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A Comparative Study of Air Pollution Monitoring in 5major cities of Andhra Pradesh with the National Capital Delhi

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Abstract
Air is important for the survival of life on Earth. The deterioration of ambient air quality is one of the emerging environmental problems in developing countries like India. Anthropogenic Air Pollution sources like the combustion of fossil fuels by industries, agricultural activities, transportation causing the pollutionof air. If the pollution increases exponentially at this rate, it could cause an imbalance between nature and thehuman life cycle. While the Coronavirus is dominating the international headlines, a silent killer is contributing nearly 7 million more deaths a year, air pollution. Coronavirus as well as many other respiratory infections including influenza, that breathing more polluted air increased risks to death. This study is focused on comparing the pollution and the pollutants that are released into the air in different cities with respect to the associated health effects and by comparing them with one of the most polluted city Delhi. This study helps to rank the cities and to know the air quality in those cities and it also helps toassess the need to decrease pollution before having a hazardous effect on Humans and the Environment. The data required is taken from Central Pollution Control Board (CPCB), a statutory organization under the Ministry of Environment and Forests, Government of India, provides air quality data of various stations across cities in India and also from Andhra Pradesh Pollution Control Board (APPCB).

Keywords: Pollution, CPCB, APPCB, AQI calculation

1. INTRODUCTION:

Air is important for the survival of life on Earth. The deterioration of ambient air quality is one of the emerging environmental problems in developing countries like India. If the pollution increases exponentially at this rate, it could cause an imbalance between nature and the human life cycle. A number of monitoring programs have been undertaken in the past throughout the world to know the quality of air by using enormous amount of data on concentration of various air pollutants such as Sulfur Dioxide (SO_2), Nitrogen oxides (NO_X), Particulate Matter (PM), Carbon Monoxide (CO), OZONE (O_3). Particulate matter includes smoke, dust, fumes, and aerosols This study is focused on comparing the pollution and the pollutants that are released into the air in five major cities of Andhra Pradesh and the health issues and the problems that can becaused due to the pollution and by comparing them with one of the most polluted city Delhi.The deterioration of ambient air quality is one of the emerging environmental problems in developing

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countries like India. Anthropogenic Air Pollution sources like the combustion of fossil fuels by industries, agricultural activities, transportation causing the pollution of air. One way to describe air quality is to report the concentrations of all pollutants with acceptable levels (standards).

To address the above concerns, the concept of an Air Quality Index (AQI) has been developed and used effectively in many developed countries for over last three decades (USEPA 1976, 2014; Ontario, 2013; Shenfield, 1970). An AQI is defined as an overall scheme that transforms weighted values of individual air pollution related parameters (SO2, CO, visibility, etc.) into a single number or set of numbers.

2. LITERATURE REVIEW:

[1]CPCB,2003; Breuer et al., [2019] stated that as of May 2020, CPCB operates and maintains 230 continuous ambient air quality monitoring stations (CAAQMS) covering all the criteria pollutants and meteorological parameters and 750 manual monitoring stations reporting PM2.5, PM10, SO2, and NO2. Monitoring guidelines estimate a need for at least 4000 CAAQMS to spatially and temporally represent India's air quality - 2800 in the urban areas and 1200 in the rural areas. The data from these monitoring stations can be used for AQI studies.

[2]Miller et al., [1982] stated that the major source of NO2 is combustion processes. An appreciable quantity of NO2 is present in rural and urban environments. Further, NO2 is showing alarmingly high increasing trend in Indian cities due to increase in number of vehicles. On inhalation, 70–90% of NO2 can be absorbed in the respiratory tract of humans, and physical exercise increases the total percentage absorbed.

[3]Thom and Ott, [1976]; Bortnick et al., [2002]; Murena, [2004] stated that an "Air Quality Index" may be defined as a single number for reporting the air quality with respect to its effects on the human health.

[4]Dockery et al., [1994] PM levels in Indian cities are about 4-5 times higher than in the US cities. These high PM levels may have severe impact on public health. The sixteen-year long survey by Dockery has revealed that there is a strong correlation between ambient PM concentrations and increase in mortality and hospitalizations due to respiratory diseases. Long-term particulate exposure was associated with an increase in risk of respiratory illness in children.

[5]Pope., [1989] stated that the major concerns for human health from exposure to PM10 include effects on breathing, respiratory symptoms, decrease in pulmonary function and damage to lung tissue, cancer, and premature death. An association between elevated PM10 levels and hospital admissions for pneumonia, bronchitis, and asthma and he also observed that 30 to 50% increase in lung cancer rates associated with exposure to respiratory particles. Associations between mortality risk and air pollution were strongest for respiratory particles.

[6]Sharma et al., [2004] through a study in Kanpur reported that the fine particles impact the pulmonary region (lower respiratory system) therefore through his study he stated that both PM10 and PM2.5 have specific health impacts and both of these pollutants should be considered for AQI.

[7]Gurjar and Lelieveld [2005] stated that Urban air pollution has emerged as a major source of severe adverse impacts on physical, biological, and socioeconomic systems including ambient air quality, human health, and property. In many cities such as megacity Delhi, the

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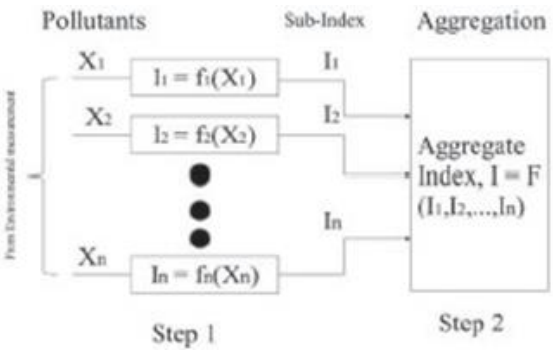
transport sector is the major source of air pollution emissions resulting in poor ambient air quality. In order to regulate these air quality index can be used.

[8]Schwartz et al., [1996] conducted a study in six US cities has shown that there is an association between fine particulate matter (PM2.5) primarily from combustion sources and daily mortality and he also reported that effects of fine particles are predominant in those areas. Finally, he observed that there is link between □□2.5 and □□10 with significant health problems, including: premature mortality, chronic respiratory disease, emergency visits and hospital admissions, aggravated asthma, acute respiratory symptoms, and decrease in lung function. □□2.5 is of specific concern because it contains a high proportion of various toxic metals and acids, and aerodynamically it can penetrate deeper into respiratory tract.

3. METHODOLOGY:

3.1 Air Quality Index

Definition: An air quality index is defined as an overall scheme that transforms the weighed values of individual air pollution related parameters (for example, pollutant concentrations) into a single number or setof numbers. The result is a set of rules (i.e., most set of equations) that translates parameter values into a simpler form by means of numerical manipulation.



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A single concentration value in µg/m^3 or ppm (parts per million) along with standards then it cannot be considered as an index i.e, all concentrations of different parameters with specific ranges of a group implies to an index value.

Structure of an index:
Primarily two steps are involved in formulating an AQI:

- formation of sub-indices (for each pollutant) and
- aggregation of sub-indices to get an overall AIR QUALITY INDEX.

Formation of sub-indices (I1, I2,...., In) for n pollutant variables/concentrations (X1, X2…….. Xn) is carried out using sub-index functions that are based on air quality standards and health effects. Mathematically;

$$I_i = f(X_i);\ I_i = 1, 2, \ldots\ldots n \longrightarrow 1$$

Aggregation of sub-indices, i carried out with some mathematical function to obtain the overall index (I),referred to as AQI.

$$I = F(I_1, I_2, I_3, \ldots, I_n) \longrightarrow 2$$

The aggregation function usually is a summation or multiplication operation or simply a maximum operator. Sub-indices (step 1) :
Sub-index function represents the relationship between pollutant concentration Xi and corresponding sub- index Ii. It is an attempt to reflect environmental consequences as the concentration of specific pollutant changes. It may take a variety of forms such as linear, non-linear and segmented

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linear. Typically, the I -Xrelationship is represented as follows:

consider a general algebraic equation, Ax+By+C=0 rewriting as

$I = \alpha X + \beta$ ⟶ 3

Where, α =slope of the line, β = intercept at X=0 i.e, Y=1

The general equation proposed by USEPA(United States Environmental Protection Agency) for the sub- index (I_i) for a given pollutant concentration (Cp); as based on 'linear segmented principle' is calculated as:

$I_i = [\{(I_{HI} - I_{LO})/(B_{HI} - B_{LO})\} * (Cp - B_{LO})] + I_{LO}$ ⟶ 4

where,

BHI= Breakpoint concentration greater or equal to given concentration.

BLO= Breakpoint concentration smaller or equal to given concentration.
IHI =AQI value corresponding to BHI
ILO = AQI value corresponding to BLO Ip = Pollutant concentration.
Similarly sub-index can be calculated can be calculated for other pollutents as well.
Note: A Group of sub-index is termed a sub-indices.

Aggregation of Sub-indices (step 2) :
Once the sub-indices are formed, they are combined or aggregated in a simple additive form or weightedadditive form:

- Weighted Additive Form
- I = Aggregated Index = $\sum w_i I_i$

  (For i=1,….,n) ⟶ 5

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where,

$\sum w_i = 1$

I_i = sub-index for pollutant i

n=number of pollutant variables

wi=weightage of the pollutant

- Min or Max Operator

$I = \text{Min or Max } (I_1, I_2, I_3, \ldots, I_n)$

3.2 AQI CALUCATOR METHOD:

CPCB created an excel sheet in which they coded all data regarding the ranges of AQI,breakponts and it's sub-index of all 8 pollutants ($PM_{2.5}$, PM_{10} , NO_X ,NH_3 , SO_2 , O_3 ,CO) in order to excecute AQI from the input data given by user.

Pre-Requisite for using the excel sheet to obtain AQI

- (Maximum 8-hr (or) Average 8-hr) data is required to calculate the AQI of O_3 & CO.
- Average 24-hrs. data is required to calculate the AQI of remaining pollutants.
- Downloaded CO pollutant data is in units of mg/m^3.
- Downloaded ($PM_{2.5}$, PM_{10} , NO_X ,NH_3 , SO_2 , O_3) pollutant data is in units of $\mu g/m^3$.

Procedure to enter data manually:

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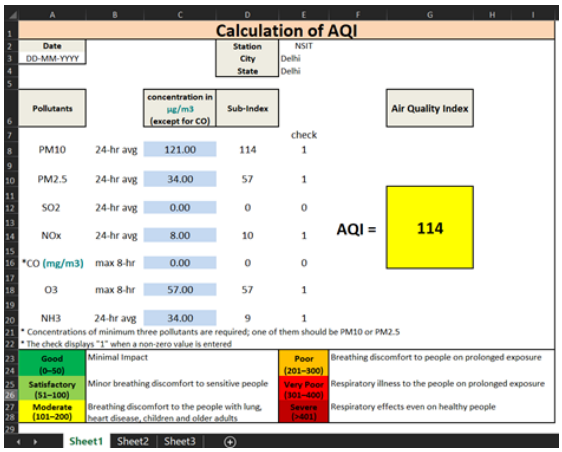

1. Calculate the concentration averages of all the pollutants (24 hrs & 8 hr).
2. Concentrations of minimum three pollutants are required; one of them should be PM10 or PM2.5
3. After entering the avg. concentration values of different pollutants a sub-index will be shown on its specified cell w.r.t its pollutant located in a same row.
4. Check Value confirmation is needed whether the value is entered or not other wise the date will not be executed.
5. The maximum of all the sub-indexes is taken as AQI and is shown with a number with its designated colour along with its description situated at the bottom of the page.

4. RESULT AND DISCUSSIONS:
AQI in 2019 & 2020:

Month	Amaravati		Rajahmundry		Tirupati		Vijayawada		Vizag		Delhi	
YEAR	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
JAN	211	79	219	88	92	53	76	-	271	114	206	168
FEB	105	61	100	73	69	56	67	-	126	95	153	154
MAR	70	41	59	51	71	51	60	-	95	77	150	104
APRIL	59	39	46	39	54	48	51	-	90	50	150	104
MAY	101	55	62	53	78	51	69	-	126	69	171	108
JUNE	55	54	62	44	46	36	54	-	107	81	145	116
JULY	30	31	41	33	34	31	28	-	98	76	109	97
AUG	20	33	42	33	32	32	39	-	82	71	68	75
SEPT	-	29	39	37	35	34	38	-	60	77	69	93
OCT	29	69	43	65	40	54	106	-	79	105	150	182
NOV	99	71	104	88	63	48	2	-	127	109	208	269
DEC	101	169	98	156	52	76	-	-	92	211	200	204

From the analysis the following point are obtained

In Amaravati

- The AQI for Amaravati in the year 2019 is 70 therefore the air quality is satisfactory.
- The AQI for Amaravati in the year 2020 is 59 therefore the air quality is satisfactory.
- Associate health impact is it may cause minor breathing discomfort to sensitive people.In Rajahmundry
- The AQI for Rajahmundry in the year 2019 is 76 therefore the air quality is satisfactory.
- The AQI for Rajahmundry in the year 2020 is 63 therefore the air quality is satisfactory.
- Associate health impact is it may cause minor breathing discomfort to sensitive people.

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In Tirupati

- The AQI for Tirupati in the year 2019 is 61 therefore the air quality is satisfactory.
- Associate health impact is it may cause minor breathing discomfort to sensitive people.
- The AQI for Tirupati in the year 2020 is 47 therefore the air quality is good.
- Associate health impact is minimal for the year 2020.

In Vijayawada

- The AQI for Vijayawada in the year 2019 is 53 therefore the air quality is satisfactory.
- The AQI for Vijayawada in the year 2020, the required data was not available.
- The AQI in 2019 is maximum in the month of January [76, Satisfactory] and least in the month of November [2, Good].
- Associate health impact is it may cause minor breathing discomfort to sensitive people.

In Vizag

- The AQI for Vizag in the year 2019 is 113 therefore the air quality is moderate.
- The associate health impact is it may cause breathing discomfort to the people with lung disease such as asthma and discomfort to people with heart disease, children and older adults.
- The AQI for Vizag in the year 2020 is 96 therefore the air quality is satisfactory.
- Associate health impact is it may cause minor breathing discomfort to sensitive people.

In Delhi

- - The AQI for Delhi in the year 2019 is 147 therefore the air quality is moderate.
- The associate health impact is it may cause breathing discomfort to the people with lung disease such as asthma and discomfort to people with heart disease, children and older adults.
- The AQI for Delhi in the year 2020 is 139 therefore the air quality is moderate.
- The associate health impact is it may cause breathing discomfort to the people with lung disease such as asthma and discomfort to people with heart disease, children and older adults.

4.1 COMPARSION WITH DELHI

- As we can observe from the above discussion that, all the five cities taken from Andhra Pradesh have less AQI than Delhi.
- We can say that these cities have less pollution than Delhi.
- But, the AQI has very small difference in the comparison.
- So, mitigation measures have to be taken to reduce the pollution before it increases.

In the view of covid-19

- From the view of present scenario, we can observe that there is decrease in AQI in the months of lockdown and due to the virus breakout.
- While it is increased after the lockdown is released.
- From this we can observe that lockdown helped in decrease the pollution where the industrial and vehicular emissions are reduced.

5. CONCLUSION:

- From the above analysis, the ranking of the cities can be given

1. VISHAKAPATNAM
2. RAJAHMUNDRY

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3. AMRAVATHI
4. TIRUPATHI
5. VIJAYAWADA

- While comparing with Delhi the annual average of every city in Andhra Pradesh is less polluted thanDelhi .
- We can see that all the cities are in satisfactory and good level mostly and except few exceptions where the AQI was in moderate level when considered monthly.
- But, people have to follow some mitigation measures to reduce the pollution before it causes harm to the human, animal and plant life.

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