4.47	9.32	106.57
F-value	18.90	27.46	18.67	9.44	6.02	48.77	0.53	14.28	10.19	5.58	4.13	20.09	25.69	12.44	2.25
'P'value	0.001	0.001	0.001	0.001	0.001	0.001	0.86ns	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.0415

 # = highest mean average of ambient air *=lowest mean average of ambient air

Table 2. Showing the ANOVA of the Ambient Air Quality of North Nazimabad area recorded during three years.

Months	NO	NO2	NOX	CH4	NMHC	THC	CO	SO2	O3	MC	WS	WD	TEMP	RH	RAD
	µg/m^3	µg/m^3	ppb	µg/m^3	Ppb	ppb	µg/m^3	µg/m^3	µg/m^3	µg/m^3	m/s	degree	°C	%	w/m^2
Aug	16.88 abc	25.37 de	20.93 d	2846.76 bcd	**592.5* f**	5345.25 abc	0.44 d	25.32 ab	22.34 a	70.74 abc	2.01 abc	275.59 a	29.70 abc	76.06 ab	203.59 cdef
Sept	21.70 abc	28.66 de	37.09 abc	3560.94 abcd	680.23 ef	5333.48 abc	0.63 bcd	13.78 b	27.49 a	78.04 ab	1.73 abc	276.06 a	30.46 abc	74.06 ab	258.06 abc
Oct	**31.41# a**	53.41 ab	46.07 ab	4876.38 ab	2222.69 bc	**7150.6# a**	0.87 abc	**13.73* b**	27.06 a	59.24 abc	1.48 bc	254.91 ab	30.23 abc	56.57 de	237.51 abcd
Nov	30.61 ab	**61.7# a**	**52.9# a**	3357.61 abcd	748.52 def	4890.59 abcd	**1.14# a**	23.22 ab	23.26 a	66.09 abc	1.28 bc	222.26 c	27.96 bc	61.05 cde	176.46 efg
Dec	23.15 abc	60.31 a	50.19 a	4008.53 abc	986.51 def	5756.99 ab	0.96 ab	35.66 ab	25.30 a	76.95 abc	**1.15* c**	**159.68* d**	20.52 de	**53.65* e**	150.56 fg
Jan	19.59 abc	54.10 ab	41.40 ab	**5170.6# a**	1750.65 cde	5878.78 ab	0.87 abc	25.48 ab	32.58 a	**84.44# a**	1.43 bc	170.41 d	**18.76* e**	54.37 e	**147.4* g**
Feb	17.54 abc	49.39 b	38.20 abc	5437.26 ab	1806.18 cd	**2398.1* d**	0.88 abc	28.12 ab	31.89 a	62.52 abc	1.52 bc	235.81 d	22.35 d	55.03 e	186.71 defg
Mar	12.46 bc	39.65 c	31.39 bcd	4542.45 ab	**3310.2# a**	3521.18 bcd	0.59 cd	26.81 ab	30.84 a	46.91 bc	1.43 bc	260.22 ab	26.05 c	60.82 cde	230.45 abcde
Apr	9.04 c	33.55 cd	24.79 cd	2110.13 cd	2972.21 ab	3855.47 bcd	0.39 d	33.02 ab	**34.25# a**	50.63 abc	1.58 bc	279.67 a	29.55 abc	63.44 bcde	276.86 ab
May	**8.22* c**	24.40 de	19.44 d	**1593.7* d**	1332.09 cdef	5056.58 abcd	0.34 d	28.34 ab	23.29 a	41.35 c	1.88 abc	280.31 a	31.01 ab	69.28 abcd	**280.6# a**
Jun	9.81 c	**20.8* e**	**17.3* d**	2987.21 bcd	1281.94 cdef	3876.82 bcd	**0.33* d**	30.26 ab	22.44 a	**37.61* c**	**2.46# a**	**285.29# a**	**32.26# a**	71.78 abc	261.04 ab
Jul	15.11 abc	25.04 de	18.54 d	4672.79 ab	1464.60 cdef	2901.85 cd	0.47 d	**43.19# ab**	**19.18* a**	42.67 c	2.11 ab	280.45 a	31.85 ab	**76.52# a**	223.49 bcde
LSD	16.18	9.27	14.24	1792.96	978.61	2474.88	0.33	22.98	16.63	29.67	0.78	29.12	3.49	11.61	49.86
F-value	1.96	23.13	6.99	3.45	6.80	2.628	5.83	1.10	0.71	2.44	1.99	19.05	14.77	4.86	7.12
'p'value	0.08ns	0.001	0.001	0.005	0.001	0.023	0.001	0.39ns	0.71ns	0.032	0.076	0.001	0.001	0.006	0.001

 # = highest mean average of ambient air * = lowest mean average of ambient air

Table 3. Showing the ANOVA of the Ambient Air Quality of Sohrab Goth area recorded during three years.

Months	NO	NO2	NOX	CH4	NMHC	THC	CO	SO2	O3	MC	WS	WD	TEMP	RH	RAD
	µg/m^3	µg/m^3	ppb	µg/m^3	ppb	ppb	µg/m^3	µg/m^3	µg/m^3	µg/m^3	m/s	degree	°C	%	w/m^2
Aug	47.39 cd	**32.6* e**	45.77 ef	3593.41 abcd	887.22 bc	6864.51 bc	**1.06* a**	**19.8* f**	14.81 a	57.43 ab	4.27 a	257.25 ab	29.38 abc	76.45 ab	273.53 ab
Sept	**32.1* d**	37.28 de	52.13 def	4082.03 abcd	1478.18 bc	6376.07 bcd	1.42 a	27.51 ef	14.04 a	65.71 ab	3.77 ab	271.38 a	29.78 abc	75.33 ab	**316.08# a**
Oct	78.13 ab	**87.1# a**	80.19 bcd	4419.35 abc	1092.47 bc	**10244.6# a**	1.44 a	37.82 ef	**12.80* a**	68.74 ab	2.35 c	235.94 b	26.57 abcd	63.32 cd	247.34 b
Nov	**90.41# a**	72.88 abc	106.58 ab	**5824.2# a**	1117.57 bc	6320.57 bcd	1.36 a	78.89 cd	15.82 a	67.94 ab	**2.16* c**	203.01 c	**41.2# a**	63.21 cd	185.56 c
Dec	82.39 ab	85.64 ab	**1113.0# a**	4111.54 abcd	1071.49 bc	7696.47 ab	1.47 a	104.34 bc	20.33 a	**77.9# a**	2.63 bc	**121.0* d**	19.11 bcd	62.35 cd	**166.45* c**
Jan	83.22 ab	83.07 ab	95.78 abc	5299.93 ab	2538.16 ab	5839.68 bcd	1.41 a	94.24 bc	18.29 a	76.31 a	2.41 c	133.56 d	**11.85* d**	**51.4* e**	193.10 c
Feb	62.85 bc	65.41 bc	71.99 cde	5818.03 a	**3870.3# a**	5185.11 bcd	1.35 a	88.76 bcd	18.77 a	76.27 a	2.20 c	255.96 ab	15.31 cd	53.21 de	250.03 b
Mar	50.83 cd	54.56 cd	68.82 cdef	4044.76 abcd	3379.91 bc	3644.76 cd	1.51 a	119.13 b	15.96 a	58.64 ab	2.76 bc	262,38 ab	25.01 abcd	61.37 cd	308.79 a
Apr	45.85 cd	59.66 c	69.26 cdef	2112.32 cd	**502.3* c**	**3278.2* d**	1.34 a	**171.1# a**	13.51 a	47.12 ab	3.08 bc	265.07 ab	27.51 abcd	67.71 bc	302.64 a
May	44.38 cd	54.2 cd	58.58 def	**1982.4* d**	548.04 c	5517.17 bcd	1.42 a	123.48 b	28.04 a	39.80 ab	4.36 a	257.25 ab	32.57 abc	82.78 a	275.39 ab
Jun	33.81 d	34.75 de	**40.11* f**	3388.09 bcd	1171.88 bc	55125.53 bcd	1.34 a	55.34 de	27 07 a	42.59 ab	4.4 a	263.79 ab	33.60 ab	80.54 a	280.65 ab
Jul	42.05 cd	55.58 cd	66.08 cdef	4261.54 abcd	1337.39 bc	3479.12 cd	**1.71# a**	35.78 ef	**36.16# a**	**35.3* b**	**4.55# a**	**275.3# a**	34.82 ab	**83.0# a**	284.40 ab
LSD	20.21	19.61	27.21	2071.62	1576.43	3041.17	0.63	32.26	21.05	33.77	1.10	30.23	15.22	9.39	37.71
F-value	8.94	8.27	6.10	3.01	4.05	3.56	0.486	17.10	0.993	1.70	6.31	25.96	2.61	11.73	14.97
'P'value	0.001	0.001	0.001	0.0116	0.002	0.0044	0.893	0.001	0.47ns	0.13ns	0.001	0.001	0.023	0.001	0.001

 # = highest mean average of ambient air * = lowest mean average of ambient air

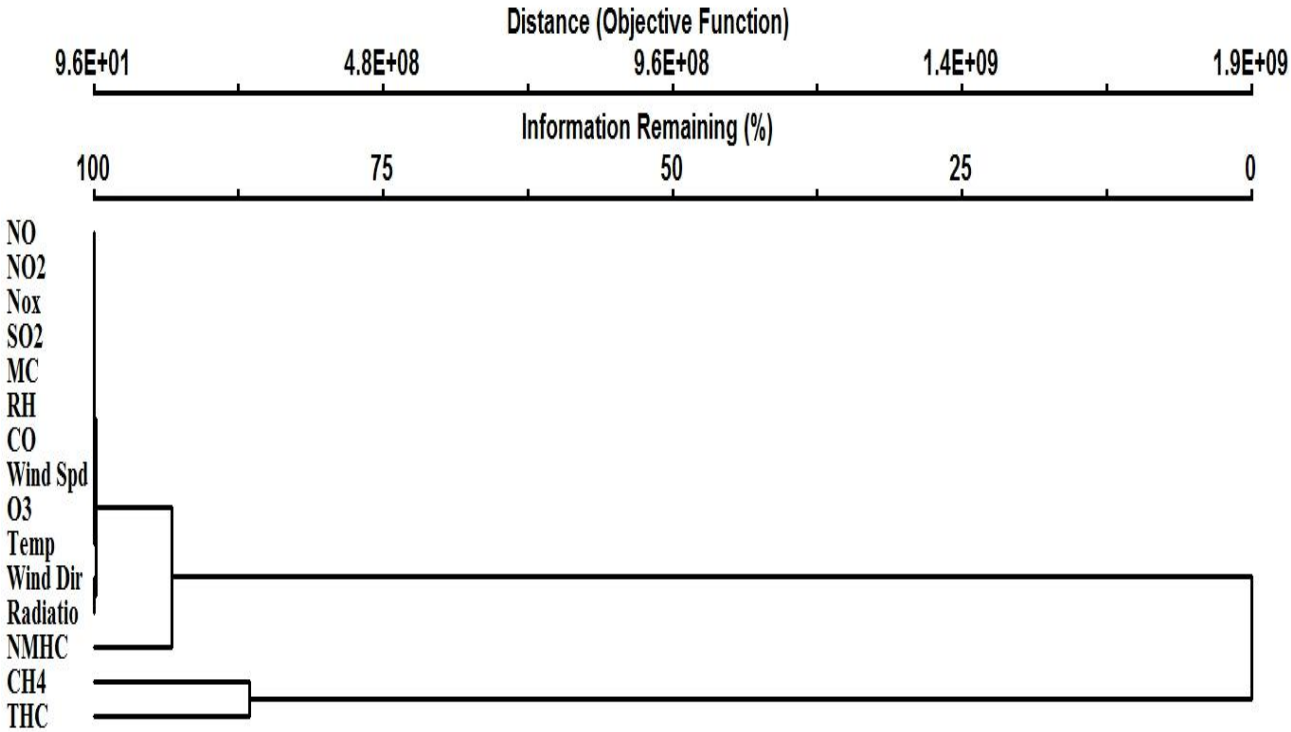

Fig.1. Showing the cluster analysis of fifteen air pollutants recorded from three (03) location.

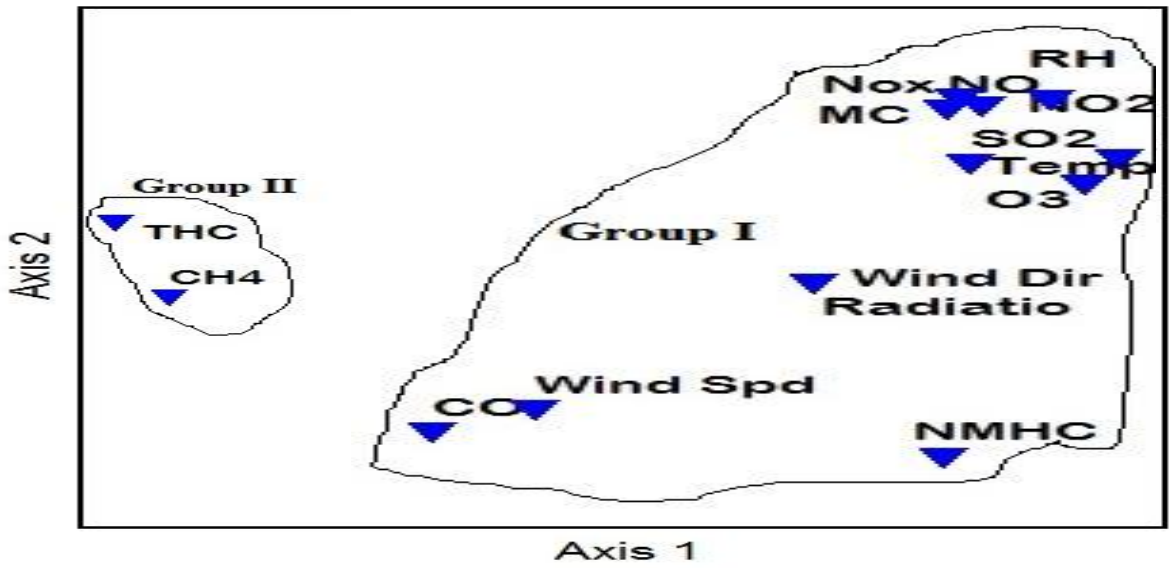

Fig.2. Showing NMS ordination of fifteen air pollutants recorded from three (03)locations.

Conclusion

The present study shows that most of the parameters of ambient air particles were found above the permissible limits of the National Environmental Quality Standard (NEQS). NEQS of five gases such as Methane, Non Methane Hydrocarbon, Total Hydro Carbon and Methane Carbon were not established yet or found in any previous studies in Karachi and need to notify the someone by the concerned authority. It was also observed that the concentration of each pollutant were increasing alarmingly with passage of time due to anthropogenic activities which may responsible to damage the natural environment and invites the natural disaster in the Karachi. The concentration of Carbon Monoxide in all three areas was found with in a permissible limit of National Environmental Quality Standard (NEQS). The Concentration of carbon monoxide

(CO) and ozone (O3) were found below, sulphur dioxide (SO2) slightly higher in few months, NO higher in Defence and Sohrab Goth areas and nitrogen dioxide (NO2) higher than the notified permissible limit. Finally it was observed that the concentrations of each pollutant was increasing alarmingly with passage of time which may be responsible to damage the healthy environment of Karachi. It may also enhance global warming and depletion of ozone layer.

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