Impact of Air Pollution on our Lives

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Air pollution occurs when harmful or excessive quantities of substances are introduced into Earth's atmosphere. Sources of air pollution include gases, particulates, and biological molecules. In the year 2020 we can see how the pollution level is decreased significantly in India due to COVID-19 and nationwide lockdown

The above picture represents , how lower air pollution levels due to the ongoing nationwide lockdown and covid-19 is attributing to the visibility of Mount Everest in a village in Bihar's Sitamarhi district.

So lets see analysed data of recorded pollution level in India in two fragments : Pre Corona & Post Corona

Data source : https://www.kaggle.com/parulpandey/breathe-india-covid-19-effect-on-pollution/data?select=city_day.csv

Source Code : https://github.com/dev-vibhor/pollution_covid19India

DATA INFO :

Data is divided in to 16 columns and two more are added through manual calculation and each row contains details of recorded level of pollutants from year 2015 to 2020 day wise for different cities

	City	Date	PM2.5	PM10	NO	NO2	NOx	NH3	CO	SO2	O3	Benzene	Toluene	Xylene	AQI	AQI_Bucket
0	Ahmedabad	2015-01-01	NaN	NaN	0.92	18.22	17.15	NaN	0.92	27.64	133.36	0.00	0.02	0.00	NaN	NaN
1	Ahmedabad	2015-01-02	NaN	NaN	0.97	15.69	16.46	NaN	0.97	24.55	34.06	3.68	5.50	3.77	NaN	NaN
2	Ahmedabad	2015-01-03	NaN	NaN	17.40	19.30	29.70	NaN	17.40	29.07	30.70	6.80	16.40	2.25	NaN	NaN
3	Ahmedabad	2015-01-04	NaN	NaN	1.70	18.48	17.97	NaN	1.70	18.59	36.08	4.43	10.14	1.00	NaN	NaN
4	Ahmedabad	2015-01-05	NaN	NaN	22.10	21.42	37.76	NaN	22.10	39.33	39.31	7.01	18.89	2.78	NaN	NaN
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
26214	Thiruvananthapuram	2020-04-27	14.13	34.27	5.60	8.98	12.48	5.65	0.49	5.50	42.41	NaN	NaN	NaN	63.0	Satisfactory
26215	Thiruvananthapuram	2020-04-28	23.84	44.32	6.27	10.01	13.80	5.73	0.44	5.62	44.55	NaN	NaN	NaN	60.0	Satisfactory
26216	Thiruvananthapuram	2020-04-29	18.54	34.48	6.17	9.67	13.35	5.93	0.51	5.52	38.97	NaN	NaN	NaN	57.0	Satisfactory
26217	Thiruvananthapuram	2020-04-30	20.57	48.19	6.28	9.52	13.56	5.84	0.46	5.32	39.23	NaN	NaN	NaN	57.0	Satisfactory
26218	Thiruvananthapuram	2020-05-01	17.58	37.49	2.56	7.84	9.34	4.85	0.45	7.10	31.16	NaN	NaN	NaN	82.0	Satisfactory

26219 rows × 16 columns

METHODLOGY FOR ANALYSIS

1) **Reading the CSV FILE using python libraries.**
2) **Replacing the NULL values using accurate method (calculating mean using group by cities , year , month and replacing NULL values by it) to increase accuracy.**
3) **Calculating BTX and Particulate Matter and updating it in the data .**
4) **Replacing left over NAN or NULL values with '0' to detect fault in cities for recording pollutants level.**
5) **summarizing the pollutant level of different Types of Air Pollutants group by year month and city for better analysis.**
6) **Summarizing of different levels of pollutants amount of cities over the period 2015 to 2020 and check if any pollutants is not recorded properly .**

ANALYSIS CATEGORIES :

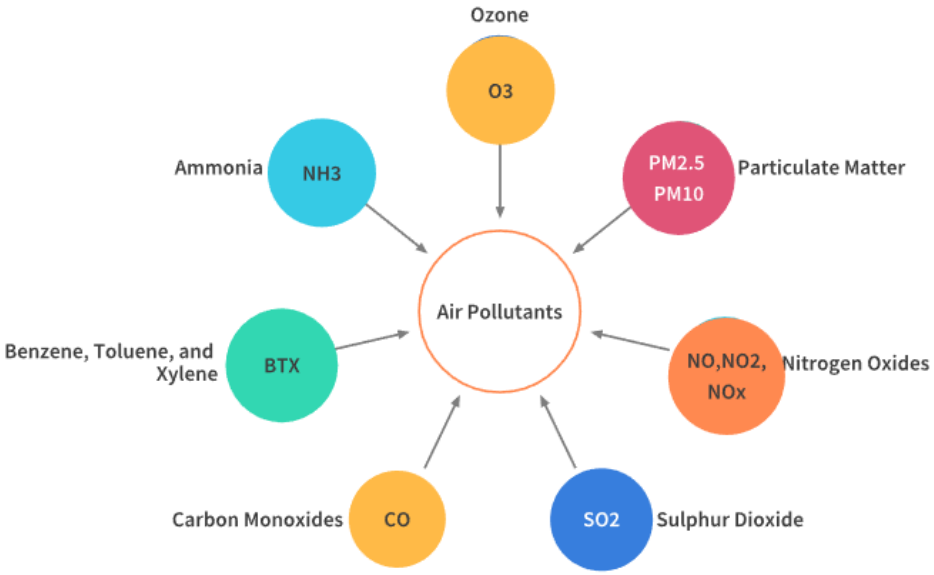
A. **The mean level of different Types of Air Pollutants and factors (AQI , Particulate Matter , BTX , CO) grouped by year and city**
B. **Different levels of AQI level of major cities (Ahmedabad , Delhi , Bangalore , Mumbai , Hyderabad , Chennai , Kolkata) before and after lockdown.**

LIMITATIONS AND ERRORS :

- **There are some empty values in dataset.**
- **Empty values may indicate cities are not well equipped with instruments to capture pollutant levels and faulty instruments . Note : (fault detection is implemented in code) .**
- **Pollutant levels changes in different seasons.**
- **For the year 2020 complete data is not present as it is ongoing.**
- **In this report only few cities and pollutants has been shown but everything can be analysed in the code**

BASIC KNOWLEDGE :

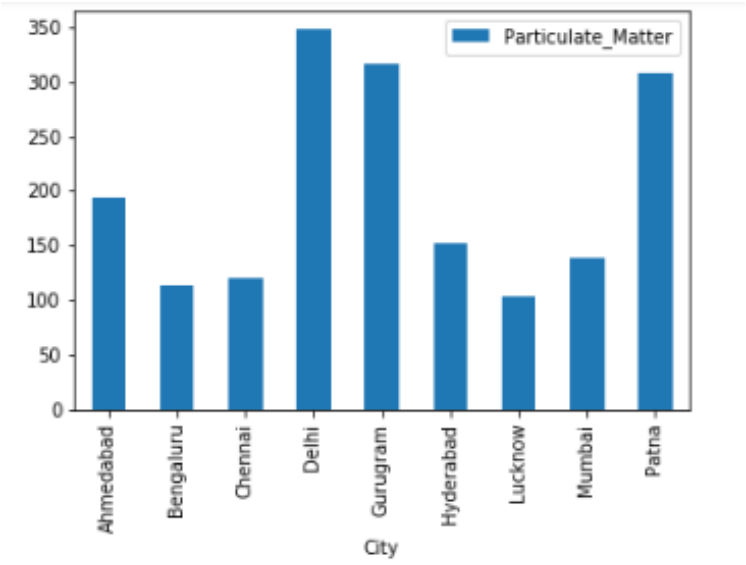
Pollutants can be classified as :



- **Particulate matter (PM2.5 and PM10)** > Particulate matter is a mix of solids and liquids, including carbon, complex organic chemicals, sulphates, nitrates, mineral dust, and water suspended in the air. PM varies in size. Some particles, such as dust, soot, dirt or smoke are large or dark enough to be seen with the naked eye. But the most damaging particles are the smaller particles, known as PM10 and PM2.5 . The following diagram will help to understand the concept more concretely.
- **Nitrogen Oxides** (NO, NO_2, NO_x) > Nitrogen oxides are a group of seven gases and compounds composed of nitrogen and oxygen, sometimes collectively known as NOx gases. The two most common and hazardous oxides of nitrogen are nitric oxide(NO) and nitrogen dioxide(NO_2)
- **Sulphur Dioxide**(SO_2) > Sulfur dioxide, or SO_2 is a colourless gas with a strong odor, similar to a just-struck match. It is formed when fuel containing sulfur, such as coal and oil, is burned, creating air pollution.
- **Carbon Monoxide**(CO) > Carbon monoxide is a colourless, highly poisonous gas. Under pressure, it becomes a liquid. It is produced by burning gasoline, natural gas, charcoal, wood, and other fuels.
- **Benzene, Toluene and Xylene** (BTX) > Benzene, toluene, xylene, and formaldehyde are well-known indoor air pollutants, especially after house decoration. They are also common pollutants in the working places of the plastic industry, chemical industry, and leather industry
- **Ammonia**(NH_3) > Ammonia pollution is pollution by the chemical ammonia (NH3) – a compound of nitrogen and hydrogen which is a by-product of agriculture and industry.
- **Ozone**(O_3) > Ground-level ozone is a colourless and highly irritating gas that forms just above the earth's surface. It is called a "secondary" pollutant because it is produced when two primary pollutants react in sunlight and stagnant air. These two primary pollutants are nitrogen oxides (NOx) and volatile organic compounds (VOCs).

A) THE MEAN LEVELS OF PARTICULATE MATTER , AQI , BTX , CO GROUPED BY YEAR AND CITY

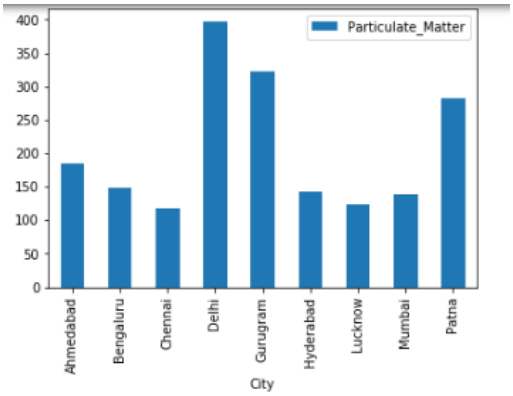
A.1) Particulate Matter.....



Details of All Cities sorted

	Date	City	Particulate_Matter
3	2015	Delhi	347.450258
4	2015	Gurugram	317.180294
8	2015	Patna	308.691811
0	2015	Ahmedabad	194.139295
5	2015	Hyderabad	152.749654
7	2015	Mumbai	138.405586
2	2015	Chennai	120.861267
1	2015	Bengaluru	112.557565
6	2015	Lucknow	102.923156

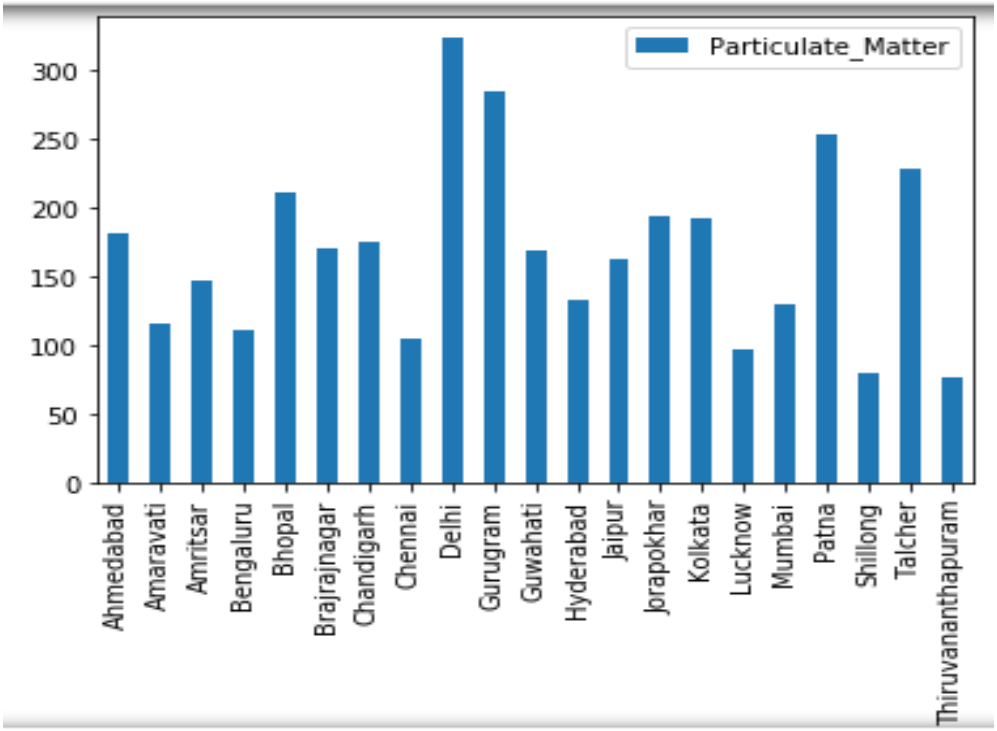
YEAR :2015 Analysis for Particulate Matter Levels



Details of All Cities sorted

	Date	City	Particulate_Matter
12	2016	Delhi	396.220502
13	2016	Gurugram	322.799778
17	2016	Patna	281.795928
9	2016	Ahmedabad	184.354293
10	2016	Bengaluru	148.937545
14	2016	Hyderabad	142.880718
16	2016	Mumbai	138.405586
15	2016	Lucknow	123.328455
11	2016	Chennai	117.388890

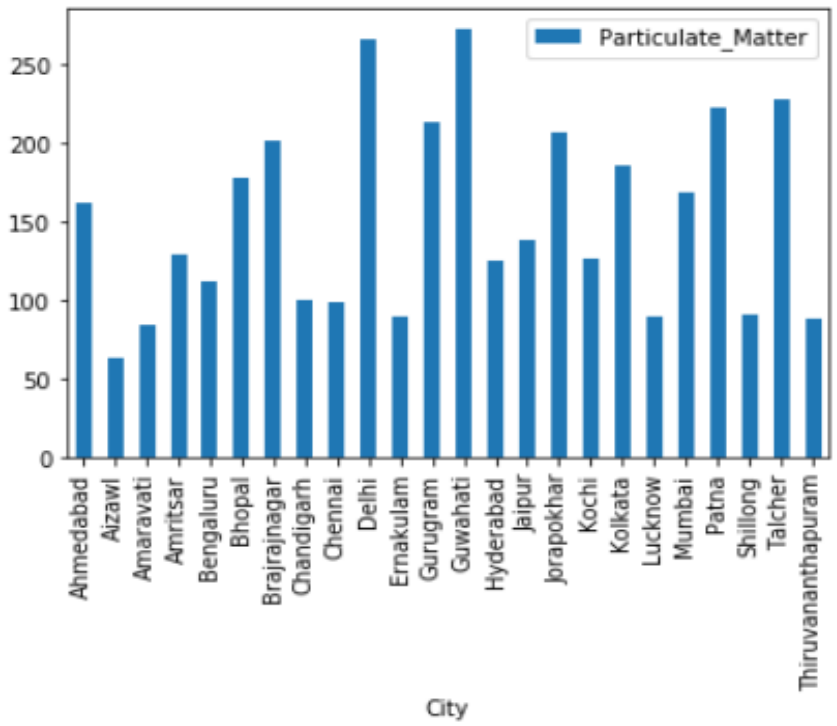
YEAR :2016 Analysis for Particulate Matter Levels



Details of All Cities sorted

	Date	City	Particulate_Matter
59	2019	Delhi	323.549288
60	2019	Gurugram	284.537243
68	2019	Patna	253.395827
70	2019	Talcher	228.580882
55	2019	Bhopal	210.662736
64	2019	Jorapokhar	194.719070
65	2019	Kolkata	191.869781
51	2019	Ahmedabad	181.251810
57	2019	Chandigarh	175.564730
56	2019	Brajrajnagar	170.265397
61	2019	Guwahati	168.489592
63	2019	Jaipur	163.108548
53	2019	Amritsar	148.075726
62	2019	Hyderabad	132.855836
67	2019	Mumbai	130.662137
52	2019	Amaravati	116.712071
54	2019	Bengaluru	111.039425
58	2019	Chennai	104.488761
66	2019	Lucknow	98.088658
69	2019	Shillong	79.993652
71	2019	Thiruvananthapuram	77.263449

YEAR :2019 Analysis for Particulate Matter Levels



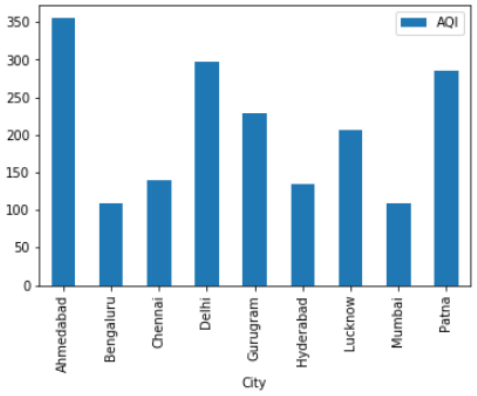
Details of All Cities sorted

	Date	City	Particulate_Matter
84	2020	Guwahati	272.340830
81	2020	Delhi	265.731148
94	2020	Talcher	227.969469
92	2020	Patna	223.045492
83	2020	Gurugram	212.922049
87	2020	Jorapokhar	207.409689
78	2020	Brajrajnagar	201.393784
89	2020	Kolkata	186.415984
77	2020	Bhopal	177.826323
91	2020	Mumbai	168.528770
72	2020	Ahmedabad	162.381148
86	2020	Jaipur	137.842295
75	2020	Amritsar	129.908780
88	2020	Kochi	127.296832
85	2020	Hyderabad	125.708033
76	2020	Bengaluru	111.635574
79	2020	Chandigarh	100.020574
80	2020	Chennai	99.542709
93	2020	Shillong	91.044622
82	2020	Ernakulam	90.151111
90	2020	Lucknow	89.391148
95	2020	Thiruvananthapuram	88.428197
74	2020	Amaravati	84.266557
73	2020	Aizawl	64.060196

YEAR :2020 Analysis for Particulate Matter Levels

"AS WE CAN SEE HOW LOCKDOWN HAS AFFECTED THE PARTICULATE MATTER LEVEL OF CITIES SUCH THAT IT HAS DECREASED IN MOST OF THE CITIES SIGNIFICANTLY AND THUS MAKING AIR MORE SUITABLE TO BREATHE "

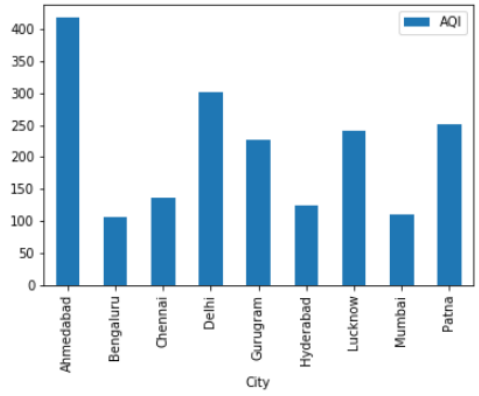
A.2) AQI.....



Details of All Cities sorted

	Date	City	AQI
0	2015	Ahmedabad	354.779616
3	2015	Delhi	297.024658
8	2015	Patna	285.862841
4	2015	Gurugram	228.864224
6	2015	Lucknow	206.541727
2	2015	Chennai	140.275032
5	2015	Hyderabad	135.297884
7	2015	Mumbai	109.352941
1	2015	Bengaluru	108.840331

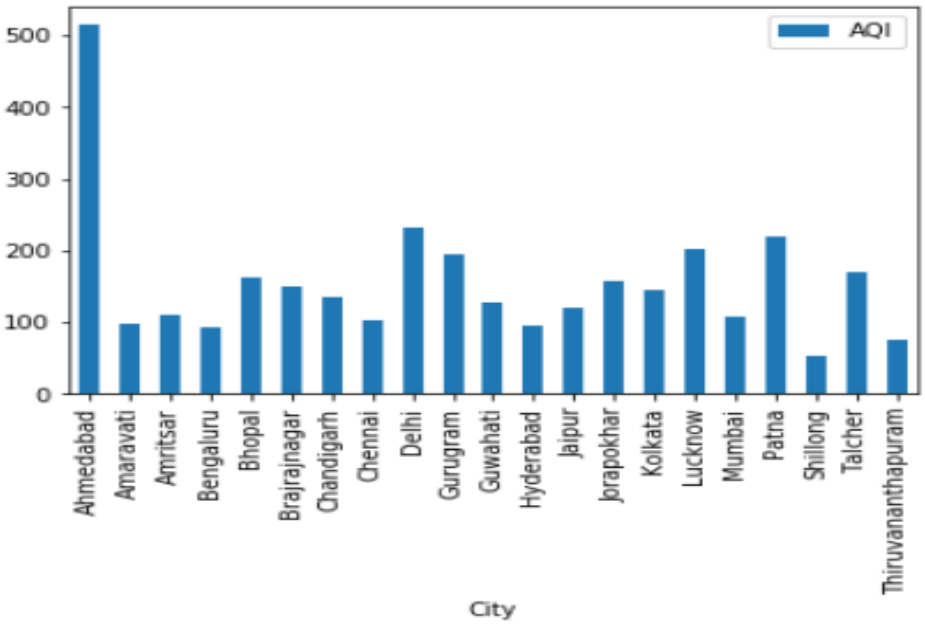
YEAR :2015 Analysis for AQI Levels



Details of All Cities sorted

	Date	City	AQI
9	2016	Ahmedabad	417.400714
12	2016	Delhi	301.265993
17	2016	Patna	251.765637
15	2016	Lucknow	241.107750
13	2016	Gurugram	227.471270
11	2016	Chennai	136.530404
14	2016	Hyderabad	123.171742
16	2016	Mumbai	109.352941
10	2016	Bengaluru	105.163617

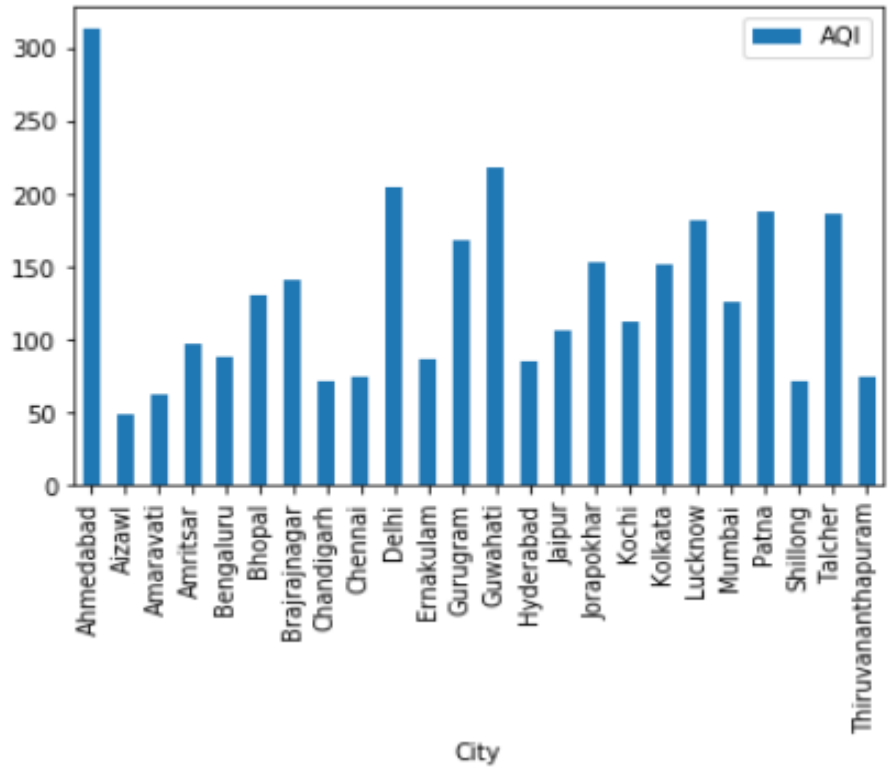
YEAR :2016 Analysis for AQI Levels



Details of All Cities sorted

	Date	City	AQI
51	2019	Ahmedabad	514.622651
59	2019	Delhi	232.104110
68	2019	Patna	218.722688
66	2019	Lucknow	202.561644
60	2019	Gurugram	195.314697
70	2019	Talcher	170.611936
55	2019	Bhopal	162.448831
64	2019	Jorapokhar	158.214494
56	2019	Brajrajnagar	148.702089
65	2019	Kolkata	143.909589
57	2019	Chandigarh	134.476491
61	2019	Guwahati	128.122105
63	2019	Jaipur	120.512329
53	2019	Amritsar	109.600255
67	2019	Mumbai	107.950685
58	2019	Chennai	102.942466
52	2019	Amaravati	98.497309
62	2019	Hyderabad	93.980822
54	2019	Bengaluru	91.602740
71	2019	Thiruvananthapuram	76.283596
69	2019	Shillong	53.630301

YEAR :2019 Analysis for AQI Levels



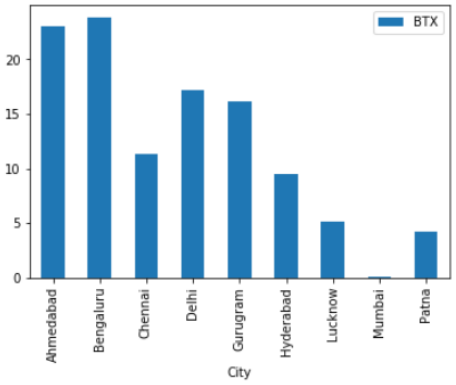
Details of All Cities sorted

	Date	City	AQI
72	2020	Ahmedabad	313.466795
84	2020	Guwahati	218.540984
81	2020	Delhi	204.172131
92	2020	Patna	188.090164
94	2020	Talcher	187.173311
90	2020	Lucknow	181.745902
83	2020	Gurugram	168.098361
87	2020	Jorapokhar	152.925052
89	2020	Kolkata	151.204918
78	2020	Brajrajnagar	141.189767
77	2020	Bhopal	130.916069
91	2020	Mumbai	126.090164
88	2020	Kochi	112.707071
86	2020	Jaipur	106.524590
75	2020	Amritsar	97.133433
76	2020	Bengaluru	87.680328
82	2020	Ernakulam	87.294737
85	2020	Hyderabad	85.713115
80	2020	Chennai	74.819672
95	2020	Thiruvananthapuram	74.647541
79	2020	Chandigarh	72.107901
93	2020	Shillong	72.021764
74	2020	Amaravati	63.032787
73	2020	Aizawl	49.098039

YEAR :2020 Analysis for AQI Levels

" AS WE CAN SEE HOW AQI LEVELS DECREASED IN THE YEAR 2020 COMPARED TO OTHER YEARS EVEN THOUGH 2020 IS STILL ON GOING AND ONLY TWO MONTHS OF LOCK DOWN HAS IMPROVED AIR QUALITY "

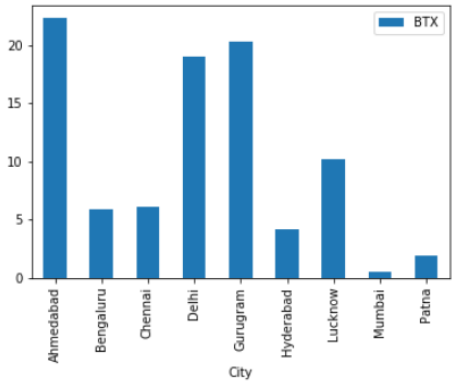
A.3) Benzene, Toluene and Xylene (BTX).....



Details of All Cities sorted

	Date	City	BTX
1	2015	Bengaluru	23.792116
0	2015	Ahmedabad	23.095766
3	2015	Delhi	17.221596
4	2015	Gurugram	16.163223
2	2015	Chennai	11.319371
5	2015	Hyderabad	9.452853
6	2015	Lucknow	5.163292
8	2015	Patna	4.172494
7	2015	Mumbai	0.006016

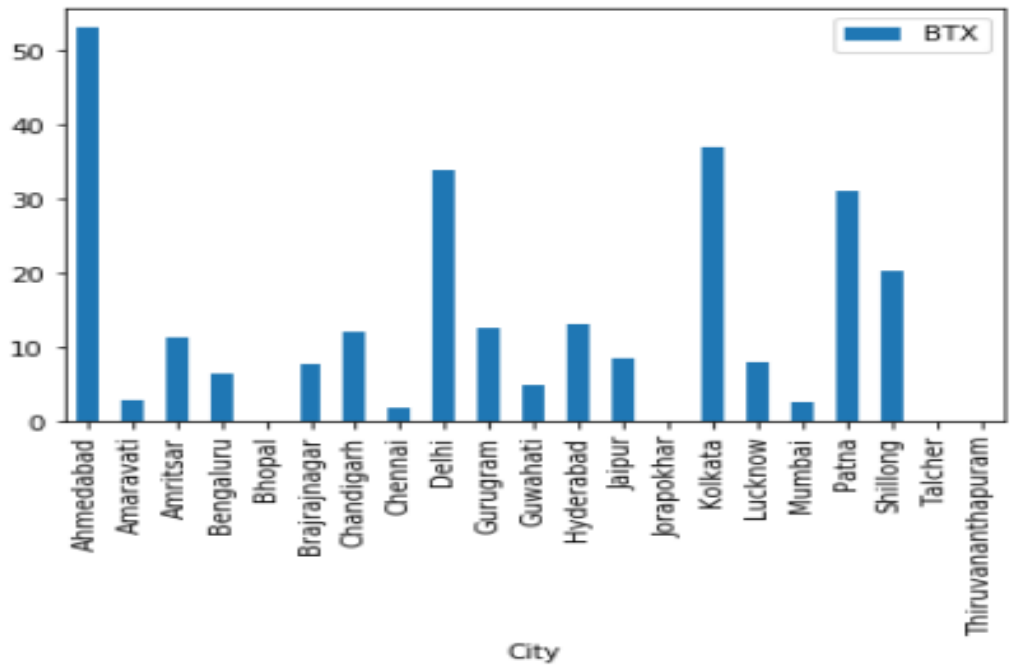
YEAR :2015 Analysis for BTX Levels



Details of All Cities sorted

	Date	City	BTX
9	2016	Ahmedabad	22.286552
13	2016	Gurugram	20.261642
12	2016	Delhi	18.966778
15	2016	Lucknow	10.158976
11	2016	Chennai	6.062970
10	2016	Bengaluru	5.923413
14	2016	Hyderabad	4.107473
17	2016	Patna	1.937170
16	2016	Mumbai	0.533908

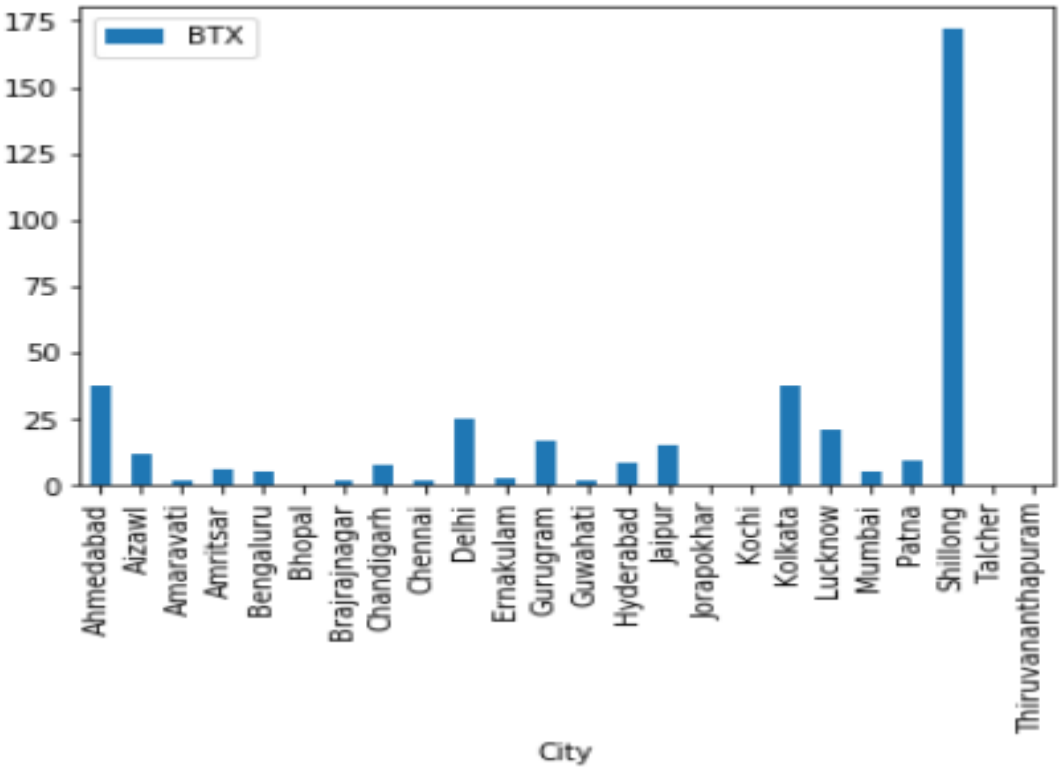
YEAR :2016 Analysis for BTX Levels



Details of All Cities sorted

	Date	City	BTX
51	2019	Ahmedabad	53.104091
65	2019	Kolkata	36.935464
59	2019	Delhi	33.885699
68	2019	Patna	31.174159
69	2019	Shillong	20.432117
62	2019	Hyderabad	13.029918
60	2019	Gurugram	12.647041
57	2019	Chandigarh	12.248099
53	2019	Amritsar	11.405451
63	2019	Jaipur	8.457205
66	2019	Lucknow	8.087534
56	2019	Brajrajnagar	7.802932
54	2019	Bengaluru	6.518521
61	2019	Guwahati	4.991590
52	2019	Amaravati	2.983088
67	2019	Mumbai	2.578095
58	2019	Chennai	1.810329
70	2019	Talcher	0.111300
64	2019	Jorapokhar	0.000000
55	2019	Bhopal	0.000000
71	2019	Thiruvananthapuram	0.000000

YEAR :2019 Analysis for BTX Levels



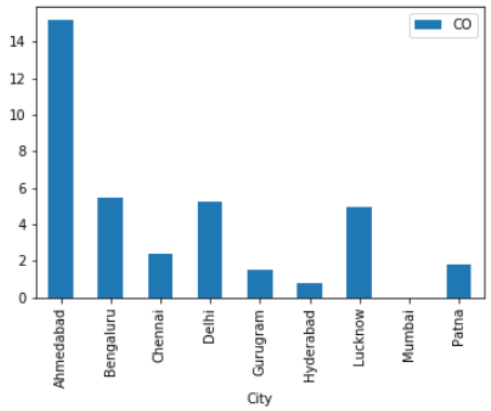
Details of All Cities sorted

	Date	City	BTX
93	2020	Shillong	171.833914
89	2020	Kolkata	37.716885
72	2020	Ahmedabad	37.403226
81	2020	Delhi	25.496557
90	2020	Lucknow	21.246230
83	2020	Gurugram	17.100144
86	2020	Jaipur	15.525410
73	2020	Aizawl	12.018077
92	2020	Patna	9.476230
85	2020	Hyderabad	8.135410
79	2020	Chandigarh	7.873361
75	2020	Amritsar	6.347447
91	2020	Mumbai	5.498514
76	2020	Bengaluru	5.438197
82	2020	Ernakulam	2.341919
84	2020	Guwahati	1.958361
78	2020	Brajrajnagar	1.883128
74	2020	Amaravati	1.613302
80	2020	Chennai	1.534180
94	2020	Talcher	0.087046
88	2020	Kochi	0.001188
87	2020	Jorapokhar	0.000000
77	2020	Bhopal	0.000000
95	2020	Thiruvananthapuram	0.000000

YEAR :2020 Analysis for BTX Levels

" As BTX is an measure of Industrial pollution we can see how the level got down in year 2020 due to various Industries shutting down temporarily due to covid-19 "

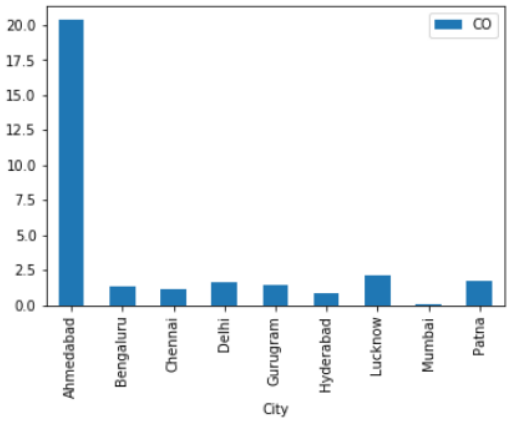
A.4) Carbon Monoxide(CO).....



Details of All Cities sorted

	Date	City	CO
0	2015	Ahmedabad	15.165533
1	2015	Bengaluru	5.485509
3	2015	Delhi	5.255151
6	2015	Lucknow	4.961534
2	2015	Chennai	2.375674
8	2015	Patna	1.811685
4	2015	Gurugram	1.492769
5	2015	Hyderabad	0.748323
7	2015	Mumbai	0.000000

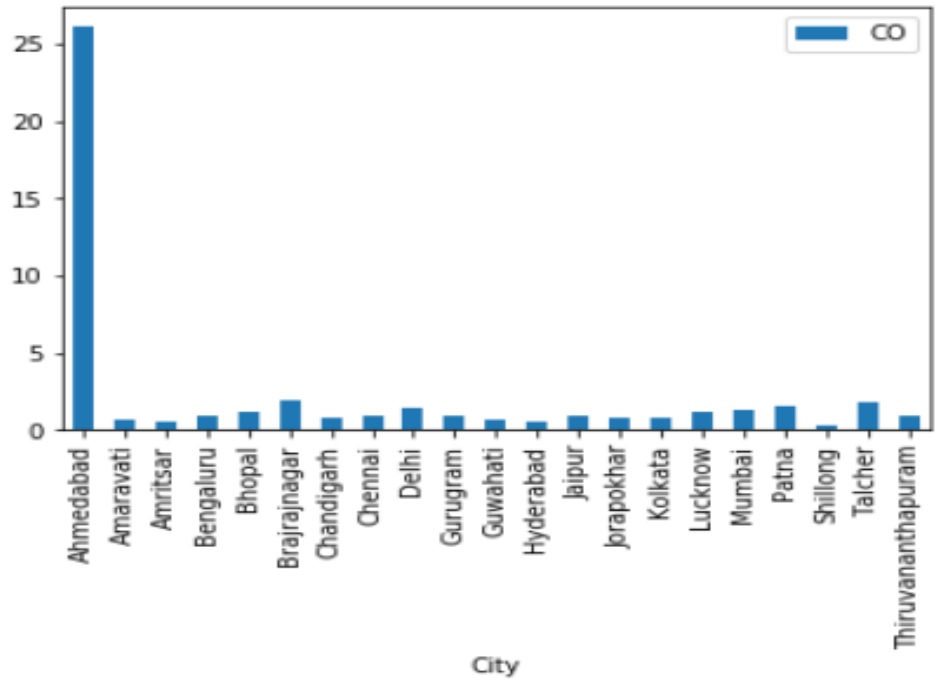
YEAR :2015 Analysis for CO Levels



Details of All Cities sorted

	Date	City	CO
9	2016	Ahmedabad	20.345558
15	2016	Lucknow	2.158007
17	2016	Patna	1.683452
12	2016	Delhi	1.610082
13	2016	Gurugram	1.436259
10	2016	Bengaluru	1.291511
11	2016	Chennai	1.129446
14	2016	Hyderabad	0.823429
16	2016	Mumbai	0.014164

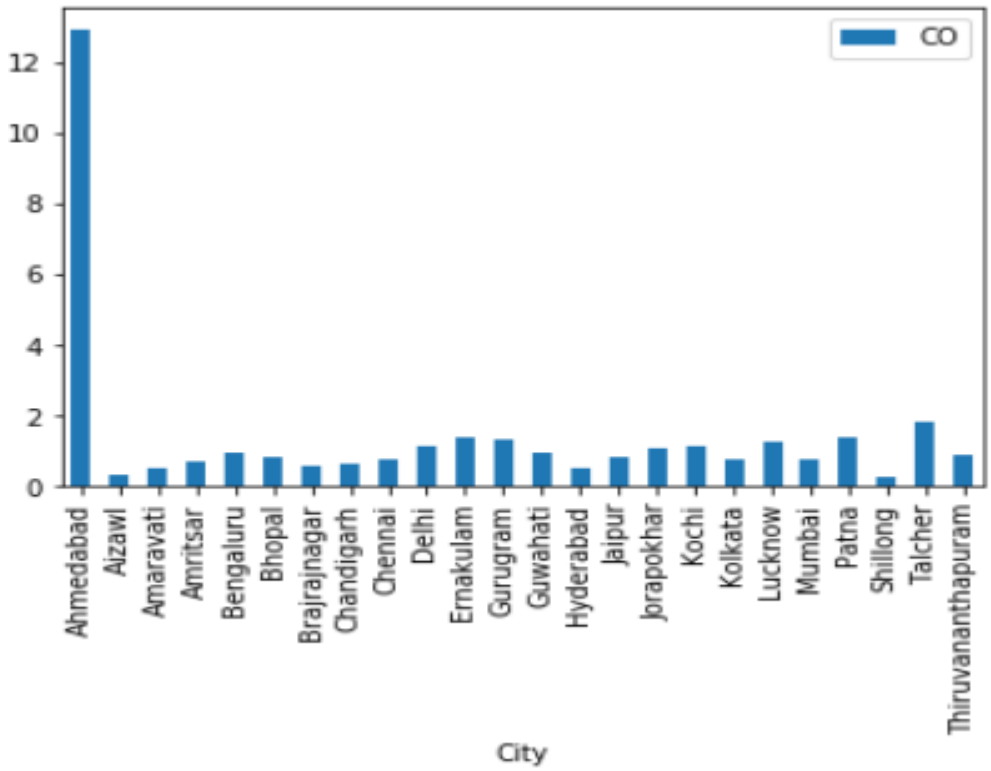
YEAR :2016 Analysis for CO Levels



Details of All Cities sorted

	Date	City	CO
51	2019	Ahmedabad	26.085216
56	2019	Brajrajnagar	1.866224
70	2019	Talcher	1.768882
68	2019	Patna	1.558239
59	2019	Delhi	1.371616
67	2019	Mumbai	1.269003
66	2019	Lucknow	1.230411
55	2019	Bhopal	1.178585
60	2019	Gurugram	0.903753
54	2019	Bengaluru	0.901753
63	2019	Jaipur	0.899562
71	2019	Thiruvananthapuram	0.884853
58	2019	Chennai	0.864027
64	2019	Jorapokhar	0.825135
65	2019	Kolkata	0.773534
57	2019	Chandigarh	0.750909
61	2019	Guwahati	0.712840
52	2019	Amaravati	0.637138
62	2019	Hyderabad	0.570110
53	2019	Amritsar	0.531242
69	2019	Shillong	0.259465

YEAR :2019 Analysis for CO Levels



Details of All Cities sorted

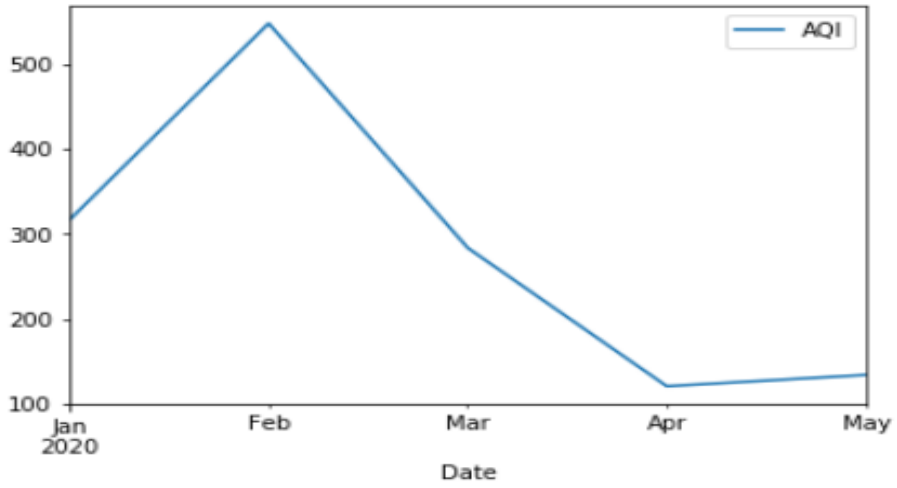
	Date	City	CO
72	2020	Ahmedabad	12.918689
94	2020	Talcher	1.800511
92	2020	Patna	1.387049
82	2020	Ernakulam	1.367778
83	2020	Gurugram	1.312705
90	2020	Lucknow	1.288525
88	2020	Kochi	1.168218
81	2020	Delhi	1.130656
87	2020	Jorapokhar	1.089422
76	2020	Bengaluru	0.955246
84	2020	Guwahati	0.941230
95	2020	Thiruvananthapuram	0.865082
77	2020	Bhopal	0.842191
86	2020	Jaipur	0.833934
89	2020	Kolkata	0.790656
91	2020	Mumbai	0.776475
80	2020	Chennai	0.744344
75	2020	Amritsar	0.679707
79	2020	Chandigarh	0.622377
78	2020	Brajrajnagar	0.553716
85	2020	Hyderabad	0.509836
74	2020	Amaravati	0.501924
73	2020	Aizawl	0.359231
93	2020	Shillong	0.259146

YEAR :2020 Analysis for CO Levels

" As CO is one of the vehicle related pollutants and in most of the cities it got reduced in year 2020 due to lockdown by viewing above graphs "

B) AQI ANALYSIS OF MAJOR CITIES BEFORE AND AFTER LOCKDOWN

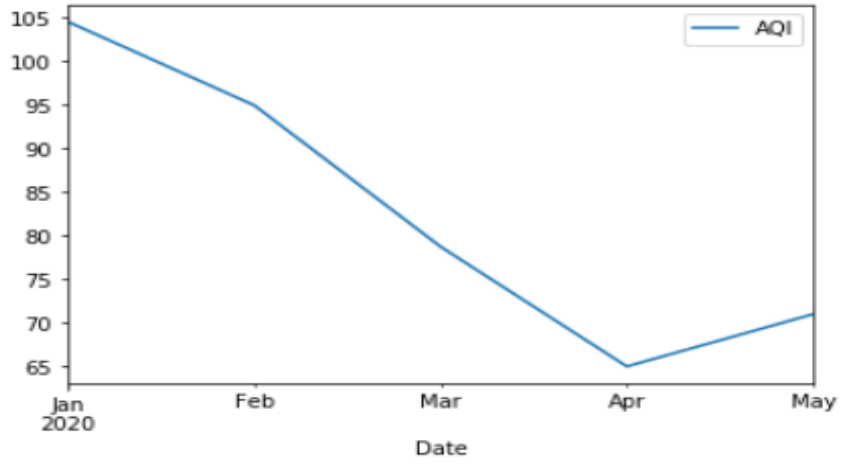
	Date	City	AQI
58	2020-01-01	Ahmedabad	316.521265
141	2020-02-01	Ahmedabad	547.689655
224	2020-03-01	Ahmedabad	283.606123
310	2020-04-01	Ahmedabad	120.733333
396	2020-05-01	Ahmedabad	134.000000



>----------CITY :Ahmedabad------ANALYSIS ON :AQI

CITY : Ahmedabad Analysis on AQI Levels

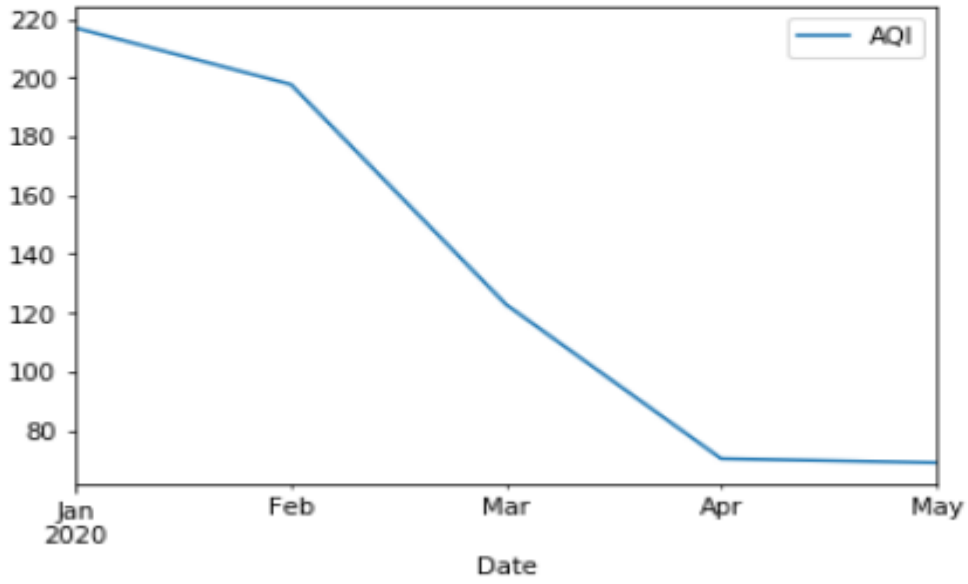
	Date	City	AQI
70	2020-01-01	Hyderabad	104.548387
153	2020-02-01	Hyderabad	94.965517
237	2020-03-01	Hyderabad	78.741935
323	2020-04-01	Hyderabad	65.000000
409	2020-05-01	Hyderabad	71.000000



>----------CITY :Hyderabad------ANALYSIS ON :AQI

CITY : Hyderabad Analysis on AQI Levels

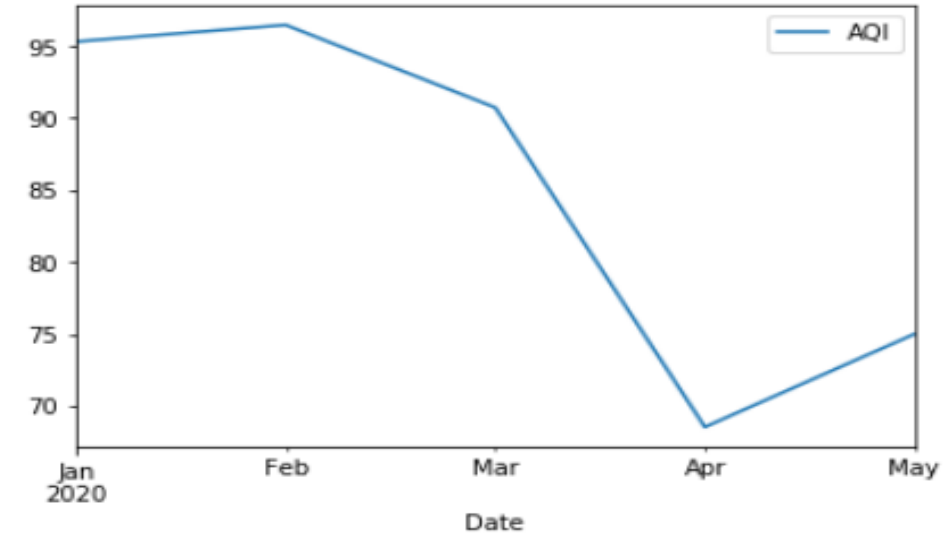
	Date	City	AQI
74	2020-01-01	Kolkata	216.935484
157	2020-02-01	Kolkata	197.724138
241	2020-03-01	Kolkata	122.838710
327	2020-04-01	Kolkata	70.366667
413	2020-05-01	Kolkata	69.000000



>----------CITY :Kolkata------ANALYSIS ON :AQI

CITY : Kolkata Analysis on AQI Levels

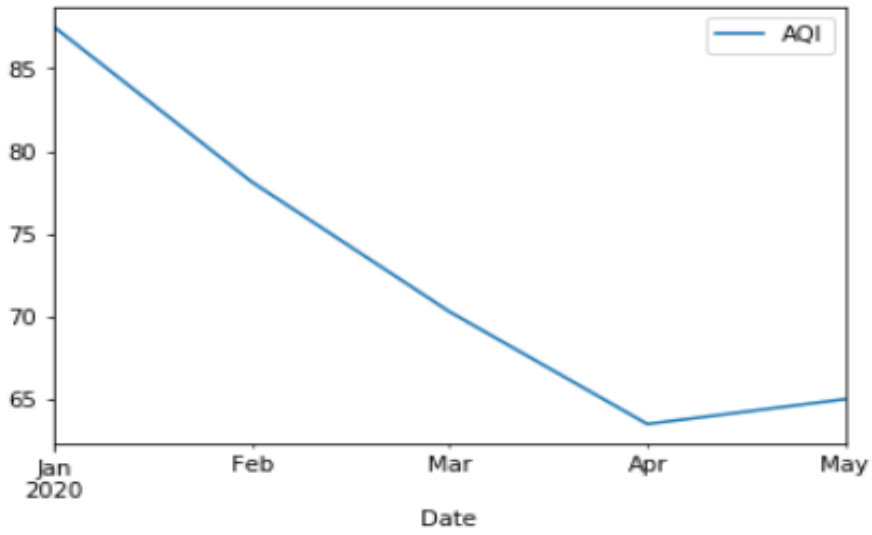
	Date	City	AQI
61	2020-01-01	Bengaluru	95.322581
144	2020-02-01	Bengaluru	96.482759
228	2020-03-01	Bengaluru	90.741935
314	2020-04-01	Bengaluru	68.533333
400	2020-05-01	Bengaluru	75.000000



>----------CITY :Bengaluru------ANALYSIS ON :AQI

CITY : Bengaluru Analysis on AQI Levels

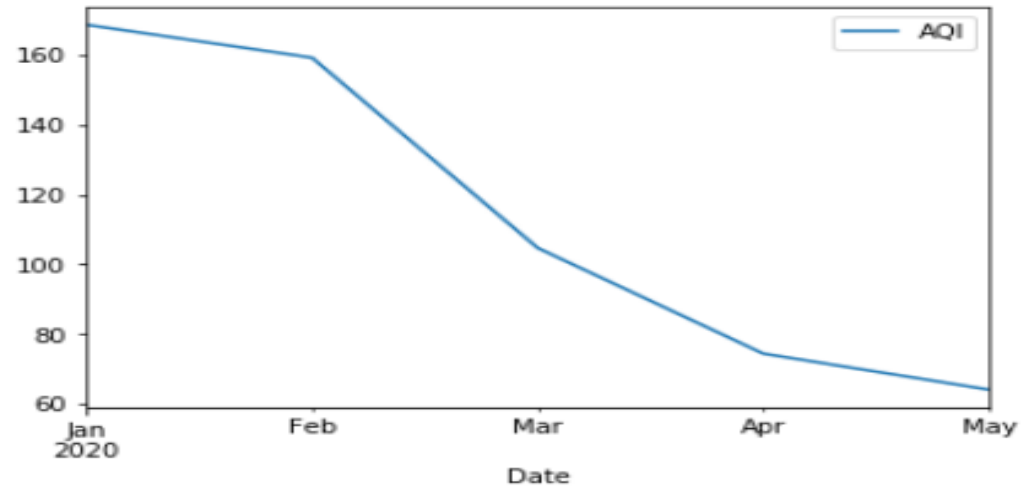
	Date	City	AQI
65	2020-01-01	Chennai	87.516129
148	2020-02-01	Chennai	78.137931
232	2020-03-01	Chennai	70.290323
318	2020-04-01	Chennai	63.500000
404	2020-05-01	Chennai	65.000000



>----------CITY :Chennai------ANALYSIS ON :AQI

CITY : Chennai Analysis on AQI Levels

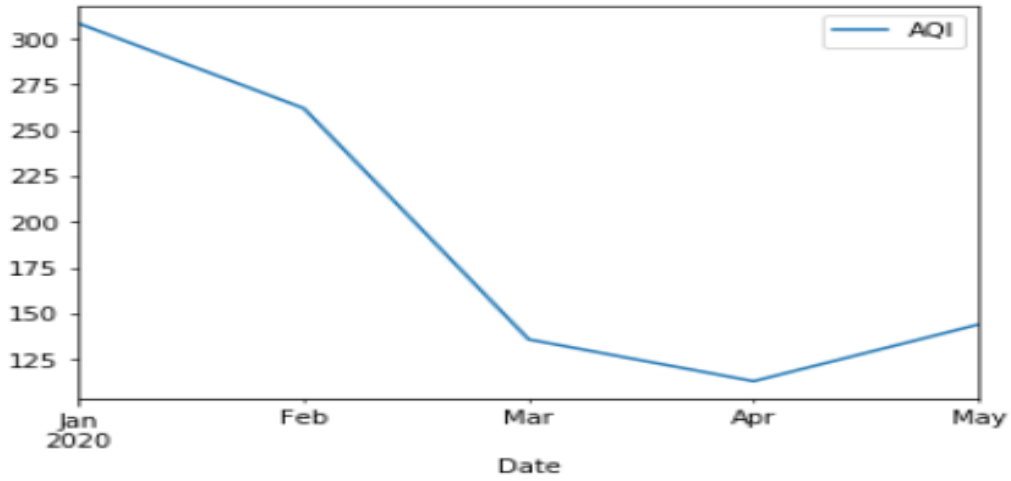
	Date	City	AQI
76	2020-01-01	Mumbai	168.645161
159	2020-02-01	Mumbai	159.206897
243	2020-03-01	Mumbai	104.645161
329	2020-04-01	Mumbai	74.333333
415	2020-05-01	Mumbai	64.000000



>----------CITY :Mumbai------ANALYSIS ON :AQI

CITY : Mumbai Analysis on AQI Levels

	Date	City	AQI
66	2020-01-01	Delhi	308.451613
149	2020-02-01	Delhi	262.137931
233	2020-03-01	Delhi	135.838710
319	2020-04-01	Delhi	113.000000
405	2020-05-01	Delhi	144.000000



>----------CITY :Delhi------ANALYSIS ON :AQI

CITY : Delhi Analysis on AQI Levels

"LESS THE AQI VALUE = MORE HEALTHY AIR , AND WE CAN SEE FOR ABOVE MAJOR CITIES THAT AIR QUALITY IMPROVED IN THE MONTH OF APRIL AND MARCH AFTER IMPLEMENTING LOCKDOWN IN 2020"

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