Toxic Gases of Atmosphere and its Probable Impacts on Environment and Public Health in Dhaka City.

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Abstract: Bangladesh ranked second among 91 countries with the worst urban air quality in the latest air pollution monitoring report by the World Health Organization(WHO, 2023). Data from the National Institute of Diseases of the Chest and Hospital shows that nearly seven million Bangladeshis suffer from asthma and more than half of them are children.In Dhaka alone, an estimated 15,000 premature deaths, as well as several million cases of pulmonary, respiratory and neurological illness are attributed to poor air quality. Bangladesh is lacking systematic ambient air quality measurements and time series data though the reports based on sporadic analysis indicate worsening air pollution in particular, in cities with heavy traffic movement and congestion, industrial and brick-kiln actives and solid waste management practices. The level of air pollution and the effects on human health was however, not assessed to that extant. With this background atmospheric toxic gas concentrations namely CO, TVOC in the ambient air were measured in some selected hot spots in Dhaka city between 2022 and 2023. Among the toxic gases concentration of CO 15818 $\mu g/m^3$, TVOC 22897 $\mu g/m^3$ were measured at different hot spots in Dhaka city appeared to be very high and exceeded the limit values suggested by the WHO, 2005 (CO 5000 $\mu g/m^3$, TVOC 8000 $\mu g/m^3$) . Significant level of diurnal variations of toxic gases were also observed. A survey on human health using structured questionnaire reveal that the people in Dhaka city are experiencing health problems like breathing problem, eye- irritation, cough, asthma, vomiting, headache in particular students, Traffic polices, Drivers appears to be the mostly affected. More than 25 percent students interviewed in Dhaka city reported to have been suffering from eye-irritation, cough, asthma, vomiting, headache and other respiratory problem. Effects on human health with any of the particular toxic gases measured could be established.

Key word: Toxic gases, Hot spots, Chronic Obstructive Pulmonary Disease.

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Introduction

The atmosphere is a thin blanket of air which envelops earth sustaining life in it and protecting it from the adverse effects of outer space. It contains a large amount of N_2 and O_2, smaller amounts of Ar and CO_2 as well as traces of other gases- He, Ne, CH_4, H_2S, O_3, NH_3, CO, TVOCs etc. On an average about 50 Ibs (Irritable bowel syndrome) of air are required per person per day to meet O_2 requirement .Clean air is necessary for healthy environment and to sustain biodiversity.Unfortunately atmosphere is used as dumping site for verities of toxic organic and inorganic gases, particulate matter, and aerosols etc. which contaminate the atmosphere. Environmental pollution and the effects on climate change is a major concern for the people's survival and lifestyle in the future. In particular, Dhaka city has become an endangered area in the country. Recently, Dhaka came in second on the list of cities with one of the worst air quality (WHO, 2023). The average air quality index (AQI) for the city was 162, which is deemed unhealthy. The lives of the city dwellers has been hampered due to air contamination, particularly atmospheric gaseous pollution. Largely as a result of increased mortality from stroke, heart disease, chronic obstructive, pulmonary disease, lung cancer and acute respiratory infections, breathing problem, tuberculosis and skin diseases. Air pollution alone accounts for 17.6% of the risk of death and disability in Bangladesh (Ahmad, S. A. et. Al., 2008) The annual economic burden of air pollution in Dhaka has been estimated at USD 192 million(DoE,2021).Bangladesh's air unhealthy to breath since 2017 (WHO, 2020).One of our era's greatest scourges is air pollution, on account not only of its impact on climate change but also its impact on public and individual health due to increased morbidity and mortality. There are many pollutants that are major factors in disease in humans. The World Health Organization (WHO, 2022) describes air pollution as a major environmental risk to health and estimates that it causes around seven million premature deaths worldwide every year, and Dhaka is one of the hard-hit cities. Despite the fact that ozone in the stratosphere plays a protective role against ultraviolet irradiation, it is harmful when in high concentration at ground level, also affecting the respiratory and cardiovascular systems(Adler, 1994). Hydrocarbons, also called volatile organic compounds (VOCs) and carbon monoxide (CO). They are produced primarily when fossil fuels like gasoline, oil or coal are burned or when some chemicals, like solvents, evaporate. NOx is emitted from power plants, motor vehicles and other sources of high-heat combustion. Volatile organic compounds (VOCs) are emitted from motor vehicles, chemical plants, refiner

ies, factories, gas stations, paint and other sources. Carbon monoxide (CO) is also primarily emitted from motor vehicles (Begum, B.A., Biswaset. Al., 2006).Furthermore, nitrogen oxide, sulfur dioxide, and Volatile Organic Compounds (VOCs) are all considered air pollutants that are harmful to humans. Carbon monoxide (CO) can even provoke direct poisoning when breathed in at high levels. Heavy metals such as lead, when absorbed into the human body, can lead to direct poisoning or chronic intoxication, depending on exposure. Diseases occurring from the aforementioned substances include principally respiratory problems such as Chronic Obstructive Pulmonary Disease (COPD), asthma, bronchiolitis, and also lung cancer, cardiovascular events, central nervous system dysfunctions, and cutaneous diseases (Mehedi, H., 2010). Last but not least, climate change resulting from environmental pollution affects the geographical distribution of many infectious diseases, as do natural disasters. The only way to tackle this problem is through public awareness coupled with a multidisciplinary approach by scientific experts; national and international organizations must address the emergence of this threat and propose sustainable solutions.

Methodology

Atmospheric toxic gases – CO, TVOC were investigated in Dhaka city to evaluate air quality and to determine the air pollutants and their probable impacts on public health. The data expressed in percentages are analyzed to understand the opinions of the respondents. Air pollution have been measured at five major locations in Dhaka City from 8 am to 8 pm on working days by using air quality detector (Model-JSM-131SE).The locations are Farm-gate, Science-Laboratory,Mouchak, Curzon hall, Topkhana and Eden Mohila College, etc.measurements of toxic gases. Temperature and humidity were conducted at 15 minutes, 30 minutes, and 60 minutes intervals throughout the year starting from 2022 to 2023 to ascertain the air quality and assess diurnal concentrations of CO, TVOC. Measurements were also carried out at 3 meters, 50 meters, and 90 meters height at Bangladesh Bank Building. The data were collected by using a structured questionnaire selected to understand their opinion. The data expressed in percentages are analyzed to understand the opinions of the respondents.

Result and Discussion

Carbon monoxide (CO)

Carbon monoxide poisoning occurs after enough inhalation of carbon monoxide (CO). Carbon monoxide is a toxic gas, but, being colorless, odorless, tasteless, and initially non-irritating, it is very difficult for people to detect. Carbon monoxide is a product of incomplete combustion of organic matter due to insufficient oxygen supply to enable complete oxidation to carbon dioxide (CO_2). It is often produced in domestic or industrial settings by older motor vehicles and other gasoline-powered tools, heaters, and cooking equipment. This prevents oxygen binding to hemoglobin, reducing the oxygen-carrying capacity of the blood, leading to hypoxia. Additionally, myoglobin and mitochondrial cytochrome oxidase are thought to be adversely affected. Carboxyhemoglobin can revert to hemoglobin, but the recovery takes time because the HbCO complex is fairly stable (Ahmad, S.A. et. Al., 2008).

CO Concentrations (μg/m^3) measured for Dhaka City during 2022 -2023.

Carbon monoxide (CO) concentrations (μg/m^3) measured for Dhaka city at different hot spots during 2022-2023.The concentrations varied from 9487 μg/m^3 to 17818 μg/m^3 in the hot spots. Among the hot spots the maximum concentrations were measured for Farm gate 17818 μg/m^3 followed by Science laboratory 14945 μg/m^3, Mohakhali 14145 μg/m^3, Mouchak 14712 μg/m^3, Topkhana 12712 μg/m^3, Curzon hall 11257 μg/m^3, Eden Mohila College 9487 μg/m^3. The average natural background concentrations of CO are around 2000-5000 μg/m^3 (WHO, 2005). The CO measured for Dhaka city and the exposure level is very high compared to the limit values set by EPA, 2002 and Bangladesh standards 5000 μg/m^3 (DoE, 2002).

Both natural and anthropogenic sources contribute to CO precursors, and the composition of emissions sources may show large variations across locations (WHO, 2012). One of the major anthropogenic sources of CO precursors is the motor vehicles. It is possible that the increasing number of motor vehicles plying in the streets of Dhaka city at present is contributing in to CO precursors. Carbon monoxide is a product of incomplete combustion of organic matter due to insufficient oxygen supply to enable complete oxidation to carbon dioxide (CO_2). A strong negative correlation ($r = - 0.23$) between CO and TVOC, positive correlation ($r = 0.65$) between CO and NO and positive correlation ($r = 0.84$) between CO and PH_3 obtained in the present investigation. It is often produced in domestic or industrial settings by older motor vehicles and other gasoline-powered tools, heaters, and cooking equipment. The reason behind the variation can be explained by the vehicular emissions of CO during this time period. It

is evident from the daily traffic movement on the street that the number of vehicles significantly increase during the day time especially between 9am – 10pm .The CO concentrations also varied with relative humidity. A significant negative correlation (r = 0.698 %) was obtained for CO and relative humidity. It is evident from the results that CO concentrations increased with increasing relative humidity and supported by EPA, 2009.The diurnal variations occur in response to changes in sunlight. Peak CO concentrations are measured in the day time.

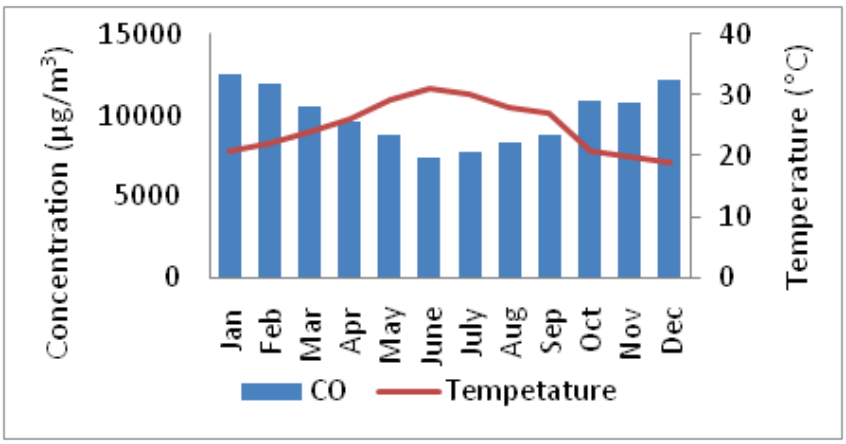

Fig. 3.1 CO variation along with temperature O^{C} in Dhaka city (2022-2023).

The concentrations of CO decreased as the temperature increased between April and September (Fig. 3.1). When the temperature starts decreasing the value of CO is increasing in October to March. Industrial emissions, vehicular emissions, anthropogenic activities, brick-kilns, city wastes burning etc. produce huge amount of CO.

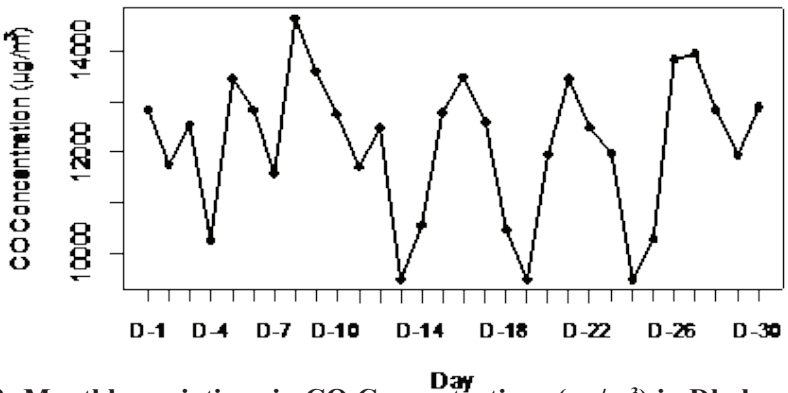

Fig. 3.2: Monthly variations in CO Concentrations (µg/m^3) in Dhaka city (June, 2023).

Carbon monoxide (CO) concentrations (µg/m^3) measured for 30 days in June, 2023 in Dhaka city presented in Fig 3.2 shows that the concentrations varied significantly from 1st June to 30th June. The Concentrations measured on 1st, 2th, 3th, 4th, 5th, 6th June were 13845 µg/m^3, 11745 µg/m^3, 13547 µg/m^3, 11245 µg/m^3, 13451 µg/m^3, 12845 µg/m^3 respectively. The highest value was 14942 µg/m^3 measured on 7th June and the lowest 9456 µg/m^3 on 13th June.The reason behind the variation can be explained by the vehicular emissions of CO during the holiday, rainy day, cloudy day in this time period. The average value is significantly different at 95% confidence between 7th June and 13th June. The lowest values were recorded on 13th and 24th June and the days were rainy day. The 2rd, 9th, 16th, 23th June were holidays and for these reason the concentrations of CO were lower than the other days.

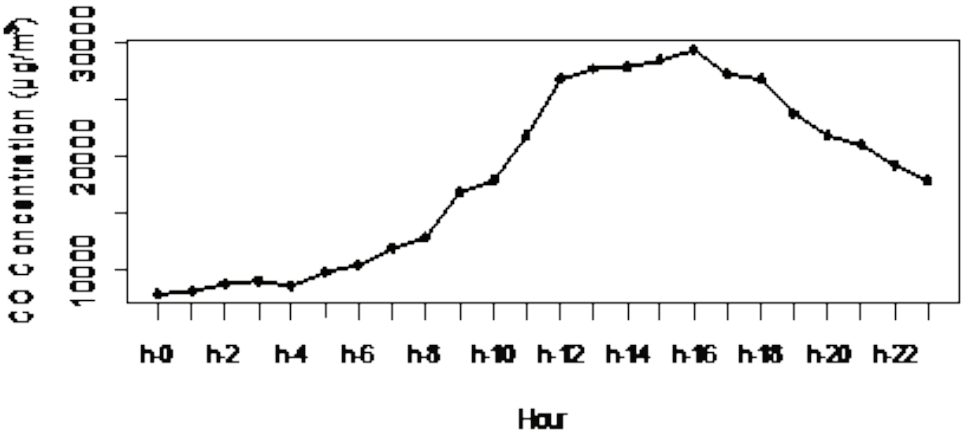

Fig. 3.3: Diurnal variation in CO Concentrations (µg/m^3) in Dhaka city (3 June, 2023).

Carbon monoxide (CO) concentrations (µg/m^3) measured for 24 hours on 3 June, 2023 in Dhaka city presented in Fig.3.3 shows that the concentrations varied significantly from 0 hour to 24 hours. The peak concentrations measured between 15 hour and 16 hour were 28547 µg/m^3, 29467 µg/m^3. The highest value 29467 µg/m^3 was measured at 16 hour and the lowest value 7956 µg/m^3 at 0 hour. The reason behind the variation could possibly be conversion of CO to other gases by the presence of sunshine, sunlight and the photochemical reaction.

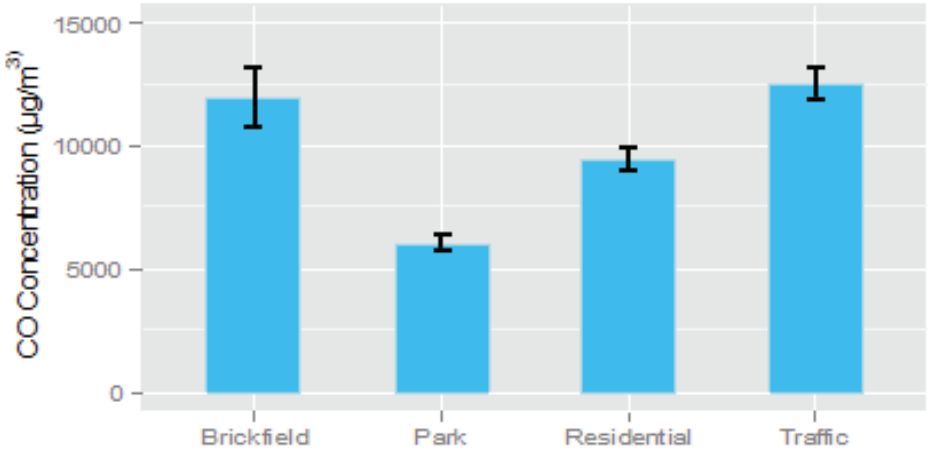

Fig. 3.4: Comparison of CO Concentrations (µg/m³) measured for different locations in and around Dhaka city from 2022-2023.

Carbon monoxide (CO) concentrations (µg/m³) determined at residential area, traffic area, park, brick-field etc. to see the locational variations presented in Fig 3.4 shows that the concentrations varied significantly from place to place. The highest concentrations measured in traffic area 13834 µg/m³ followed by brick-field 12845 µg/m³, residential area 9976 µg/m³ and park area 6612 µg/m³ (Fig 3.4). The CO concentration measured for traffic areas were significantly higher than that measured for park and residential areas at 95% confidence level. Industrial emissions, vehicular emissions, anthropogenic activities, brick-kilns, city wastes burning etc. Produce a huge amount of CO. The number of running vehicles, long time traffic jam produce CO resulting in an air pollution. Use of low quality coal, wood in brick-kilns also produce a huge amount of CO (Iidfcl, H., 2009).

Total Volatile Organic Compounds (TVOCs)

Total Volatile organic compounds (TVOCs), such as toluene, benzene, and xylene have been found to be associated with cancer in humans. The use of new products and materials has actually resulted in increased concentrations of TVOCs. TVOCs pollute indoor air and may have adverse effects on human health.

TVOC Concentrations (µg/m³) measured for Dhaka City during 2022 -2023.

Total volatile organic compounds (TVOC) concentrations (µg/m³) measured for Dhaka city at different hot spots. The concentrations varied from 10548 µg/m³ to

15881 µg/m³ in the hot spots. Among the hot spots the maximum concentrations were measured for Farmgate 15881 µg/m³ followed by Science laboratory 14945 µg/m³, Topkhana 14548 µg/m³, Mouchak 14712 µg/m³, Curzon hall 11257 µg/m³, Eden Mohila College 10548 µg/m³, Breathing low levels of VOCs for long periods of time may increase some people's risk of health problems.

A strong negative correlation (r = - 0.72) between O_3 and TVOC, negative correlation (r = - 0.70) between NO and TVOC and negative correlation (r = - 0.50) between TVOC and SO_2 obtained in the present investigation. The variation can be explained by the presence of sunshine, solar radiation and the photochemical reactions by which TVOC is converted to O_3 during day time period. The TVOC concentrations also varied with relative humidity. A significant positive correlation (r = 0.698) was obtained for TVOC and relative humidity. The diurnal variation occur in response to changes in sunlight. Peak TVOC concentrations are measured in the afternoon.

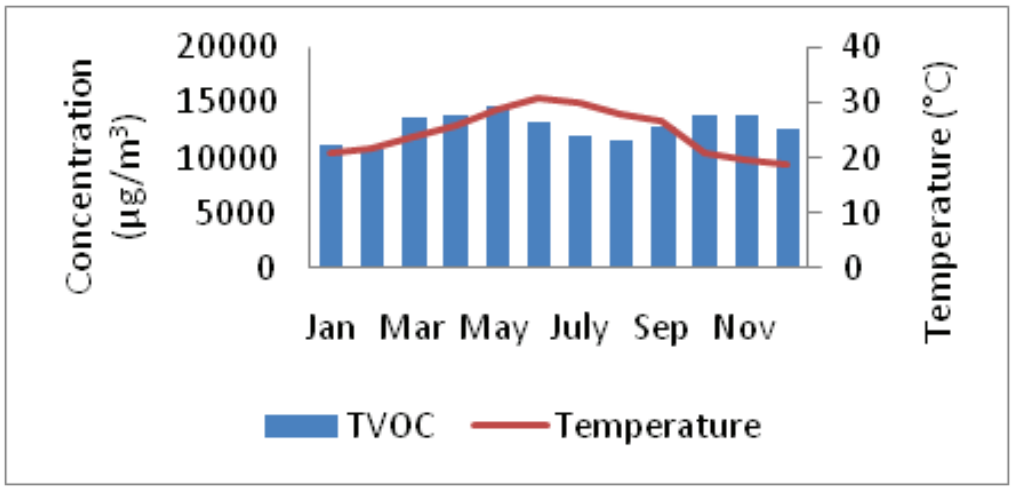

Fig. 3.5: TVOC variation along with temperature O^C in Dhaka city (2022-2023).

The concentrations of TVOC decreased as the temperature increased between April and September (Fig.3.5). When the temperature starts decreasing the value of TVOC is increasing in October to March. Industrial emissions, vehicular emissions, anthropogenic activities, brick-kilns, city wastes burning etc. produce huge amount of TVOC.

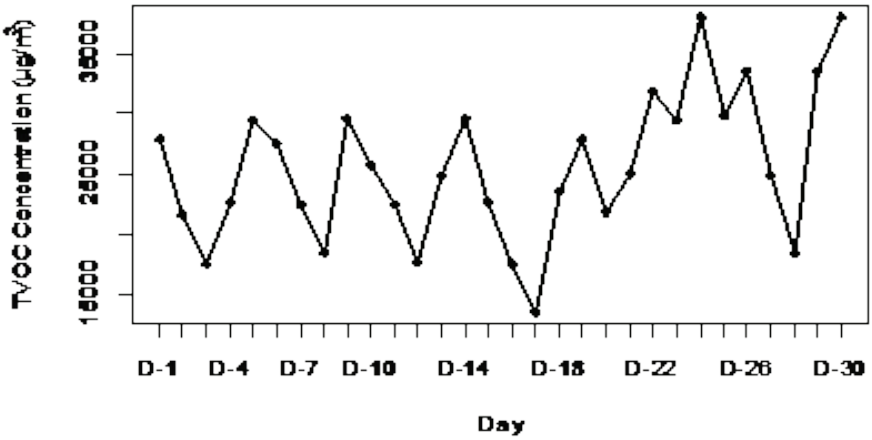

Fig. 3.6: Monthly variations in TVOC Concentrations (µg/m^3) in Dhaka city (June, 2023).

Total Volatile Organic Compounds (TVOC) concentrations (µg/m^3) measured for 30 days on June, 2023 in Dhaka city presented in Fig 3.6 shows that the concentrations varied significantly from 1st June to 30th June. The Concentrations measured on 1st, 2th, 3th, 4th, 5th, 6th June were 27845 µg/m^3, 21548 µg/m^3, 17458 µg/m^3, 22548 µg/m^3, 29458 µg/m^3, 27451 µg/m^3. The highest value was 37945 µg/m^3 in 24th June and 30th June and the lowest value was 17458µg/m^3 in 3th June.The reason behind the variation can be explained by the vehicular emissions of TVOC during the holyday, rainy day, cloudy day in this time period. The average value is significantly different as the 95% confidence between 3th June and 30th June. The lowest value was found in 2th and 3th, 12th June because these days were rainy day. The 2rd, 9th, 16th, 23th June were holidays. For these reason the concentrations of TVOC were low than the other days.

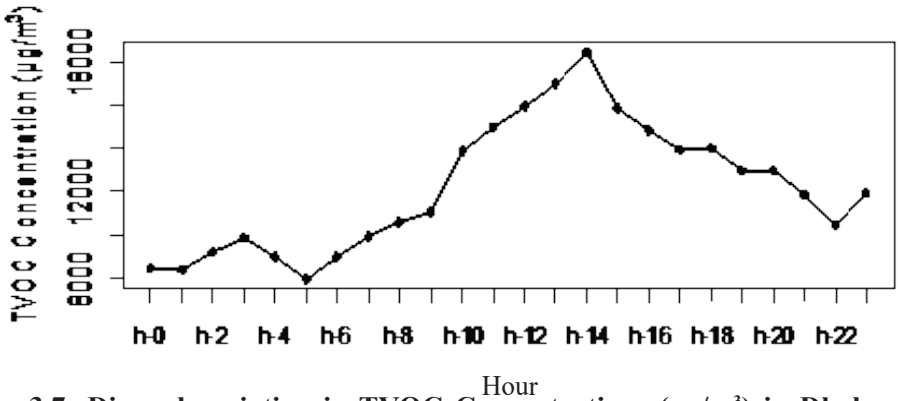

Fig. 3.7: Diurnal variation in TVOC Concentrations (µg/m^3) in Dhaka city (3 June, 2023).

Total Volatile Organic Compounds (TVOC) concentrations (µg/m3) measured for 24 hours on 3 June, 2023 in Dhaka city presented in Fig.3.7 shows that the concentrations varied significantly from 0 hour to 24 hours. The concentrations measured a peak between 11 hour to 18 hour were 14978 µg/m^3, 15945 µg/m^3, 16956 µg/m^3, 18454 µg/m^3, 15845 µg/m^3, 14834 µg/m^3, 13956 µg/m^3, 13978 µg/m^3.The highest value was 18454 µg/m^3 in 14 hour and the lowest value was 8385 µg/m^3 in 1 hour. The reason behind the variation can be explained by the presence of sunshine, sunlight and the photochemical reaction convert to another gases during this day time period. The reason behind the variation can be explained by the vehicular emissions of TVOC during this time period. It is evident from the daily traffic movement on the street that the number of vehicles significantly increase during the day time especially between11am–2pm. The TVOC concentrations also varied with relative humidity. Fig.3.7 that the concentrations varied significantly from hour to hour. The average value is significantly different as the 95% confidence level in 24 hours.

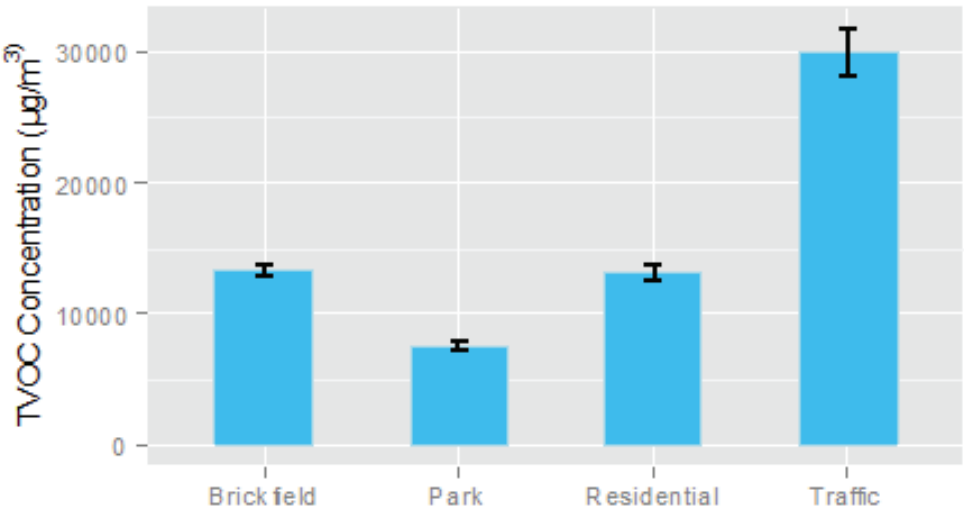

Fig. 3.8: Comparison of TVOC Concentrations (µg/m^3) measured for different locations in and around Dhaka city from 2022-2023.

Total Volatile Organic Compounds TVOC concentrations determined at residential area, traffic area, park, brick-field etc. to observe the locations variation. Presented in Fig 3.8 shows that the concentrations varied significantly from place to place. The

highest concentrations measured in traffic area 29978 μg/m^3 followed by brick-field 13634 μg/m^3, residential area 12257 μg/m^3 in and park area 8974 μg/m^3. Although the difference between traffic and residential area, the average value is significantly different as the 95% confidence. The average value is significantly different as the 95% confidence between brickfield and park. The average value is significantly different as the 95% confidence between traffic and park. Due to Industrial emissions, vehicular emissions, anthropogenic activities, brick-kilns, city wastes burning etc. are produce a huge amount of TVOC. Huge amount of running vehicles, long time traffic jam produced TVOC resulting in an air pollution. To use low quality coal, wood in brick-kilns to produce a huge amount of TVOC (EPA, 2009).

Environmental Impacts of Toxic Gases

Air pollution is harming not only human health but also the environment in which we live. Acid rain is wet (rain, fog, snow) or dry (particulates and gas) precipitation containing toxic amounts of nitric and sulfuric acids. They are able to acidify the water and soil environments, damage trees and plantations, and even damage buildings and outdoor sculptures, constructions, and statues. Ozone, as discussed previously, occurs both at ground level and in the upper level (stratosphere) of the Earth's atmosphere. Stratospheric ozone is protecting us from the Sun's harmful ultraviolet (UV) rays. In contrast, ground-level ozone is harmful to human health and is a pollutant (Hoffman, K., 2013). Unfortunately, stratospheric ozone is gradually damaged by ozone-depleting substances (i.e., chemicals, pesticides, and aerosols). If this protecting stratospheric ozone layer is thinned, then UV radiation can reach our Earth, with harmful effects for human life (skin cancer) and crops .In plants, ozone penetrates through the stomata, inducing them to close, which blocks CO transfer and induces a reduction in photosynthesis. Global climate change is an important issue that concerns mankind. As is known, the “greenhouse effect” keeps the Earth's temperature stable. Unhappily, anthropogenic activities have destroyed this protecting temperature effect by producing large amounts of greenhouse gases, and global warming is mounting, with harmful effects on human health, animals, forests, wildlife, agriculture, and the water environment (Agarwal, S.K., 1991). A report states that global warming is adding to the health risks of poor people. Wildlife is burdened by toxic pollutants coming from the air, soil, or water ecosystem and, in this way, animals can develop health problems when exposed to high levels of pollutants. Reproductive failure and

birth effects have been reported. An impairment in photosynthetic rhythm and metabolism is observed in plants exposed to the effects of ozone. Sulfur and nitrogen oxides are involved in the formation of acid rain and are harmful to plants and marine organisms. Last but not least, as mentioned above, the toxicity associated with lead and other metals is the main threat to our ecosystems (air, water, and soil) and living creatures(-Baumbach, G., 1993).

Impacts of Air Pollution on Health

People exposed to high concentrations of air pollutants experience disease symptoms and states of greater and lesser seriousness. These effects are grouped into short- and long-term effects affecting health. Short-term effects are temporary and range from simple discomfort, such as irritation of the eyes, nose, skin, throat, wheezing, coughing and chest tightness, and breathing difficulties, to more serious states, such as asthma, pneumonia, bronchitis, and lung and heart problems(Aktar, M.M., 2005). Long-term effects are more frequent in people with a predisposing disease state. Chronic obstructive pulmonary disease (COPD) may be induced following air pollution, increasing morbidity and mortality. Long-term effects from traffic, industrial air pollution, and combustion of fuels are the major factors for COPD risk. Psychological complications, autism, retinopathy, fetal growth, and low birth weight seem to be related to long-term air pollution (Guttikunda, S., 2009).

Table 3.1: Students are exposed by toxic gases in Dhaka city.

Age-group	Number of persons	Health Problem
5-10	22	Breathing Problem, Eye-irritation.
10-15	46	Breathing Problem, Eye-irritation.
15-20	125	Breathing Problem, Eye-irritation, Skin diseases.
20-25	35	Eye-irritation, Cough, Skin diseases.

Table 3.2: Traffic Polices, Drivers are exposed by toxic gases in Dhaka city.

Age-group	Number of persons	Health Problem
30-35	34	Breathing Problem, Eye-irritation.
35-40	47	Breathing Problem, Eye-irritation.
40-45	65	Breathing Problem, Eye-irritation, Skin diseases.
45-50	12	Lung- cancer, Bronchitis, Skin diseases.

Whether these is any through effects of atmospheric toxic gases on public health were investigated in the affected areas particularly in the cities through questionnaire from the city dwellers (278 persons).Data were also collected from traffic polices, drivers, students Peoples are supposed to suffer from eye-irritations, skin problem, respiration problems, bronchitis, asthma , inhalation, lung- cancer and other pulmonary diseases due to the emission of vehicular and industrial toxic gases such as - CO, TVOC. Students in the age group of 15-20, 20-25 years were suffering from – Breathing Problem, Eye-irritation, Cough , skin diseases etc. Most of the Traffic police, Drivers in the age group of 30-35, 35-40, 45-50 years were suffering from – Lung- Cancer, Bronchitis, Breathing Problem, Eye-irritation, Cough , skin diseases etc. because they were exposed by toxic gases in the long time day by day.

Recommendations

Some recommendations are put forward -

- Emission control measures to be taken.
- Improve traffic management system in Dhaka city.
- Use of alternative fuel source like bio-fuel and low emission automobiles to be introduced.
- Use of catalytic converter in all kind of motor vehicles to be enforced.
- Brick making and brick- kilns establishment (control) Act to be enacted.
- Introduction of 3R concept (Reduce, Reuse, Recycle) to be enforced in case of solid waste management in Dhaka city.
- The toxic waste from industries can be controlled through installation of scrubbers. Effluent treatment plant (ETP) should be installed.
- Regulation for controlling construction dust should be enforced.
- Steps to be taken for creating public awareness regarding health effects of air pollution through seminars and talk shows.
- Government should strengthen vehicle emission standards, regulations, mon itoring and enforcement.

Conclusion

The present research was able to generate significant level of information regarding concentrations of some of the toxic gases in the ambient air of Dhaka city and the probable sources. The number of automobiles have been increasing in Dhaka city at the rate of at least 10 percent annually, which has been contributing to air pollution on one hand and traffic congestion on the other. Although existing air quality , monitoring data is limited, it has been clearly shown that the average ambient concentrations of suspended particulate matter (SPM) in Dhaka city is higher than the Bangladesh National Ambient Air Quality Standard(200µg/m^3) and much higher than the WHO guidelines (120µg/m^3). It was however, not possible to link any of the particular toxic gases measured affecting human health. Significantly high levels of some of the toxic gases measured compared to different areas are indicative of deteriorating air quality in Dhaka city and deserves continuous monitoring and policy framing for curbing production and emission of the gases.

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