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To cite this article: Shaurya Singh *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **796** 012055

View the article online for updates and enhancements.

Evaluation on Risk Assessment on Indoor Air Pollution: A Case Study of Delhi-NCR Region

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Abstract:

The study is focused at delineating the major causes of air pollutants in Delhi NCR region in different aspects specifically in terms of computation of Air Quality index. The major air eight pollutants are considered for calculation of Air Quality index i.e. CO, NO_2, SO_2, $PM_{2.5}$, PM_{10}, O_3, NH_3, and Pb. The prediction of air pollution is performed in two phases. The first phase computes the Air Quality Index values for all the pollutants in a day. The second phase computes threshold value of Air Quality Index as an average of previous values. The air pollution for the days in chosen month is predicted by comparing the threshold value with the average of the previous two-month values. A computer aided program is drafted and compiled on JAVA programming language of Oracle Corporation using BlueJ development environment in order to compute the Air Quality index. The program uses pollutant level values user enters and it analyses the different levels for pollutants and thereafter computes the Air Quality index level of every pollutant and tells the prominent pollutants along with its final computed value. The AQI generated can be used to analyse the level of exposures a person faces in day-to-day life and how remedies can be opted to cure the exposure towards indoor air pollution. The collected pollutants data and computed Air Quality index shows that the people in DELHI-NCR region are exposed to huge air pollution and it is relevant to the indoor air quality also.

The study lessening that the air contaminations at indoor, individuals should utilise the clean energies and an improvement should be done in ovens to consume the fuel productively and vent outflows to the outside. Air cleaners that can improve the air quality productively can be helpful to cop up the scenario.

Keywords: Indoor air pollution; Air Quality Index; JAVA programming language; Risk assessment; Environmental protection; HEPA filter

1. **Introduction:**

Air pollution is the introduction of particulates, biologicalmolecules, or other harmful substances into the Earth'satmosphere. It is a global concern and a majorenvironmental health problem. It is the fifth leading risk factor for mortality worldwide. People are dying morebecause of air pollution than malnutrition, road trafficinjuries, and alcohol use. The quality of life in a place ismeasured using several factors in which air quality plays avital role. Its measurement is based on the concentration ofpollutants in the atmosphere and is called AQI.Air contamination is a genuine worldwide global medical issue that is overseen most viably in numerous zones of the world. Fixations of surrounding air contaminations as of now surpass levels accepted to generously expand dangers of intense and constant unfavourable human wellbeing impacts. According to researcher (Laumbach et al., 2015), individuals spend about 90% of their everyday time inside overall, with about 70% of their everyday time in private homes. Utilization of air purifiers with most of them using HEPA filters nowadasy with other filters also to ensure maximum amount of pollutants to be trapped in filter. Also climate change encompasses several environmental and weather modifications, including extreme natural events and gradual climate variations. Some of the studies suggest that the impact of climate change on mental health might range from mild stress and distress symptoms to clinical disorders, mainly including anxiety, sleep disturbances, depression, and stress/trauma-related disorders (Marazziti et al., 2021). The vulnerability about the viability of medicines, produced a feeling of bewilderment and uncertainty in the entire total population. The significant contaminations in open air are particulate matter (PM), ozone (O_3), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), and Lead (Pb). The toxins in the encompassing air can be isolated into essential and optional sorts. Sometimes the inconvenient impacts of air contamination are affirmed to be related with developing grimness and mortality (Xu-Qin Jiang, et al., 2016). Smoking end is a significant and generally simple measure to take for all cigarette smokers especially patients with constant respiratory sicknesses.

Most of the household fuels are incompletely combusted and are usually burnt in an open fire or simple stove which produces a huge amount of smoke (Kirk R. Smith et al., 2017). All this results in a large amount of incompletely combusted fuel and traps the smoke indoor due to poorly ventilated houses. Humans living in severe poverty are extremely exposed to household air pollution. In their commission they tried to relate the link between household air pollution and respiratory diseases, infection, lung cancer and lastly the chronic lungs diseases. Convenient HEPA channel air cleaners as well as air purifiers can bring down indoor PM2.5 focuses and SHS openings in exceptionally dirtied settings (Kirk R. Smith et al., 2017). They are a prominent way of decreasing exposure to indoor air pollutants. For external travel, N95 masks are advised to be wore all the time to reduce exposure of air pollution. There is a direct relation between air pollution and lungs (Pascal M., 2013). On average, humans breathe 15 m^3 of air per day and, in urban areas, more than 80% of the time is spent indoors. Lung pathologies are very common (the prevalence of asthma is estimated at 5.8%, that of chronic obstructive pulmonary disease between 6% and 8%, lung cancer is the most common in men) and represents the fourth cause of death in France (7% of causes). Also, with the measuring parameter i.e. Air quality index (AQI), defines the way of computing AQI and ways of taking the collected data to analyse the data and generate the resulted work. Full 24 hours are required to obtain an AQI value (that's 24-hourly values for PM or the max 1-hour or 8- hour value in a 24-hour period for other pollutants). The report includes:

• Reporting area

• Reporting periods

• Critical pollutants in study area (the pollutant with the highest AQI value).

 • AQI values

• Category descriptor and colour (if your report uses colour)

• The sensitive groups for all pollutants with an AQI over 100.

Ample of literature is available based upon the indoor air quality pollutants. But still the field is infancy and need some emerging or edge cutting technologies those can be helpful to coup the scenario. Based upon the literature the authors observed the following objectives

- Prominent solution to day-to-day problems in breathing and inhaling contaminated air.

- To analyse the occurrence of air pollutants.

- To find a statistical way to generate the theoretical value of air pollutants.

- To relate generated values with human exposure in travel procedure.

- Remedies to figure out to overcome with existing polluted air quality.

Interventions are needed to lower household PM2.5 exposures. In the AQI system, specific concentration ranges are grouped into air quality descriptor categories. India is a developing country. With urbanization and industrialization, air pollution in India is also increasing. Delhi, India's capital territory, is ranked the world's most polluted capital and is at 11th position overall. To understand and measure ambient air quality in India, the Ministry of Environment, Forest, and Climate Change developed and launched the AQI system on 17-October-2014. In Indian AQI System (IND-AQI), the following eight pollutants are considered for calculation of AQI: CO, NO_2, SO_2, $PM_{2.5}$, PM_{10}, O_3, NH_3, and Pb. To present the status of air quality and its effects on human health, the following six air quality description categories have been adopted: Good, Satisfactory, moderately polluted, Poor, Very Poor, and Severe. In the created world, individuals spend about 90% of their everyday time inside overall, with about 70% of their everyday time in private homes.

2. Materials and Methodology

2.1 Data collection

The proposed research work uses air pollution data set downloaded from Central Pollution Control Board New Delhi Department website. This data set contains data with four - six attributes that were collected. Air pollutants parameters are Air Quality Index (AQI) values of

NO_2, SO_2, CO, $PM_{2.5}$, PM_{10} and O_3. Data set is pre-processed and analysed to predict air pollution.

2.2 Data Set Used

BlueJ by Java, software is used to write code to compute the Air Quality Index (AQI) value utilising the different pollutants value provided by user. As soon as the program receives the input, it calculates the Air Quality Index (AQI) of different pollutants in the air and finally provides the final computed the Air Quality Index (AQI) analysing different pollutant's value. It also gives result in accordance with the AQI computed and tells us if the Air Quality is healthy, moderate, unhealthy, or hazardous.

Steps in Analysis:

1. In pre-processing step, the parameters NO, $PM_{2.5}$, CO, SO_2, O_3 are separated on monthly basis.

2. The following new formula is computed

$$I_p = [(I_{Hi} - I_{Lo})(C_P - BP_{LO})/(BP_{HI} - BP_{LO})] + L_{LO}$$

Where I_P = the index for pollutant P.

C_P = the truncated concentration of pollutant P.

BP_{HI} = the concentration breakpoint $>= C_P$.

BP_{LO} = the concentration breakpoint $<= C_P$.

I_{HI} = the AQI value corresponding to BP_{HI}.

I_{LO} = the AQI value corresponding to BP_{LO}.

To find the value of Air Quality Index for a day, month, or a year

1. Average of AQI value in 24 hours of a day is computed for every single factor each day.

2. Average of AQI values of all the days in highest value is computed.

3. Compute the greatest AQI among all pollutants.

4. An actual AQI value of all the factors is evaluated and final AQI relating the air appearance and status are printed.

5. Stop

2.3 AIR CLEANING

There are three different strategies that can be used to prevent bad indoor air quality: source control, increase ventilation and air cleaning. An air purifier is a product that uses the last strategy. There are a few air cleaning technologies that are used in air purifiers for indoor environment. The most common ones are High-efficiency particulate absorption (HEPA), electrostatic purification, ionizer, and carbon filter.

Table 2.1: Monthly Data from Central Pollution Control Board department

	Column1	Column2	Column3	Column4	Column5	Column6	Column7
	PM2.5	PM10	NO2	NH3	SO2	CO	OZONE
02-Jan	464	391	125	15	22	147	55
03-Jan	-	-	116	14	46	116	33
04-Jan	385	-	95	14	34	98	28
05-Jan	183	-	73	15	22	106	30
06-Jan	177	-	84	13	30	94	31
07-Jan	281	-	66	12	27	104	46
08-Jan	293	179	72	12	19	99	29
09-Jan	330	195	65	10	20	95	23
10-Jan	363	275	87	9	29	105	60
11-Jan	316	187	71	11	18	85	20
12-Jan	293	164	83	12	15	95	24
13-Jan	317	201	96	13	17	105	17
14-Jan	-	-	-	-	-	106	30
15-Jan	452	379	116	13	39	122	55
16-Jan		-	-	-	-	111	61
17-Jan	437	342	113	15	33	114	13
18-Jan	389	247	78	15	22	107	22
19-Jan	394	293	60	12	22	105	21
20-Jan	433	358	102	12	35	112	19
21-Jan	340	196	83	13	18	105	17
22-Jan	343	204	112	11	20	110	21
23-Jan	358	302	101	10	17	104	17
24-Jan	345	180	65	12	14	101	27
25-Jan	393	293	77	11	16	110	14
26-Jan	360	234	76	11	16	104	18
27-Jan	386	288	92	11	19	111	33
28-Jan	350	270	87	10	20	101	21

29-Jan	377	340	122	11	31	125	46
30-Jan	428	372	111	10	20	109	34
31-Jan	330	231	106	8	22	105	21

Many harmful gases are released to the atmosphere by industrialization processes. Automobile emissions, fires on agricultural land, construction sites dust, burning garbage are a significant contributor to air pollution in India.By particulate matter concentration, 22 of the 30 most polluted cities in the world are in India. Table 2.2 below shows the concentration range and the health statements for AQI categories.

Table 2.2: Adopted National Air Quality Index Report by Central Pollution Control Board 2009

AQI	Associated health impacts
Good (0-50)	Minimal impact
Satisfactory (51-100)	May cause minor breathing discomfort to sensitive people.
Moderately Polluted (101-200)	May cause breathing discomfort to the people with lung disease such as asthma and discomfort to people with heart disease, children and older adults.
Poor (201-300)	May cause breathing discomfort to the people with lung disease such as asthma and discomfort to people with heart disease, children and older adults.
Very Poor (301-400)	May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lungs and heart diseases.
Severe (401-500)	May cause respiratory effects even on healthy people and serious health impacts on people with lung/heart diseases. The health impacts may be experienced even during light physical activity.

2.4 Air Purifier

The solution that peoples use to clean the indoor air in the polluted areas is called air purifiers. It is a device that most people that are affected by poor air quality keep in their homes and offices. The air purifier's function is usually to create airflow in the home by suction from a fan inside the device. The air then passes through some sort of filter media which traps the polluted particles, and out comes clean air. However, most air purifiers on the market today are using a

so called HEPA filter, which need replacement every few months and consume a lot of energy. This solution is rather costly and is not suitable for everyone, since one of the most important factors to customers when buying an air purifier is the price. An air purifier is also a part of the furnishings in a home, which also makes the aesthetic design of the air purifier important. When talking about air purifiers and when their performance is measured and compared, the termPM stands for particulate matter and is used for describing the size in microns for small air -borne particles. $PM_{2.5}$ is the particle size which is the most dangerous and is the particle size which bigger cities, like Beijing, are mostly struggling with. Unfortunately, it is also difficult to remove from the air. Different air purifiers are therefore compared by how many percentages of $PM_{2.5}$ they can remove. Some of the models in the market claims that they can remove up to 99.99% of the airborne particles of the size of $PM_{0.3}$ and bigger sizes. An air purifier is usually equipped with a fan that absorbs air and lets the air pass through a filter media where particles get stuck. Usually there is a pre-filter that captures larger particles. Behind the pre-filter, some air cleaning technology, usually a finer filter, captures smaller sized particles.The air that comes through is clean from harmful particles (Dr. A. Law, personal communication, May 2017). There is usually some type of front panel with possibilities to control the air purifier. Typical functions on the front panel are controls to change fan speed level, change to night mode, set timer and indicator when to change/clean filter. After some time of use, particles that are captured makes the filter too dirty and depending on what type of filter the air purifier use, the filter either needs to be cleaned or be changed.The most used fan in air purifiers is the centrifugal fan. It is easy to manufacture energy efficient and generates a uniform airflow. Air purifiers with centrifugal fan usually have the air inlet on the frontside and the outlet facing upwards. This is because the centrifugal fan changes the direction of airflow. It absorbs the air around its centre axis and blows the air out from its sides. According to Dr. A. Law, the most optimal place to put an air purifier is in the middle of a room without anything around it that may block the circulation of airflow. The air purifier should also be used where the user is

spending his/her time the most. During daytime and evenings, a user might spend most of the time in the living room while at night in the bedroom. The most important specifications for an air purifier are:

- How well it can remove $PM_{2.5}$.

- The range - how fast it can change the air in a room.

- Noise level.

- Size and efficient use of space.

- Design

- Price

To understand better why some particles, do damage to our health it is important to understand how they enter our bodies. There are three major regions of air filter in our bodies that may collect and sediment particles during inhalation of air: the nasopharyngeal region, tracheobronchial region and the alveolar region.

3. Results and discussion

3.1 Analysis of Location based Air Pollution (Mostly indoor).
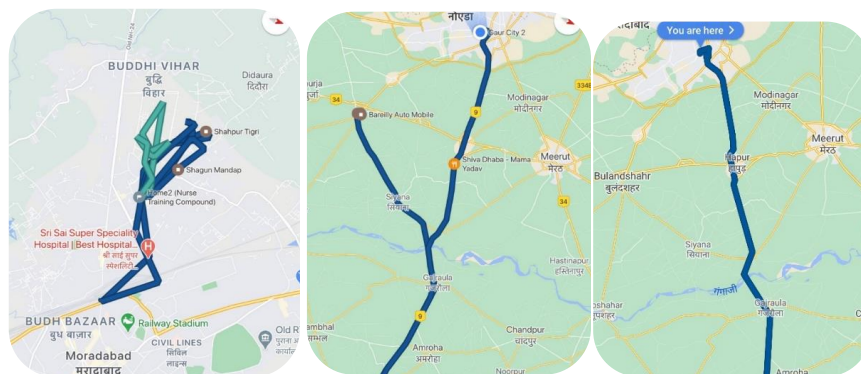
PARTICIPANT 1   **PARTICIPANT 2**   **PARTICIPANT 3**

Based upon the participants travel locations, I gathered the parameter wise data from manual stations under CPCB website. By using the collected data in the JAVA program to find the

relevant AQI values so that the AQI values can be used to judge the level of contamination in air.

3.2 Collection of data

Following table depicts the data collected from Central pollution control board National Air Quality Monitoring Programme (NAMP).

Table 3.1 Central pollution control board National Air Quality Monitoring Programme (NAMP).

Parameter-wise data tables of Manual Stations under NAMP

June 2018	Pitampura				Sirifort			Shahdara		
	SO_2	NO_2	PM_{10}	$PM_{2.5}$	SO_2	NO_2	PM_{10}	SO_2	NO_2	PM_{10}
04.06.2018	22	80	373	154	4	45	158	4	69	161
06.06.2018	14	51	303	149	4	31	255	4	33	185
08.06.2018	4	55	224	136	4	21	609	4	49	277
12.06.2018	4	37	915	200	4	30	781	NA	NA	NA
14.06.2018	4	21	791	337	4	29	725	4	34	572
18.06.2018	4	23	504	206	4	24	143	4	28	231
20.06.2018	7	30	373	219	4	24	409	8	26	167
22.06.2018	4	38	413	102	4	28	187	5	39	227
26.06.2018	4	40	141	139	4	30	406	4	31	164
28.06.2018	12	68	104	NA	4	22	62	8	27	72

June 2018	Janakpuri				Nizamuddin				Shahzada Bagh		
	SO_2	NO_2	PM_{10}	$PM_{2.5}$	SO_2	NO_2	PM_{10}	$PM_{2.5}$	SO_2	NO_2	PM_{10}
01.06.2018	4	43	399	35	4	49	253	NA	4	49	290
05.06.2018	11	38	318	40	4	38	297	NA	4	53	304
07.06.2018	7	40	117	54	4	63	233	NA	5	80	163
11.06.2018	4	48	319	36	4	31	147	NA	4	53	183
13.06.2018	4	25	NA	74	4	18	425	NA	4	40	918
15.06.2018	5	33	606	52	4	13	431	NA	5	31	476
19.06.2018	4	19	235	NA	4	28	451	NA	4	54	189
21.06.2018	5	24	282	67	4	38	708	115	7	64	219
25.06.2018	NA	NA	NA	NA	4	32	495	107	4	53	237
27.06.2018	4	44	115	31	6	36	202	112	4	68	93

Note: NA denotes Data is not available for the day

3.3 Compilation of Source Code of Program

```java
import java.util.Arrays;
import java.util.Scanner;
public class AQI
{

    public void main()
    { double ipo3,o3,ippm25,pm25,ipco,co,ipno,no,ipso,so,ippm10,pm10;
        Scanner in = new Scanner(System.in);
         System.out.println("Enter ozone value");
         o3 = in.nextFloat();
         System.out.println("Enter PM2.5 value");
         pm25= in.nextFloat();
         System.out.println("Enter PM10 value");
         pm10= in.nextFloat();
         System.out.println("Enter CO value");
         co= in.nextFloat();
         System.out.println("Enter SO2 value");
         so= in.nextFloat();
         System.out.println("Enter NO2 value");
         no= in.nextFloat();

         if(o3<55)
        {ipo3=(50/54*o3);
            System.out.println("AQI Related To Ozone is Good and Value is "+ipo3);
        }
        else if(o3>=55&o3<=70)
            {ipo3=((100-51)/(70-55)*(o3-55)+51.0);
                System.out.println("AQI Related To Ozone is Moderate and Value is
"+ipo3);
            }
            else if(o3>=0071&o3<=85)
            {ipo3=((150-101)/(85-071)*(o3-71)+101);
                System.out.println("AQI Related To Ozone is Unhealthy For Sensitive
Groups and Value is "+ipo3);
            }
                else if(o3>=86&o3<=105)
            {ipo3=((200-151)/(105-86)*(o3-86)+151);
                System.out.println("AQI Related To Ozone is Unhealthy and Value is
"+ipo3);
            }
                else if(o3>=106&o3<=200)
            {ipo3=((300-201)/(200-106)*(o3-106)+201);
                System.out.println("AQI Related To Ozone is Very Unhealthy and Value
is "+ipo3);
            }
                 else if(o3>=86&o3<=105)
            {ipo3=((300-201)/(200-106)*(o3-106)+201);
                System.out.println("AQI Related To Ozone is hazardous and Value is
"+ipo3);
            }
```

```
                    e se
                  { ipo3=450;
                       System.out.println("AQI Related To Ozone is hazardous and Value is
"+ipo3);
                   }


             if(pm25>=0&pm25<=12)
         {ippm25=((50-0)/(12-0.000)*(pm25-0));
             System.out.println("AQI Related To PM2.5 is Good and Value is "+ippm25);

         }
        else if(pm25>=12.1&pm25<=35.4)
             {ippm25=((100-51)/(35.4-12.1)*(pm25-12.1)+51);
                 System.out.println("AQI Related To PM@2.5 is Moderate and Value is
"+ippm25);
             }
                 else if(pm25>=35.5&pm25<=55.4)
             {ippm25=((150-101)/(55.4-35.5)*(pm25-35.5)+101);
                 System.out.println("AQI Related To PM2.5 is Unhealthy For Sensitive
Groups and Value is "+ippm25);
             }
                 else if(pm25>=55.5&pm25<=150.4)
             {ippm25=((200-151)/(150.4-55.5)*(pm25-55.5)+151);
                 System.out.println("AQI Related To PM2.5 is Unhealthy and Value is
"+ippm25);
             }
                 else if(pm25>=150.5&pm25<=250.4)
             {ippm25=((300-201)/(250.4-150.5)*(pm25-150.5)+201);
                 System.out.println("AQI Related To PM2.5 is Very Unhealthy and Value
is "+ippm25);
             }
                  else if(pm25>=250.5&pm25<=350.4)
             {ippm25=((300-201)/(350.4-250.5)*(pm25-250.5)+201);
                 System.out.println("AQI Related To PM2.5 is hazardous and Value is
"+ippm25);
             }
                 else
                 {ippm25=450;
                       System.out.println("AQI Related To PM2.5 is hazardous and Value
is "+ipo3);}

             if(co>=0&co<=4.4)
         {ipco=((50-0)/(4.4-0)*(co-0)+0);
             System.out.println("AQI Related To CARBON MONOXIDE is Good and Value is
"+ipco);}
        else if(co>=4.5&co<=9.4)
             {ipco=((100-51)/(9.4-4.5)*(co-4.5)+51);
                 System.out.println("AQI Related To CARBON MONOXIDE is Moderate and
Value is "+ipco);
             }
```

```java
            else if(co>=9.5&co<=12.4)
            {ipco=((150-101)/(12.4-9.5)*(co-9.5)+101);
                System.out.println("AQI Related To CARBON MONOXIDE is Unhealthy For
Sensitive Groups and Value is "+ipco);
            }
                else if(co>=12.5&co<=15.4)
            {ipco=((200-151)/(15.4-12.5)*(co-12.5)+151);
                System.out.println("AQI Related To CARBON MONOXIDE is Unhealthy and
Value is "+ipco);
            }
            else if(co>=15.5&co<=30.4)
            {ipco=((300-201)/(30.4-15.5)*(co-15.5)+201);
                System.out.println("AQI Related To Ozone is Very Unhealthy and Value
is "+ipco);
            }
            else if(co>=30.5&co<=40.4)
            {ipco=((300-201)/(40.4-30.5)*(co-30.5)+201);
                 System.out.println("AQI Related To CARBON MONOXIDE is hazardous and
Value is "+ipco);
            }
                else
              { ipco=450;
                    System.out.println("AQI Related To CARBON MONOXIDE is hazardous
and Value is "+ipco);


             if(so>=0&so<=35)
             {ipso=((50-0)/(35-0)*(so-0)+0);System.out.println("AQI Related To
SULPHUR DIOXIDE is Good and Value is "+ipso);}

            else if(so>=36&&so<=75)
            {ipso=((100-51)/(75-36)*(so-36)+51);System.out.println("AQI Related To
SULPHUR DIOXIDE is Moderate and Value is "+ipso);
            }
                else if(so>=76&so<=185)
            {ipso=((150-101)/(185-76)*(so-76)+101);System.out.println("AQI Related To
SULPHUR DIOXIDE is Unhealthy For Sensitive Groups and Value is "+ipso);
            }
                else if(so>=186&so<=304)
            {ipso=((200-151)/(304-186)*(so-186)+151);System.out.println("AQI Related
To SULPHUR DIOXIDE is Unhealthy and Value is "+ipso);
            }
                else if(so>=305&so<=604)
            {ipso=((300-201)/(604-305)*(so-305)+201);System.out.println("AQI Related
To SULPHUR DIOXIDE is Very Unhealthy and Value is "+ipso);
            }
                else if(so>=605&so<=804)
            {ipso=((300-201)/(804-605)*(so-605)+201);System.out.println("AQI Related
To SULPHUR DIOXIDE is hazardous and Value is "+ipso);
            }
```

```
                    e se
                    {ipso=450;System.out.println("AQI Related To SULPHUR DIOXIDE is
hazardous and Value is "+ipso);
                    }

            if(no>=0&no<=53)
        {ipno=((50-0)/(53-0)*(no-0)+0);System.out.println("AQI Related To NITROGEN
MONOIXDE is Good and Value is "+ipno);}

            else if(no>=54&no<=100)
            {ipno=((100-51)/(100-54)*(no-54)+51);System.out.println("AQI Related To
NITROGEN MONOIXDE is Moderate and Value is "+ipno);
            }
                else if(no>=101&no<=360)
            {ipno=((150-101)/(360-101)*(no-101)+101);System.out.println("AQI Related
To NITROGEN MONOIXDE is Unhealthy For Sensitive Groups and Value is "+ipno);
            }
                else if(no>=361&no<=649)
            {ipno=((200-151)/(649-361)*(no-361)+151);System.out.println("AQI Related
To NITROGEN MONOIXDE is Unhealthy and Value is "+ipno);
            }
                else if(no>=650&no<=1249)
            {ipno=((300-201)/(1249-650)*(no-650)+201);System.out.println("AQI Related
To NITROGEN MONOIXDE is Very Unhealthy and Value is "+ipno);
            }
                 else if(no>=1250&no<=1649)
            {ipno=((300-201)/(1649-1250)*(no-1249)+201);System.out.println("AQI
Related To NITROGEN MONOIXDE is hazardous and Value is "+ipno);
            }
                else
                {ipno=450;System.out.println("AQI Related To NITROGEN MONOIXDE is
hazardous and Value is "+ipno);
                }

            if(pm10>=0&pm10<=54)
        {ippm10=((50-0)/(54-0)*(pm10-0)+0);System.out.println("AQI Related To PM10 is
Good and Value is "+ippm10);}

            else if(pm10>=55&pm10<=154)
            {ippm10=((100-51)/(154-55)*(pm10-55)+51);System.out.println("AQI Related
To PM10 is Moderate and Value is "+ippm10);
            }
                else if(pm10>=155&pm10<=254)
            {ippm10=((150-101)/(254-155)*(pm10-155)+101);System.out.println("AQI
Related To PM10 is Unhealthy For Sensitive Groups and Value is "+ippm10);
            }
                else if(pm10>=255&pm10<=354)
            {ippm10=((200-151)/(354-255)*(pm10-255)+151);System.out.println("AQI
Related To PM10 is Unhealthy and Value is "+ippm10);
            }
                else if(pm10>=355&pm10<=424)
```

```
            {ippm10=((300-201)/(424-355)*(pm10-355)+201);System.out.println("AQI
Related To PM10 is Very Unhealthy and Value is "+ippm10);
            }
                else
                {ippm10=450;System.out.println("AQI Related To PM10 is hazardous and
Value is "+ippm10);}


                double AQI=0;
                if(o3<pm25)
                {AQI=pm25;}
                else if(pm25<o3)
                {AQI=o3;}
                  else if(o3<pm10)
                  {AQI=pm10;}
                else if(pm10<o3)
                {AQI=o3;}
                  else if(o3<so)
                {AQI=so;}
                  else if(so<o3)
                {AQI=o3;}
                  else if(o3<no)
                {AQI=no;}
                  else if(no<o3)
                {AQI=o3;}
                  else if(o3<co)
                {AQI=co;}
                  else if(co<o3)
                {AQI=o3;}
                  if(AQI>=0&AQI<=50)
                  System.out.println("Final AQI of Overall Pollutants is Good which
equals to ="+AQI);
                        else if(AQI>=51&AQI<=100)
                        System.out.println("Final AQI of Overall Pollutants is Moderate
which equals to ="+AQI);
                        else if(AQI>=101&AQI<=150)
                        System.out.println("Final AQI of Overall Pollutants is Unhealthy
For Sensitive Groups which equals to ="+AQI);
                        else if(AQI>=151&AQI<=200)
                        System.out.println("Final AQI of Overall Pollutants is Unhealthy
which equals to ="+AQI);
                        else if(AQI>=201&AQI<=300)
                        System.out.println("Final AQI of Overall Pollutants is very
Unhealthy which equals to ="+AQI);
                        else
                        System.out.println("Final AQI of Overall Pollutants is Hazardous
which equals to ="+AQI);
                }
            }}
```
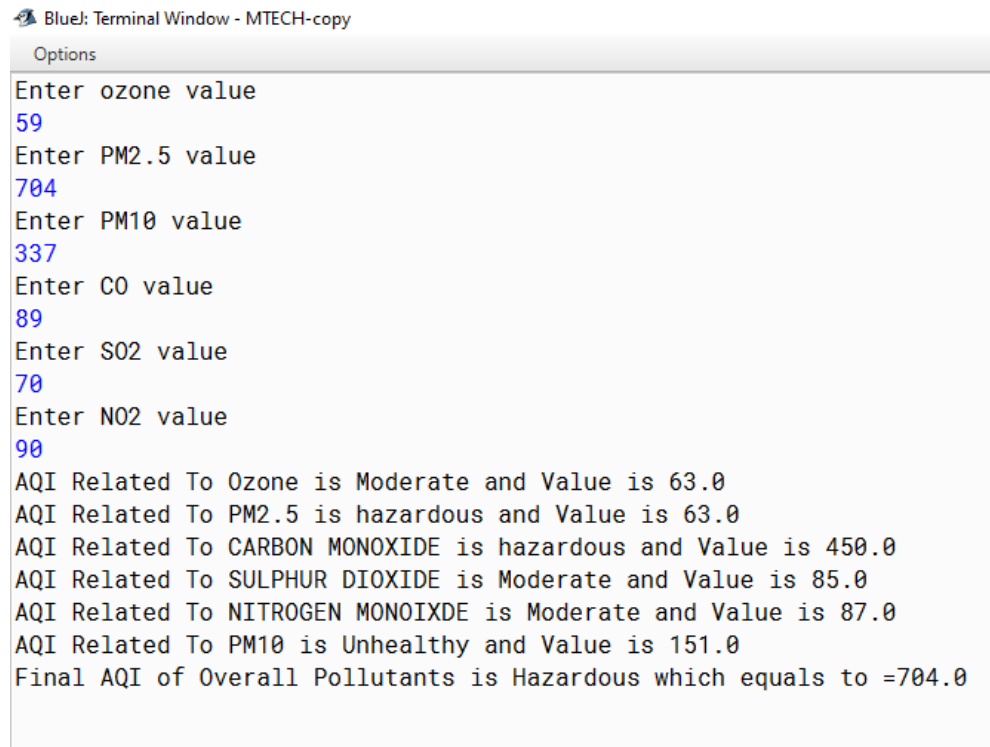
Source Code of AQI Calculator

3.4 Calculating AQI Values

Using the values from CPCB website, the following outcomes were generated and the AQI was

reported. Using the AQI, we can relate the level of air contamination and the related exposure

of a human. Simultaneously the ill effects and harms can be related with the exposure

conditions.

Fig. 3.1 AQI Calculated for respective pollutant values provided

Table 3.2: AQI values computed and respective status

	OZONE	PM2.5	PM10	CO	SO2	NO2		AQI	Status
2-Jan	55	464	391	147	22	125		464	Hazardous
3-Jan	33	-	-	116	46	116		33	Good
4-Jan	28	385	-	98	34	95		385	Hazardous
5-Jan	30	183	-	106	22	73		183	Unhealthy
6-Jan	31	177	-	94	30	84		177	Unhealthy
7-Jan	46	281	-	104	27	66		281	very Unhealthy
8-Jan	29	293	179	99	19	72		293	very Unhealthy
9-Jan	23	330	195	95	20	65		330	Hazardous
10-Jan	60	363	275	105	29	87		363	Hazardous
11-Jan	20	316	187	85	18	71		316	Hazardous
12-Jan	24	293	164	95	15	83		293	very Unhealthy
13-Jan	17	317	201	105	17	96		317	Hazardous
14-Jan	30	-	-	106	-	-		30	good

15-Jan		55	452	379	122	39	116		452	Hazardous
16-Jan		61		-	111	-	-		61	moderate
17-Jan		13	437	342	114	33	113		437	Hazardous
18-Jan		22	389	247	107	22	78		389	Hazardous
19-Jan		21	394	293	105	22	60		394	Hazardous
20-Jan		19	433	358	112	35	102		433	Hazardous
21-Jan		17	340	196	105	18	83		340	Hazardous
22-Jan		21	343	204	110	20	112		343	Hazardous
23-Jan		17	358	302	104	17	101		358	Hazardous
24-Jan		27	345	180	101	14	65		354	Hazardous
25-Jan		14	393	293	110	16	77		393	Hazardous
26-Jan		18	360	234	104	16	76		360	Hazardous
27-Jan		33	386	288	111	19	92		386	Hazardous
28-Jan		21	350	270	101	20	87		350	Hazardous
29-Jan		46	377	340	125	31	122		377	Hazardous
30-Jan		34	428	372	109	20	111		428	Hazardous
31-Jan		21	330	231	105	22	106		330	Hazardous
		47	-	-	100		-		47	Good

3.5 Observation

Different AQI is computed relevantly and the level of exposure is considered. There are huge values of AQI mostly dominated in P.M $_{2.5}$ and P.M$_{10}$ pollutants. A person is severely affected in Delhi- NCR Region to these Air pollutants and majority of the people are having breathing and chronic lungs diseases either known or unknown to diseases. Severe exposure to these values can cause cancer related diseases in lungs and respiratory tract. Immediate actions should be taken by people observing air pollution related problems and remedies should be taken to reduce future contamination.

3.6 Interviews

Interviews are generally seen as an appropriate tool to use for gathering information from participants regarding personal experience, opinions, attitudes, and perceptions. Mr. Mayank Kumar lives in Bangalore Karnataka, India and he commutes to work 5 days a week. He usually prefers his own vehicle than public transport for personal convenience. He told me that he sometimes faces breathing problems when in city centre and at home also. Mr. Jitendra Kumar lives in NOIDA Uttar Pradesh, India. He also works 5 days a week. He has to travel

Pitampura New Delhi, India for his office. He majorly faces breathing problems and has eyes burning issues usually twice a week. In home also, he usually faces these problems on a less but prominent scale.

3.7 Use of AIR PURIFIER

An air purifier is a device that absorbs and removes harmful particles from its surrounding environment to prevent respiratory diseases on humans. The most widespread use for an air purifier is to clean the air from harmful airborne particles in homes, hospitals and office environments. Some of the airborne particles that an air purifier removes includes air pollutants, allergens, cigarette smoke and dust. Many are emitted by human activities where some of the common sources is construction work, traffic, and industry.

An Air Purifier is a simple device to capture the relative air pollutants up to an appropriate level in relation of cleaning of air from pollutants. Various Air purifiers are available in market nowadays but due to high-cost ranges, most of the population is not able to utilise these devices. A cost-effective device is needed to be prepared so that the population of all income classes can use these devices and maintain their indoor air pollution to reduced level and breathe clean air.

Indoor air pollution reduction is necessary because a human being spend more than 12-14 hours of a single day at home itself. So, to reduce pollutants intake through air, air purifier is a modern and advantageous way to roll out.

CONCLUSION

Air pollution is dangerous for nature as well as for human beings. Prediction and remedial actions are the need of the hour. In this research work, the data set chosen from CPCB website is pre-processed first to separate pollutant parameters NO_2, CO, SO_2, O_3, $PM_{2.5}$, $P.M_{10}$. The prediction of air pollution is performed in two phases. The first phase computes AQI values for all the pollutants in a day. The second phase computes threshold value of AQI as an average of previous AQI values. Usually, the maximum of all AQI values is the final general AQI reported

to public. Air pollution for the days in chosen month is predicted by comparing the threshold value with the average of the previous two-month values. The results are found to be encouraging. Further research work is in progress to include other environmental parameters. Also, a new and efficient design is under development for air purifier to reduce development cost and increased efficiency. Atmospheric pollution is closely related to people's life. Although we can use the biological method of monitoring air pollutants to take measures to prevent the disease, the most fundamental way for our health is that do everything you to reduce emissions of pollutants. Only in this way, environment will become cleaner, and our children will thrive under the blue sky and white clouds.

- The air quality is degrading day by day and is indoor air quality.

- People are not majorly aware about the indoor air pollution and its ill effects.

- The travel pattern and relative pollutant data collected and AQI computed shows that people in DELHI-NCR region are exposed to huge air pollution and relevantly to indoor air pollution.

- Air purifier and Use of layered Mask is an effective way to breathe clean air on personal level.

- New techniques should be used to improve design and make cost efficient air purifier design.

- People need to adopt ways to improve or avoid indoor air pollution.

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