Report on
AIR QUALITY

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Abstract:

Air quality is connected to the environment. It refers the quality of air: good or poor air quality. So, it contains major effect on human and animals even plants. Some devasting accident was happening in past because of poor air quality. This report is the overview of air quality, how air is contaminated and what is the poisons, how air quality information is gathered and break down gathered information. A genuine pollutant city-based dataset is appeared and is portraying each progression of investigating. All examinations are portraying and endeavouring to discover which poison is more hazardous and computing Air quality Index.

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1.Introduction:

Pollution is a major issue for the natural environment. In 2015 reported, 9 million people killed by pollution [1]. There are many pollutions which affect the environment. Major forms are Air pollution, water pollution, noise pollution, soil pollution, plastic pollution, radioactive pollution etc. Among them, air pollution is one of the burning topics now. Air is polluted by both ways, man-made and natural way. When industry revolution began, the climate was changing. Because at that time, industries threw chemical and pollutants into the air. Beside people faced climate changes and it affected on their daily work. Sometimes a foggy situation occurred, no cars, no flights were smoothly driven. As a result, people understand the situation and tried to applied rules and regulation on industries. Recent time, air quality condition is also not good.

Air quality refers to the condition of the air which is surrounding by us. Quality has two sides good and bad quality. Good air quality is clean, clear and pollutants free such as dust, smoke and among gaseous pollutants. Good quality air is healthy for breathing, and also human life and crops growing. Bad or poor-quality air can affect human health and the environment. Poor air quality includes of pollutants like Sulfur Dioxide (SO2), particulate matter, Hydrocarbons (HC) and volatile organic compounds (VOC), Lead, Carbon Dioxide (CO2) and Carbon Monoxide (CO), Nitrogen Oxides (NOx), and Smog [4].

Why Air Quality?

For human living air is essential and basic components. Every year appx. 24,000 people die because of air pollution in the UK. NHS has been estimated at £20 billion costs of poor health as a result of air pollution [2]. According to the International Energy Agency, the nation with the most death from air pollution is Turkmenistan. In Turkmenistan, 108 people deaths per 100k people because of air pollution. Most polluted nation according to PM 2.5 (Particulate matter) is Saudi Arabia with 108 AQI. (Source: WHO). The average person inhales around 14000 litres of air every day. In general, breathing

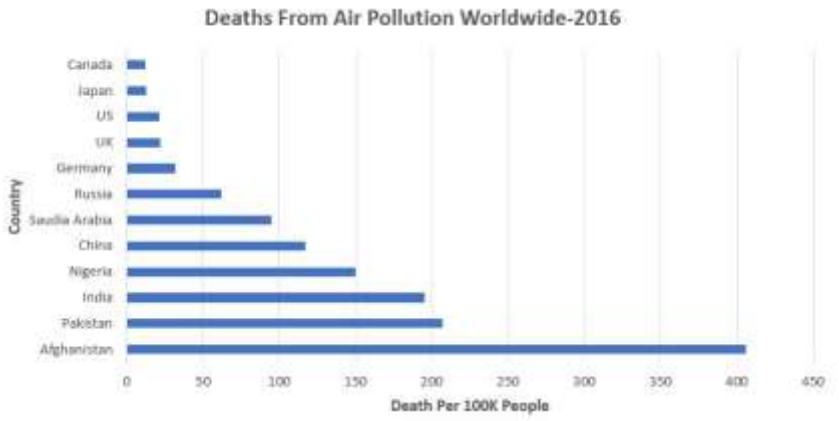


Figure 1.1: Deaths from Air Pollution Worldwide

poor quality air is bad for health and it causes at least some form of discomfort. Some of the more common problems associated with poor air quality. Such as Aggravated asthma and respiratory problems, Headaches and anxiety, Cancer, heart problems, premature birth, chronic bronchitis, pneumonia, and emphysema etc [3]. According to figure 1.1, it shows Afghanistan is the most death nation from air pollution with 405 per 100k people. On the other hand, Canada and japan have 4 people. Bangladesh is the 4th most pullulated nation is the world where I born. People here face serious health problems and lots of industries emission bad air with chemical. I want to research data of Bangladeshi air where is the similarity and dissimilarity pollutants. All these serious issues inspired me to know deeply about air pollution, air quality data and how these data affect human and environment. On the other hand, the estimated annual deaths per energy source 32.72% for brown coal, 24.62% of coal, 18.43% of oil. (Figure 1.2)

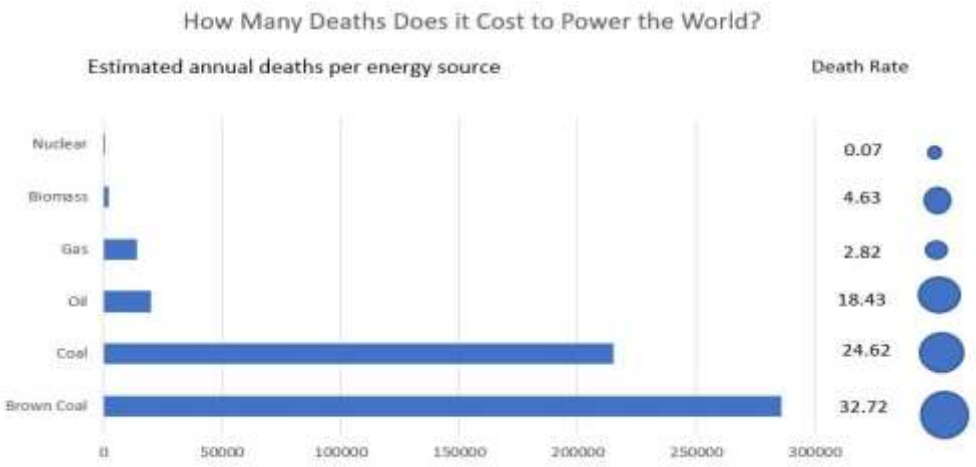


Figure 1.2: The estimated annual deaths per energy source 2014

2.Methods and Materials:

2.1Air Pollutant and define:

Air pollution is making health and environmental problem and it can produce other things- acid rain, global warming, and the ozone layer is deteriorated. Human life, plant life, animal life and property could be affected as an air pollutant. Air pollutants are classified into two categories:

2.1.1 Primary pollutants:

Primary pollutants are discharged from a source directly into the environment. Such as from figure 2.1 Sulfur dioxide and Hydrocarbons

Figure 2.1: Presents of primary and secondary pollutants in environment (Source: https://iasmania.com/environment-pollution-air-pollutants)

2.1.2 Secondary pollutants:

Secondary pollutants are the collection of two or more pollutants with chemical reaction. Such as from figure 2.1 Particulate matter, Ozone.

2.1.3 How to define and process:

Chemicals present in the environment. Use composition of the clean air as a benchmark. When the concentration of a chemical in the air is above the benchmark, it is termed as an air pollutant [2].

2.2Major Air Pollutants:

Bellow names some common pollutants, their sources, and their effect on the environment.

Criteria Gases

i. Carbon monoxide (CO)
ii. Ground-level Ozone (O3)
iii. Nitrogen Dioxide (NO2)
iv. Sulfur Dioxide (SO2)

Particulates

i. PM2.5 FRM/FEM Mass
ii. PM2.5 non FRM/FEM Mass
iii. PM10 Mass PM2.5 Speciation

Meteorological

i. Barometric Pressure
ii. Relative Humidity and Dewpoint
iii. Temperature
iv. Winds (Resultant)

Toxics

i. Lead (Pb)
ii. Hazardous Air Pollutants (HAPs)
iii. Nitrous Oxides (NONOxNOy)
iv. Volatile Organic Compounds (VOCs)

2.2.1 Carbon monoxide (CO):

The carbon monoxide analyzer measures the concentration of carbon monoxide present in the ambient air by Non-Dispersive Infrared Radiation [NDIR] method. It is also called Gas Filter Wheel Correlation method. The analyzer works as follows [9]:

i. Sample air passes through a particulate filter. This particulate filter removes particulates and other contaminants from the sample air.
ii. Then the sample air goes to the measurement cell through a pre-heater which warms the air.
iii. On the other hand, there is an Infrared source that generates infrared radiation [6].
iv. After this IR source a gas filter correlation wheel is present which is rotated by a motor. This gas filter correlation wheel includes two gas filled chambers: A. A reference chamber which is filled with CO [500,000 ppm]. B. A measure chamber which is filled with nitrogen.

2.2.2 Ground-level Ozone (O_3):

The O3 analyzer measures the concentration of ozone present in the ambient air by Ultra Violet Absorption method. It is also called UV Photometry. The analyzer works as follows [9]:

i. The sample air goes through the particulate filter to remove particulates and other contaminants from the sample air.
ii. Then the sample enters into the measurement cell.
iii. A mercury vapor lamp is used to emit UV light at 254 nm wave length. In the measurement cell this UV light is absorbed by the sample.

2.2.3 Nitrogen Dioxide (NO2):

The NOx analyzer measures the concentration of oxides of nitrogen present in the ambient air by Chemiluminescence method. The analyzer works as follows [9]:

i. The sample air pass through a micron filter which removes the unwanted particulates from the sample air.
ii. Then the sample goes to the chemiluminescence reaction cell through one way. In the cell NO molecules present in the sample react with ozone to form excited NO_2*.
$NO + O_3 = NO_2* + O_2$ [Chemiluminescence Reaction]The ozone comes to the cell from ozone generator which produces10,000 ppm ozone.
iii. This excited NO_2* molecule returns to the ground state and emits radiation. This radiation is detected by Photo Multiplier Tube [PMT] that produces a small electric current. This current is directly proportional to the concentration of NO.

2.2.4 Sulfur Dioxide (SO_2):

The sulfur dioxide analyzer measures the concentration of sulfur dioxide present in the ambient air by Ultraviolet Fluorescence method. The analyzer works as follows [9]:

i. Sample air passes through a particulate filter. This particulate filter removes particulates and other contaminants from the sample air.
ii. Then the sample air goes through the hydrocarbon kicker, which removes hydrocarbon from the sample [4].
iii. After that the sample enters into the fluorescence cell.
iv. A zinc lamp is used as a UV source. This UV lamp supplies UV light of 214 nm wavelength which passes through an optical filter and enter in to the fluorescence cell.

2.2.5 Particulate Matter (PM10 and PM2.5):

At the point when beta beams go through a material, they can be assimilated, reflected or go specifically through. The constriction of force in beta beams is corresponding to the measure of material present [5]. The weakening through most materials is moderately predictable and depends on the electron thickness of the material (computed by separating the nuclear number by the nuclear mass).

The weakening for most materials is around 0.5, with the exception of hydrogen and overwhelming metals. Beta weakening has been utilized as a part of generation lines as a quality control check of item thickness for over 40 years. For instance, in the generation of cellophane plastic wrap, a beta check is utilized to guarantee that the thickness of the cellophane stays inside particular [6].

The standard behind beta constriction particulate examining instruments (beta measure) is that vitality is assimilated from beta particles as they go through PM gathered on a channel media.

Beta check instruments have been intended to exploit this logical guideline to screen/measure PM fixations. The constriction because of just the PM is quantifiable if a benchmark beta tally through simply the channel can be built up before inspecting. The distinction between the pattern beta tally and the beta tally in the wake of examining is straightforwardly corresponding to the mass of PM in the example.

2.3Air Quality Monitoring Type:

In general air quality monitoring can be grouped into following types [2]:

i. **Emissions Monitoring:** This type of monitoring focuses on emissions coming out of naturally and man-made sources.
ii. **Ambient Monitoring:** The emphasis is on ambient air concentration of toxic as well as non-toxic contaminants.
iii. **Deposition Monitoring:** This type of network measures the dry and wet deposition of atmospheric contaminants.
iv. **Visibility Monitoring:** Ability to see things is primary focus of this type of monitoring.
v. **Upper Air Monitoring:** A look at ambient concentrations in upper atmosphere with the help of satellites, airplanes etc.
vi. **Health Monitoring:** Recognizes the importance of risk assessment and risk management in public health studies.

2.4Air Quality Index

AQI helps in understanding the level at which air is polluted and the associated health effects that might concern [2]. AQI for five major air pollutants:

i. ground-level ozone,
ii. particulate matter,
iii. carbon monoxide,
iv. sulfur dioxide, and
v. nitrogen dioxide.

2.4.1 Purpose of AQI:

Daily release of air quality conditions to the public Convey the health implications of air quality Protect public interest and take actions to reduce emissions Forecast air pollution level Table-1.

Table 1: AQI Index of Environmental Protection Agency – USA [10]

Catagory	**Index level**	**Risk**
Good	0-50	The AQI value for a community is between 0 and 50 then the air quality is considered satisfactory, and air pollution poses little or no risk.
Moderate	51-100	The AQI is between 51 and 100 then the Air quality is acceptable
Unhealthy for Sensitive Groups	101-150	When AQI values are between 101 and 150, members of sensitive groups may experience health effects. This means they are likely to be affected at lower levels than the general public.
Unhealthy	151-200	Everyone may begin to experience health effects when AQI values are between 151 and 200. Members of sensitive groups may experience more serious health effects.
Very Unhealthy	201-300	AQI values between 201 and 300 trigger a health alert, meaning everyone may experience more serious health effects.
Hazardous	301-500	AQI values over 300 trigger health warnings of emergency conditions. The entire population is more likely to be affected.

2.4.2 AQI Calculation:

AQI Calculating Formula:

$$I = \frac{I_{high}-I_{low}}{C_{high}-C_{low}}(C - C_{low}) + I_{low}$$

Where,

I= the (Air Quality) index,
C= the pollutant concentration,
I_{high} = the index breakpoint corresponding to $C_{high,}$
I_{low} = the index breakpoint corresponding to $C_{low,}$
C_{high}= the concentration breakpoint that is ≥ C,

C_{low}= the concentration breakpoint that is ≤ C,
Suppose a monitor records a 24-hour average fine particle (PM2.5) concentration of 12.0 micrograms per cubic meter. The equation above results in an AQI of:

$$I = \frac{50\text{-}0}{12.0\text{-}0}(12.0\text{-}0) + 0 = 50$$

corresponding to air quality in the "Good" range. To convert an air pollutant concentration to an AQI, Environmental Protection Agency – USA has developed a calculator.

3. Data Collection, analysis and results:

3.1 Data processing of Bangladeshi Air quality data:

The air quality data generated at the monitoring stations (figure 2.2) are centrally retrieved into Central Data Station at the DoE Head Office using EnVIEW 2000 software and as SQL database. The CASE/DoE air quality network structure is given in Figure 4. The data is scrutinized for outliers and invalid ones and later the data is checked, compiled, processed and analyzed statistically to get the information on the annual mean, standard deviation, temporal coverage etc. of the pollutants measured. Figure shows the data flow in the DoE air quality monitoring network [9]. In the present report, results of PM2.5, PM10, SO2, NOx, CO and O3 for the year 2017 are presented:

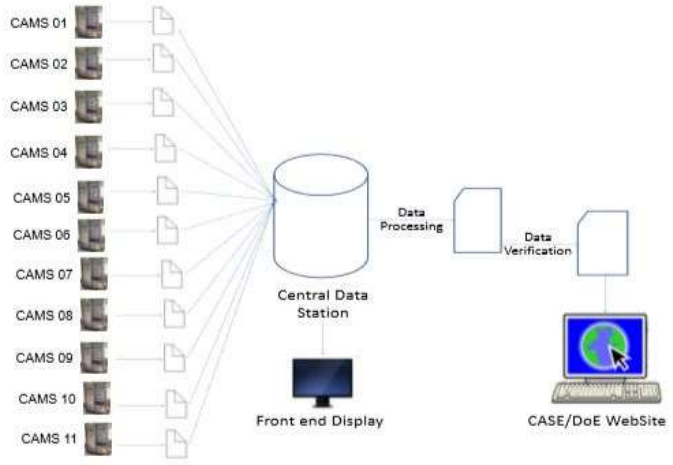


Figure 2.2: Air Quality Monitoring Network (Source: Air Quality Status and Trends of Bangladesh: 2013-2015)

While processing the air quality data if 75% of the data availability in a day could not be fulfilled for any parameter at any station due to force majeure like power failure, analyzer non-operational etc., values monitored are considered as nonrepresentative values and excluded for assessing the ambient air quality for that day.

3.1.2 Quality Assurance/Quality Control of Data and Management

Quality assurance and Quality control (QA/QC) is an essential part of any monitoring system. To obtain reliable data from the air quality monitoring stations proper QA/QC measures has to be in place as these data will be used to support policy decisions. QA/QC is a programme of activities which ensures that overall measurements meet pre-defined standards of quality, with a stated level of confidence. In order to ensure the quality of data the CASE/DoE carry out various exercises as follows:

3.2 Air Quality Monitoring Results

Air quality data is collected from Clean Air and Sustainable Environment Project Bangladesh. The specific location of data is Darus Salam, Dhaka, Bangladesh and collection period are January 2017 to December 2017 (figure 3.1). Here is data overview [11]:

AIR QUALITY DATASET OF BANGLADESH-2017											
Date	Year	SO2	NO2	CO	O3	PM2.5	PM10	Solar Rad	Humidity	Temperature	Rainfall
January	2017	9,87	60,18	1,81	14,5	165	218	131,8	55,39	28,74	0,71
February	2017	7,28	148	1,73	5,9	152	225	143	48	27,7	1,23
March	2017	6,63	119	1,53	6,19	147	188	193	61	30	1,63
April	2017	4,89	74,3	2,07	5,81	122	163	202	66,3	33	1,49
May	2017	4,3	60,9	1,68	16,4	74	123	216	64,5	33,4	2,4
June	2017	3,7	51,4	2,58	12,2	47,1	63,3	166	76,9	33	3,7
July	2017	2,9	57,3	1,13	4,13	35,4	58,1	148	76,1	30,9	3,08
August	2017	1,98	70,78	2,09	6,09	41,3	63,36	152	57,41	27	3,63
September	2017	2,77	56,6	1,41	4,98	46,7	67,7	171	57,2	27	1,36
October	2017	3,68	133	1,31	6,81	58,6	95,8	168	52,7	30	1,78
November	2017	10,9	195	2,46	4,75	97,5	163	154	47	29,4	1,05
December	2017	10,1	176	1,33	1,55	124	175	100	60,8	26,8	0,94

Figure 3.1: Air quality datasets

3.3Data Analysis:

In general, it is observed that the temporal coverage of the air quality data on criteria pollutants is fairly good except few cases. Initial assessment of the data shows that monthly average PM concentration levels in both fractions (PM2.5 and PM10) in all monitoring sites are high and usually exceed the Bangladesh National Ambient Air Quality Standards (BNAAQS). Maximum value of the PM concentration levels reaches as high as 2/3-fold compared to the 24 hours BNAAQS values (150 µg/m3 for PM10 and 65 µg/m3 for PM2.5), especially during winter periods. Thus, PM is recognized as the most important pollutant of concern for Bangladesh.

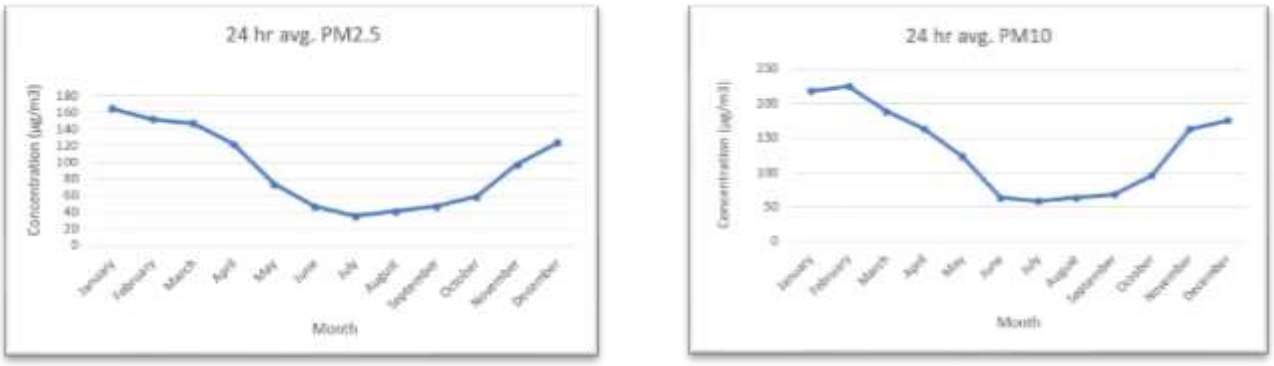
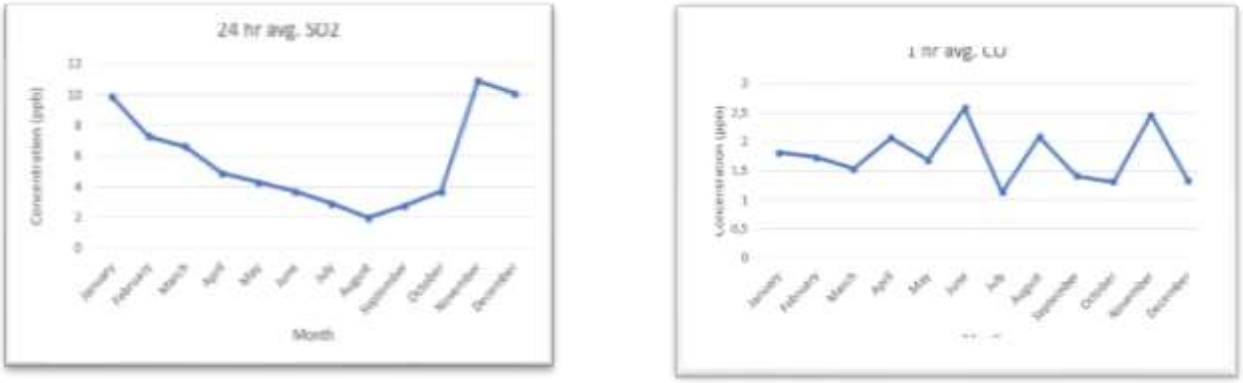


Figure 3.2: Data Visualization of PM2.5 and PM10 in 2017

From Figure 3.2, PM2.5 and PM10 is decreasing from the months of January to June. They have stable for next two months then they increase steadily.

It is observed from the Figure 3.3 that 1-hour average CO, 24-hour average SO2, 1-hour average O3, 1-hour average NO2, Rainfall and humidity concentration levels are within the BNAAQS values. This is to be noted that the CAMS is located in an urban/semi-residential area, away from traffic hotspot, it is expected that the measured CO concentration would be low and exposure due to CO levels to general population is less. CO concentration close to traffic hotspots usually be higher and needs to be monitored systematically near those places for better judgment on the exposure levels of the commuters and pedestrians' due to CO pollution levels in the city.



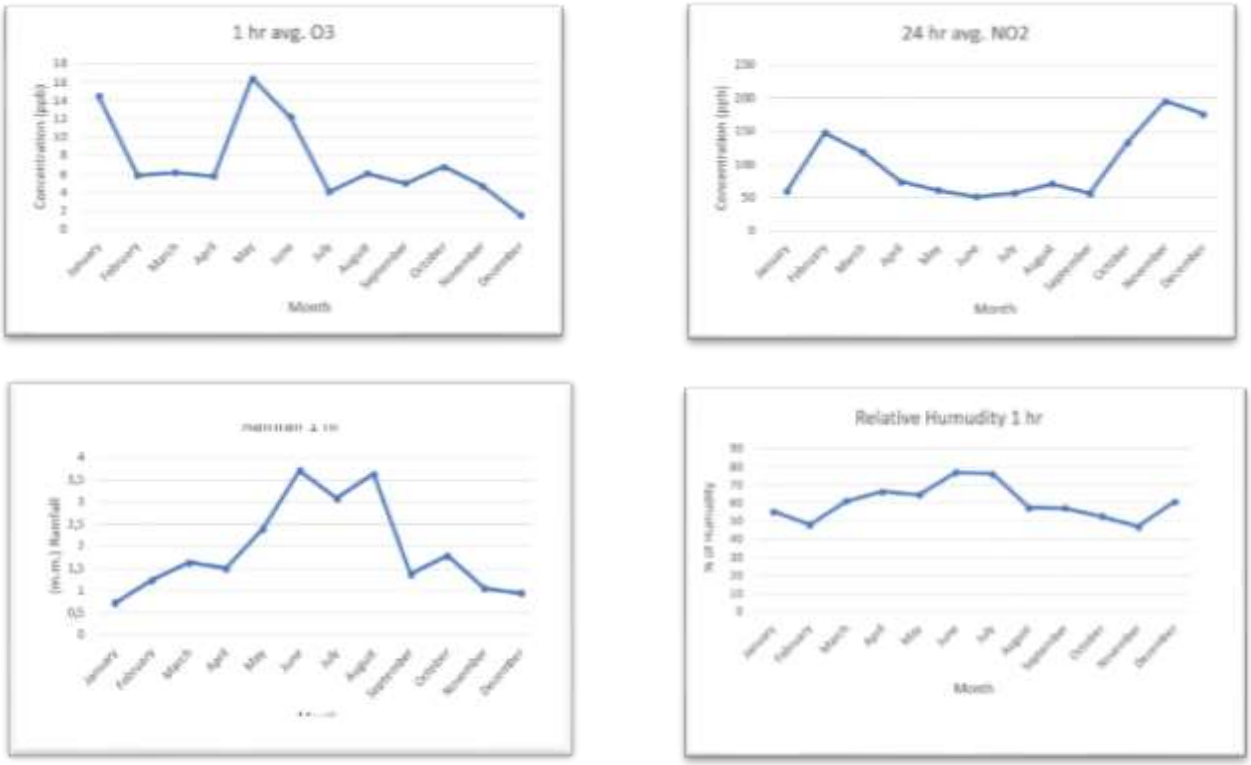


Figure 3.3**:** Data Visualization of each pollutants in 2017

Given the level of traffic in cities, and the lack of controls on the vehicular emissions, there is significant NO emitted. The NO reacts quickly with O3 to produce NO2 and O2 and in the presence of sunlight reaches a photolytic steady state. The high degree of titration of ozone by NO and resulting high concentrations of NO observed at the urban sites strongly indicated that there will be significantly high concentrations of ozone and secondary particulate matter in the areas downwind of the major urban centers

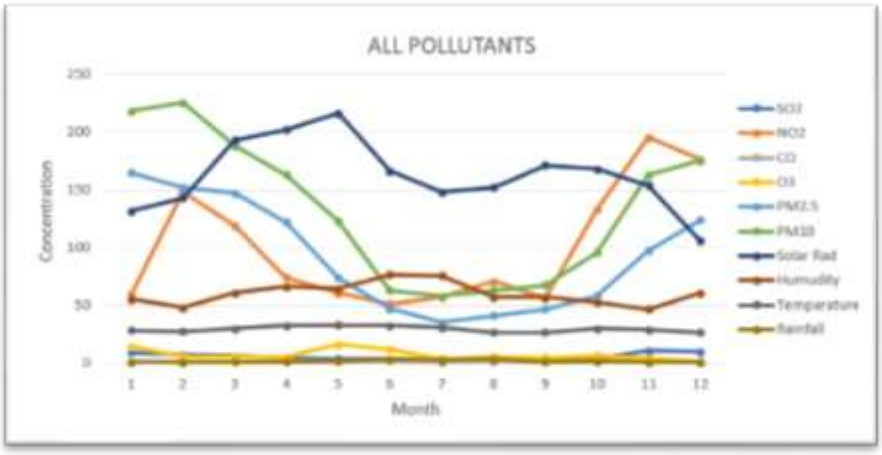


Figure 3.4: Overall all pollutants data visualization 2017

Overall 2017, all pollutants behaviour is seen on figure 3.3. Here all pollutants are decreasing from beginning of the year but an exception is found for NO2 and solar Rad where they are increasing significantly. But middle of the year, June to August, all pollutants are down. Because all pollutants are varied by seasonal changes. On that time, weather is clean due to rainy season. When the rainy season is over, they are grown up and take place as before as they were.

3.4 Air Quality Index (AQI) of Bangladesh:

An AQI value of 100 generally corresponds to the national air quality standard for the pollutant, which is the level that set by the mandated Environment Protection Agency (e.g., for Bangladesh Department of Environment) to protect public health. AQI values below 100 are generally thought of as satisfactory. When AQI values are above 100, air quality is considered to be unhealthy-at first for certain sensitive groups of people, then for everyone as AQI values get higher. The AQI standard for Bangladesh is given in Table 2.

Table 2: Air Quality Index (AQI) for Bangladesh

Air Quality Index (AQI) Range	Category		Color
	English	Bangla	
0-50	Good	Bhalo	Green
51-100	Moderate	-	Yellow Green
101-150	Caution	-	Yellow
151-200	Unhealthy	Ashasthykar	Orange
201-300	Very Unhealthy	Khub Ashasthykar	Red
301-500	Extremely Unhealthy	Ottanto Ashasthykar	Purple

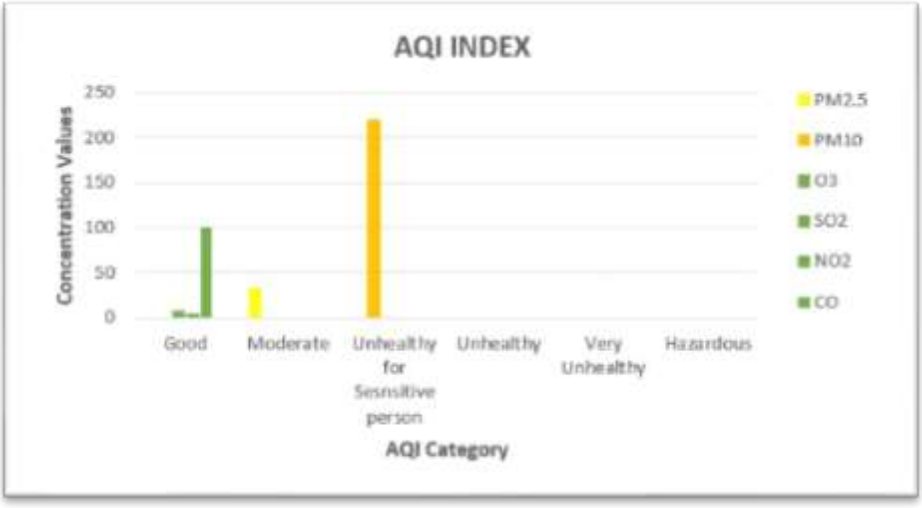


Figure 3.5: AQI Graphically presentation

Calculating AQI of dataset and follow AQI of Bangladesh, Particulate PM10 is high and unhealthy for sensible person. On the other hand, Particulate PM2.5 is moderate. On the other hand, O_3, SO_2, NO_2 and CO is Good. Graphically presentation is shown in figure 3.5

3.5 Opinion:

The data capture rate and the data quality were satisfactory during the reporting stations and parameters due to unavoidable reasons, and efforts were made to analyze the available data. In general, gaseous pollutants appear not exceeding the BNAAQS where as particulate pollutants in both fractions (PM2.5 and PM10) are usually show non-attainment especially during winter season when participation rate as well as wind speed are very low. While in the rainy season (from May to October) both PM10 and PM2.5 concentration remain below the standard values because of scavenging of particulate matter by rainfall. Thus, particulate matter looks like most important pollution that needs attention to reduce it for improving the air quality. The sources of observed high PM2.5 concentrations expected to be of anthropogenic origin and needs specific interventions to reduce it. From the analysis of PM2.5/PM10 mass ratios it was observed that more than 50% of PM10 particles are coarse particles and are originates mostly from resuspended soil dust.

5.Conclusion:

Air is importance element of environment. It should be clean, clear and pollutants free. A quality should be maintained for preventing pollutions. Rules and regulation can control man made pollution. Technical assistance for green production technologies in industries including brick making industries. Investment planning in order to move towards cleaner production technologies. Strengthening policy and legal instruments, etc. to facilitate introduction of cleaner production technologies. Rehabilitating and strengthening existing air quality R&D capabilities including laboratories. Apart from, people should care and awareness of air quality.

6.Reference

All references are shown below:

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